Platform-based Innovation Management

A Framework to Manage Open Innovation in Two-sided Platform Businesses

Von der Fakultät Konstruktions-, Produktions- und Fahrzeugtechnik
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Karlsruhe, im Dezember 2011

Simone Scholten

Affirmation

I declare that the work presented in this dissertation is, to the best of my knowledge and belief, original and that any ideas, techniques, quotations, or any other material from the published work of other people included in my dissertation are fully acknowledged in accordance with the standard referencing practices.

Simone Scholten

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1. Introduction

Global economy migrates from vertically integrated enterprises towards specialized enterprises interoperating to flexibly co-create end-to-end value. Step by step, these transformations alter traditional supply chains, while centering on customers and their need for individual end-to-end solutions (Basole et al., 2008; Kagermann et al., 2008; Heuser et al., 2007; Cherbakov et al., 2005; Li et al., 2002). As driving force of these business transformations, academic literature refers to the customers' demand for 'whole solutions' (Moore, 1999), individual product and service customization, speed and high levels of product and service quality - all in a seamless fashion and preferably from a single provider. This means that in many instances, customers will only use and continue using products and services, if their value preferences and criteria are met or even exceeded by the solution provider (Basole & Rouse, 2008). In addition, preferences change rapidly, driven by an increased demand for innovation, flexibility and shorter time-to-market (Cherbakov et al., 2005), whereas market requirements may even change while the solution is still under development (Iansiti & MacCormack, 1999). In consequence, corporate innovation efforts become riskier and more costly. In order to cope with these challenges while keeping the focus on core competencies and cost efficiencies, companies, i.e. in High Tech industry, are implementing open modular platform concepts. They enable them to create vibrant ecosystems of innovation around their offerings (Gawer & Cusumano, 2002; 2008; Evans et al., 2006, Chesbrough, 2003a). This process cannot be reduced to simple outsourcing decisions, but is part of renewed strategies of open innovation in an increasingly dynamic economic climate. Within this economic environment companies are forced to open their business models in order to gain competitive advantage by benefiting from the expertise of external partners, collaborative value creation, and the resulting pace of innovation outside the company borders (Chesbrough, 2006; 2007; Chesbrough & Crowther, 2006; Gassmann, 2006; Reichenwald & Piller, 2006).

Correspondingly, an increasing number of companies strives for 'platform leadership'. Platform leadership represents a company's strategic intentions to make its products or services "the foundation on which other companies build their products or offer their services" (Gawer & Cusumano, 2002: 6). This allows them to complement the platform's core value proposition and benefit from external innovation. The emerging platform ecosystem consisting of customers and autonomous partners complementing the core platform offer represents a collaborative arrangement that is actively shaped and controlled by the platform owner in a manner to co-create the platform's overall value proposition, extend its market reach and support its market adoption (Hagel & Brown,

2008). Leading examples refer to the platform ecosystems of Intel, Apple, SAP, eBay, Facebook or Salesforce that license their platform technologies to independent software vendors and application developers, while motivating them to complement the core platform value proposition. This trend is also visible in the automobile industry: One example refers to the BMW initiative of the Open Source development platform for the automobile industry, named GENIVI. It is expected that a common reference platform will be critical for the greater auto ecosystem to develop innovative and sophisticated in-car entertainment applications (Wülfing, 2009). Similarly, Volkswagen has opened up its infotainment system and allows external developers to create new software applications.

1.1. Research Motivation

Platform ecosystems represent a prime example of 'open innovation', enabling a single company to benefit from value creation outside the company's borders. Within the context of a platform leadership strategy (see section 3.2), opening up dedicated interfaces to external complementary resources, however, changes the company's business model from formerly being 'single-sided' to then being 'two-sided', indicating the number of markets the company now has to serve (see section 2.3.1). Per definition, 'two-sided platform businesses' are perceived as platform operating companies that have opened up their business model and dedicated platform interfaces to external complementary resources (Evans, 2004; Gawer & Cusumano, 2002; 2008). These organizations are targeted at motivating autonomous third party companies to complement the core platform value proposition to the customer. Correspondingly, the characteristic of two-sided platform businesses is the mediating role between two or more types of customers who are mutually dependent, and whose joint participation makes the platform valuable to each other (Evans et al., 2004).

Notably, two-sided platform businesses differ significantly in their economic rational and strategic behavior from non-platform businesses. Explicitly in platform competition, indirect network externalities become crucial to these businesses' success: They imply that the more buyers (customers) are attracted to a platform, the more valuable the platform becomes to sellers (complementing third party companies) and, consequently, the more sellers are attracted to it. In turn, the more sellers are offering innovative complementary products and services on top of the platform, the higher the variety and likelihood to match individual customer requirements (Rochet & Tirole, 2003). As a result, the broader the customer choice of complementary offerings on top of the platform is, the greater is the utility customers are able to derive from the platform and the greater the platform's profitability for the platform owner and its complementors (Caillaud & Jullien, 2003; Cusumano, 2008). In this context, empirical investigations, e.g. on the organization of

platform leadership (Gawer & Cusumano, 2002; 2008; Boudreau, 2006) have come to the conclusion that innovation outcomes are noticeably shaped by the opening of the platform to external development resources. In particular, the observation that platform owners such as Apple, Inc., Salesforce, Inc. or eBay, Inc. succeeded in mobilizing thousands of independent software vendors and application developers to build and innovate complementary applications on top of their platforms centers attention on the platform owner's managerial capabilities. Gawer & Cusumano (2002) conclude that stimulating and channeling external complementary innovations in order to exploit the dynamics of platform markets becomes a key to a platform's market success: "Platform leaders usually need to perform a delicate balancing act between competing and collaborating with complements producers, whose products [and services] are necessary to create demand for the platform" (Gawer & Cusumano, 2002: 10). These insights indicate that the management of innovational efforts in open modular platform contexts is no longer confined to the legal boundaries of an organization. This implies significant modifications to the platform owner's innovation management in order to achieve competitive advantage in dynamic platform environments (Scholten & Scholten, 2010).

Despite the importance of external complementary innovation for the platform's overall success (Teece, 1986; Gawer & Cusumano, 2002; 2008) as well as the growing interest in open innovation (Chesbrough, 2003a; Chesbrough et al., 2006), little light has yet been shed on the related open innovation processes and on the respective management control techniques to gain competitive advantage, ensure focus and value capture of open innovation efforts (Hagel & Brown, 2008). Explicitly, the peculiarities of managing an open innovation process in the context of a platform leadership strategy lack academic attention (Scholten & Scholten, 2010). "At a time, when increasing numbers of companies are focusing their businesses on areas, in which they have a distinct advantage and are growing more dependent on third parties to create complete solutions, excelling in strategically managing complementors could not be more important" (Yoffie & Kwak, 2006: 90). Similarly, Battaglia et al. (2004) add that successfully adopting a platform leadership strategy can lead to enhanced supplier management and customer satisfaction. However, suppliers, customers, and distributors are not the only partners with a potential to co-create value. "Companies, which independently provide complementary products or services directly to mutual customers […] can play an equally important role" (Yoffie & Kwak, 2006: 90).

1.2. Research Purpose

Given the strategic relevance of external complementary innovations for platform success, the present work seeks to further the understanding of managing open innovation in two-

sided platform businesses. With reference to Gawer & Cusumano (2002; 2008) it is argued that the capability to effectively steer external complementary innovation efforts within the context of a platform leadership strategy becomes critical to sustaining competitive advantage in platform markets. This is in line with Teece (1986) who states that the successful commercialization of an innovation requires know-how to be utilized in conjunction with complementary assets. In the present case of open modular platform concepts the innovation is characterized by its systemic nature. This means that an innovation to be successful requires adjustments to be made in other parts of the system (Chesbrough & Teece, 1996, Teece, 1986). Platform ecosystems, hence, need to be coordinated by the platform owner in order to provide and adjust complementary parts of the system in a cost efficient and scalable manner.

Against this background, the present work perceives platform ecosystems as strong, highly scalable business arrangements to leverage external complementary innovational efforts on top of a 'platform' (see section 2.1.1). Explicitly, it is argued that value creation two-sided platform businesses differs from the traditional supply chain approach as they entail at least a triangular set of relationships (see section 2.3.1). As a consequence, the innovation process becomes increasingly open and collaborative. Directing external complementary innovational efforts to co-create and deliver value, while ensuring the overall quality, reliability, and consistency of the platform-based solution, hence, turns out to become a primary challenge to innovation management. Major obstacles occurring in the pursuit of an innovation goal, however, emerge from the peculiarities of the platform ecosystem, being determined by the non-linear and autonomous behavior of interdependent third party companies, striving for own profitability (Scholten & Scholten, 2010).

Given the significant differences between platform and non-platform businesses, the present work claims that two-sided platform business models require the platform owner to implement a dedicated platform-based innovation management approach appropriate to managing value creation and capture in two-sided platform environments. Correspondingly, the research purpose of the present work is to:

- Explore the peculiarities of innovation management in two-sided platform businesses;
- Develop a platform-based innovation management framework that guides the platform owner in holistically managing open innovation efforts within the context of its platform leadership strategy.

With reference to the qualitative research method applied in this work, the research purpose represents the initial focus of inquiry to achieve depth of understanding. It will be further specified in chapter 2, leading to detailed research questions.

1.3. Research Method

The present inquiry follows the qualitative research method. Throughout academic literature, qualitative research is understood as "any kind of research that produces findings not arrived at by means of statistical procedures or other means of quantification" (Strauss & Corbin, 1990: 17). According to these authors as well as Myers (2009) the qualitative research method can be applied, when academia lacks an in-depth understanding of a certain topic. Therefore, the choice of the qualitative research method is justified due to the recent void of knowledge concerning the peculiarities of managing open innovation in two-sided platform businesses (see also section 3.5). Further, Fossey et al. (2002), Lincoln & Guba (1985) or Stiles (1999) argue that criteria to evaluate the quality of quantitative research base on (a) 'good practice' in the conduct of the research (methodological rigor) and (b) on the 'trustworthiness' of the interpretation of information gathered (interpretive rigor). In summary, a sound qualitative research requires a systematic and rigorous research design, data collection and analysis as well as a trustworthy interpretation and reporting of findings (Fossey et al., 2002). In the sequel, the aspects of methodological and interpretive rigor are explained within the context of the present work.

1.3.1. Methodological Rigor

Methodological rigor embraces a series of elements that, in combination with interpretive rigor (see section 1.3.2), determines the quality of the present study. These elements allow gathering an in-depth understanding of managing open innovation in two-sided platform businesses. They embrace the definition and refinement of research questions, data collection and data analysis:

- *Research Questions:* Within the context of 'good practice', Stiles (1999) claims that both the 'initial domain of inquiry' as well as the 'research questions' should be clearly and explicitly articulated. This enables the reader to understand the intentions of the respective work. Beyond, it enables the reader to evaluate the fit between these intentions and subsequent choices related to sampling, information-gathering, and analysis. In line with Stiles (1999), the research purpose in section 1.2 is broadly defined, providing the initial focus of inquiry to achieve depth of understanding. As the present work progresses and more information is gathered throughout chapter 2, the research purpose is further specified, leading to dedicated research questions in section 2.4). These questions, then, guide the inquiry to a more focused information gathering process throughout the state-of-the-art analysis in chapter 3. Fossey et al. (2002) characterize this approach as flexible and responsive to the research context. This means that the research issue evolves in response to the setting, data and its

analysis. This way, data collection, analysis and interpretation are related to each other in an iterative manner, rather than following one after another in a stepwise sequence.

- *Data Collection:* Guided by the research questions identified in chapter 2, the data collection process bases on primary as well as secondary data. Secondary data has been obtained through intense literature reviews in the intersecting area of 'platform management' and 'open innovation', targeted at obtaining a thorough and detailed understanding of recent academic findings on how to manage innovation in open modular platform contexts. Primary data, in turn, has been collected by means of semi-structured interviews, interactions with focus groups as well as by observing the processes and control mechanisms leading platform owners in the ICT industry have implemented to steer external complementary innovational efforts within the context of their platform leadership strategy. As recommended by Guba (1978), the decision to finalize the data collection process has been taken, once all relevant data sources have been considered and regularities appeared within the context of the research goals. The following sub-sections detail the applied approaches of data collection.

  (a) *Literature Review*: The literature review critically discusses current state-of-the-art research (Caulley, 1992), highlighting related shortcomings. This involves an intense literature search to identify publications and determine, which literature is relevant to the subject. For the present work, four literature streams have been considered relevant: (1) literature on a 'decentralized organization of systemic innovations'; (2) literature on 'platform leadership'; (3) literature on 'platform-based product and service development' and (4) literature on 'innovation strategy and management control'.

  (b) *Interviews*: In order to mitigate the risk of missing important aspects of the subject being explored, about 50 semi-structured interviews have been conducted within timeframe of the present work. These interviews further provided the basis for transferring the work's findings to a concrete platform setting (see chapter 6). The interview partners embraced senior executives, corporate strategists and innovation experts at SAP, eliciting the author's understanding of the challenges and requirements a leading platform owner in the ICT industry faces with regard to managing open innovation within the context of its platform leadership strategy.

  (c) *Observation*: In addition to these interviews, the observation method has been applied for data collection. At the example of purposefully selected 6 platform owners, insights have been gathered on how platform owners in the ICT industry are actually steering and sourcing external complementary innovation efforts within the context of their platform leadership strategy. The observational data

gathered has been used for the purpose of describing major sub-processes and decision gates as well as relevant means of managerial controls that enable platform owners to steer external complementary innovation efforts within the context of a platform leadership strategy.

- *Data Analysis*: Qualitative data analysis is understood as "working with data, organizing it, breaking it into manageable units, synthesizing it, searching for patterns, discovering, what is important and what is to be learned, and deciding what [to] tell others" (Bogdan & Biklen, 1982: 145). Within the present work, the process of data analysis embraces reviewing, synthesizing and interpreting the collected data in order to describe and explain the phenomenon under study. Therefore, the collected data has been analyzed in a stepwise approach: In a first step, the collected raw data has been reviewed from a neutral perspective in order to identify emerging themes. Then, the data has been categorized, addressing the challenges and requirements placed on innovation management in two-sided platform contexts (see section 4.4). In a third step, the insights gained have been aggregated, gradually modified and compared with Vahs & Burmester's (2002) widely accepted definition of innovation management. Taking this definition as guiding frame, finally, allowed formulating the primary tasks of innovation management in two-sided platform businesses (see section 5.1). These interpretations served as foundations for the development of the 'platform-based innovation management framework'.

1.3.2. Interpretive Rigor

Fossey et al. (2002), in line with Denzin & Lincoln (1994), emphasize that throughout a qualitative research study the interpretive process occurs at many points: First, beginning with making sense of what is read, heard and observed during the data gathering process. Secondly, when building an understanding concerning the interpretation of data and, third, by describing the findings. Thus, assessing the quality of qualitative research embraces, besides methodological rigor, demonstrating the trustworthiness of interpretations. Lincoln & Guba (1985) outline four criteria for assessing the trustworthiness of qualitative research:

- *Credibility to Establish Truth Value:* Truth value of research efforts is determined by assessing to which extent the findings of the qualitative study reflect the 'real world' described by the researcher. Thereby, credibility depends less on sample size than on the richness of the information gathered as well as on the analytical abilities of the researcher (Patton, 1990). According to Denzin (1978) as well as Patton (1990), credibility can be enhanced through 'triangulation of data', which can be categorized into four different types: First, methodological triangulation, meaning to use more than

one method to gather data. Secondly, data triangulation, involving time, space, and persons. Third, triangulation through multiple investigators, and, forth, theory triangulation, that means, using more than one theoretical scheme in the interpretation of the phenomenon. As indicated in section 1.3.1, the present work establishes truth value by applying the technique of 'methodological triangulation'. Therefore, multiple methods of gathering data have been applied throughout the data collection process, namely literature review as well as interview and observation techniques. This allows illuminating the research issue from different perspectives, mitigating the risk of missing importing aspects relevant to the research topic and increasing the credibility of research efforts.

- *Transferability to Prove Applicability:* The term 'applicability' is understood as the extent to which findings can be applied to other contexts and settings (De Vos, 1998). Concerning the transferability of findings in qualitative research, Lincoln & Guba (1985) admit that they cannot be specified or assessed by the researcher. Nevertheless, the researcher is able to provide sufficient information to be used by the reader to determine, whether the findings are applicable to the new situation. In order to prove the applicability of findings, the present work refers to Kefting (1991) who proposes a 'dense description' of both the research methodology as well as the transfer setting as an appropriate means to achieve applicability. While the research methodology is described in detail throughout this section, the transfer setting is described in chapter 6. Therein, the single case study approach has been applied. At the case of SAP's two-sided platform business the resulting requirements placed on innovation management (see section 4.4) have been evaluated. Finally, the findings of the present work have been applied to the case of SAP by developing and recommending a dedicated 'co-innovation' process model.
- *Dependability to Demonstrate Consistency*: The term 'consistency' concerns the extent to which the study can be replicated in a similar context, leading to the same results. Correspondingly, Tutty et al. (1996) consider demonstrating dependability as adequate strategy to ensure the consistency of research efforts. Within the present work, the dependability of findings has been achieved by a dense description of the applied research method as well as methodological triangulation, involving different data sources and data gathering methods. Additionally, consistency of findings has been attained by achieving consensus in discussions with two different focus groups. They consisted of senior executives, corporate strategists and innovation experts. In each of these groups, the author presented the identified challenges, implications and requirements placed on innovation management in two-sided platform businesses, the working definition of platform-based innovation management as well as the platform-

based innovation management framework, including the platform-based innovation process model. The succeeding discussions within each focus group revealed the participants' perception and requirements towards a 'platform-based innovation management'. They further entailed valuable feedback to the author's understanding of managing open innovation efforts within the context of a platform leadership strategy as well as concrete improvements of the platform-based innovation process model. Upon request of SAP's CEO, the author summarized her findings as a white paper to the SAP Board.

- *Confirmability to Show Neutrality*: As qualitative research relies on interpretations, it is frequently considered being subjective by nature (Lincoln & Guba, 1985; Eisner, 1991). In order to overcome the criticism that 'subjectivity' in research leads to results that are both unreliable and invalid, Patton (1990), in example, calls for qualitative research that is neutral. Phillips (1990), in turn, highlights that 'good' qualitative research is objective, in the sense that it has been opened up to criticism, and that the reasons and evidence offered have withstood serious scrutiny. He expects that these works have faced potential refutation, and insofar as they have withstood, they can be regarded as worthy of further investigation. In the present case, the confirmability of research findings has been achieved through intense discussions with the focus groups described earlier. Further, the transfer of research findings into SAP's solution management confirms the results.

1.4. Structure of the Dissertation

The present work has been structured according to the qualitative research method.

- *Chapter 1:* With regard to recent business transformations altering traditional supply chains, chapter 1 stresses the emergence of open modular platforms and the author's motivation for researching the peculiarities and requirements of managing open innovation in two-sided platform businesses. Further, chapter 1 explains the research purpose, complemented by the description of research method and the structure of the dissertation.
- *Chapter 2:* Academia emphasizes the importance of orchestrating external complementary innovational efforts for platform success, however, lacks explicit elaborations on innovation management in two-sided platform businesses. Following the qualitative research method, chapter 2 specifies the research purpose and identifies dedicated research questions that guide the succeeding state-of-the-art analysis in chapter 3.

- *Chapter 3:* Chapter 3 reviews state-of-the-art research in four research streams: (1) literature on a 'decentralized organization of systemic innovation'; (2) literature on 'platform leadership'; (3) literature on 'platform-based product and service development' and (4) literature on 'innovation strategy and management control'. The chapter closes with a critical discussion of state-of-the-art findings, leading to a comprehensive understanding of recent shortcomings in academic research.
- *Chapter 4:* In chapter 4, the challenges and requirements are derived that two-sided platform businesses place on innovation management. In a first phase, the elicitation process embraces a literature review to identify the business environmental characteristics that determine successful value creation in two-sided platform businesses. Then, the challenges and implications of two-sided platform businesses on innovation management are analyzed by means of expert interviews, focus group discussions and an observational study in the ICT industry. The chapter closes with a specification of requirements two-sided platform businesses place on managing open innovation in the context of a platform leadership strategy.
- *Chapter 5:* Based on the identified requirements two-sided platform businesses place on innovation management, the 'Platform-based Innovation Management Framework' is developed. It embraces a definition of 'platform-based innovation management' as well as three core elements: First, the 'Platform-based Innovation Management Cycle'; secondly, the 'Guiding Principles of Innovation Planning and Decision Making' and third, the 'Platform-based Control Model'. Interlinking these core elements allows modeling the 'Platform-based Innovation Process'. From the platform owner's perspective, the process model describes the flow of activities, control mechanisms as well as interactions with customers and complementors that guide the platform owner in orchestrating external complementary innovational efforts within the context of its platform leadership strategy.
- *Chapter 6:* Chapter 6 evaluates the quality of research findings, targeted at assessing and establishing their trustworthiness. By applying the single case study approach, the author is able to provide the reader with a 'dense description' of a concrete platform setting, in which to discuss and transfer the findings in order to establish the criteria of trustworthiness.
- *Chapter 7:* The conclusive view in chapter 7 forms the completion of this thesis. Therein, the research achievements gained throughout the present work are critically discussed, highlighting their contributions as well as restrictions. The chapter closes with suggestions for further research avenues.

Figure 1 depicts the structure of the present work.

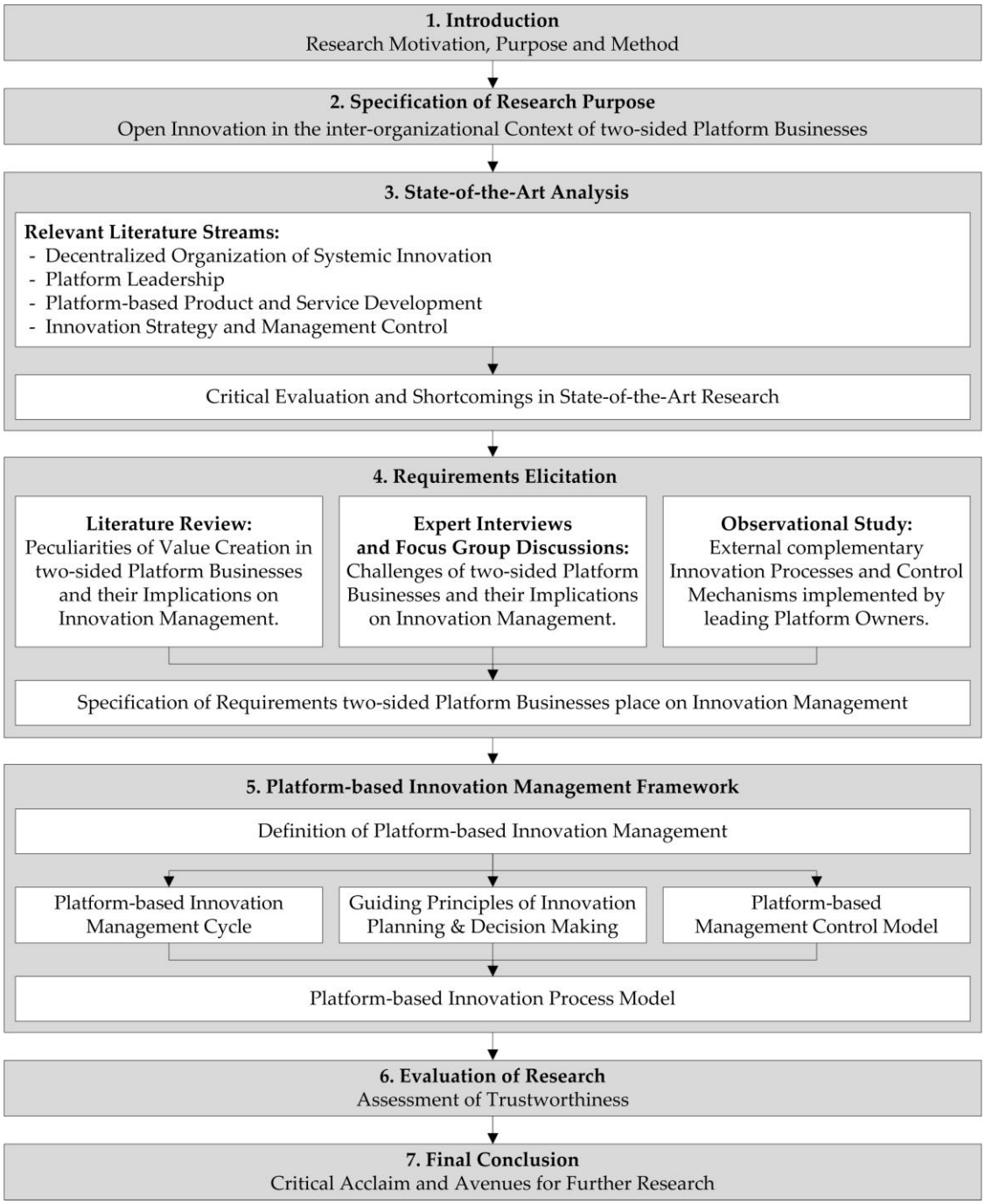


Figure 1: Structure of the Dissertation (own illustration)

1.5. List of Publications

Throughout the past years, major findings of the present work have been peer-reviewed in a double-blind manner and published in the frame of conference proceedings and journal articles. This way, they have been made available for a wider academic discussion.

Year	Publication
2011	Scholten, S. and Scholten, U. (2011). Platform-based Innovation Management: Directing External Innovational Efforts in Coopetive Platform Ecosystems. In: Journal of the Knowledge Economy of Springer. New York / Heidelberg: Springer Science and Business Media (in print).
2010	Scholten, S. and Scholten, U. (2010). Platform-based Innovation Management: Directing External Innovational Efforts in Complex Self-organizing Platform Ecosystems. In: Proceedings of PICMET Int. Conference. Portland: IEEE.
2010	Fischer, R., Scholten, U. and Scholten, S. (2010). A Reference Architecture for Feedback-based Control of Service Ecosystems. In: Proceeding of the 4th IEEE International Conference on Digital Ecosystems and Technologies (DEST), Dubai.
2009	Scholten, S. and Heuser, L. (2009). The Challenge of Steering Open Innovation applied at the Example of SAP Research. In: Proceedings of the TIM Forum. Stuttgart: Fraunhofer IAO.
2009	Scholten, S., Scholten, U. and Fischer, R. (2010). Composite Solutions for Consumer-Driven Supply Chains: How to Control the Service Ecosystem? In: Bogaschewsky, R., Eßig, M., Lasch, R. and Stölzle, W. (Eds.): Supply Management Research, Advanced Studies in Supply Management. Frankfurt/Main: Bundesverband Materialwirtschaft, Einkauf & Logistik.
2009	Fischer, R., Scholten, U., Scholten, S. and Tai, S. (2009). Information-based Control of Service-enabling Ecosystems. In: Proceedings of the ESBE'09 - International Workshop on Enabling Service Business Ecosystems, co-located with Mediterranean Conference on Information Systems (MCIS) 2009 in Athens. Online at: http://ceur-ws.org/Vol-530.
2007	Heuser, L., Lacher, S.; Perlmann, S. (2007). Flexible Prozessgestaltung als Basis innovativer Geschäftsmodelle. In: Oberweis et al. (eds): eOrganization: Service-, Process, Market Engineering, 8. Internationale Tagung Wirtschaftsinformatik (Band 1). Karlsruhe: Universitätsverlag.
2007	Heuser, L., Perlmann, S. and Lacher, S. (2007). Business Innovation im Mittelstand: Das Internet der Dienste als Wegbereiter einer Lean Service Innovation. In: Schuh, G. and Wiegand, B. (eds): Lean Management Summit, Laboratorium für Werkzeugmaschinen und Betriebslehre. RWTH Aachen.

2. Specification of Research Purpose

Given the shift to open modular platform concepts, this chapter specifies the research purpose indicated in section 1.2. In a first step, the key terms relevant to the present work are defined: They embrace: 'Platform', 'platform ecosystem', and 'platform strategy'. Section 2.2, then, explains the recent paradigm shift from closed to open innovation, highlighting the necessity to jointly create value. Next, section 2.3 explores the peculiarities of two-sided platform businesses that are relevant to managing open innovation within this context. Finally, section 2.4 derives the resulting research questions that guide the state-of-the-art analysis in chapter 3.

2.1. Key Terms and Definitions

Research on the emergence and peculiarities of platforms in the ICT industry has developed rapidly over the past years. Therein, three important research streams can be distinguished: First, the engineering-centric perspective focuses on product and service platforms that allow a sharing and reuse of common components and processes in order to develop families of products and services. The second research stream considers platform leadership as primary competitive advantage and explores its managerial and organizational consequences. Finally, research on the economics of open modular platform systems has emerged only recently, with focus on the economic implications of two- or multisided markets. Initially being considered separately, these research streams are now merging, widening the understanding of assets and drawbacks in platform strategy. In order to provide a common understanding of open modular platforms and their implications on innovation management, the following paragraphs introduces the relevant terms and definitions.

2.1.1. Platform

Corresponding to its wide application, the term 'platform' connotes different meanings. According to the research streams introduced above, Baldwin & Woodard (2009) have identified three distinct, but related fields throughout academic literature, wherein the term 'platform' has been used: Product and service development, technology strategy, and industrial economics. Throughout the first field, the term is applied to describe the platform-based development concept that enables companies to create new product and service generations or families. Within this research stream, a product platform is most commonly defined as a "set of subsystems and interfaces that form a common structure from which a stream of derivative products can be efficiently developed and produced" (Meyer & Lehnerd, 1997: 39). The second research stream considers platforms as valuable

points of control and rent extraction in an industry (Baldwin & Woodard, 2009). Explicitly, Gawer (2009: 3-4) defines a platform as "a building block, which can be a product, a technology, or a service that acts as a foundation upon which other firms can develop complementary products, technologies or services". Finally, industrial economics examines focal platforms in their ability to connect, mediate and coordinate between two or multiple groups of platform users, also referred to as platform sides (see section 2.3.1). Within the economic context of two-sided platforms, a platform is understood as a means of providing the "infrastructure and rules that facilitate the (multiple) groups' transactions […]. Worth noticing is that in some cases, platforms rely on physical products, as with customers' credit cards and merchants' authorization terminals. In other cases, they are places providing services, like shopping malls or Web sites such as Monster and eBay" (Eisenmann et al., 2006: 94). Platforms as conceived of by Boudreau (2008) and Parker & Van Alstyne (2008) are "components used in common across a product family, whose functionality can be extended by applications". They encompass the set of components and rules employed in common in most user transactions (Boudreau, 2008). Given these multiple definitions, the present work adopts the definition as proposed by Gawer (2009), while considering its economic implications.

2.1.2. Platform Ecosystem

The ecosystem construct, as a way of making interdependencies more explicit, has gained prominence in business strategy (e.g. Moore, 1993; Iansiti & Levien, 2004; Adner, 2006). These approaches are targeted at understanding coordination among partners in exchange networks that are characterized by simultaneous cooperation and competition (Brandenburger & Nalebuff, 1996). Platform ecosystems are considered as platform-based value constellations as defined by Normann & Ramirez (1993): According to them, value constellations are inter-organizational networks that link firms with different assets and competencies together in response to or in anticipation of new market opportunities. These value constellations create value for a targeted customer groups. Platform ecosystems are assembled by a platform owner who serves as gate-keeper, while deciding who to participate in the platform ecosystem. The platform owner, in turn, is understood as the firm that owns the core platform and defines its forward evolution. The resulting relationship between the platform owner and other complementary third party firms is considered as being that between an incumbent monopolist and an actual or potential competitor in other complementary markets (Cusumano & Gawer, 2002). Consequently, the platform owner has to define fundamental governance processes to coordinate activities within the platform ecosystem. These activities are characteristically organized in modular, loosely coupled processes, providing the participants with high degrees of freedom, while defining dedicated interfaces (Hagel & Brown, 2008).

Throughout the present work, platform ecosystems are perceived as particularly powerful means of open innovation, designed to leverage the potential of distributed innovation activities pursued by hundreds or thousands of platform ecosystem participants. The distinctive innovation power of platform ecosystems, hence, emerges from the peculiarities of platform ecosystems, being determined by the non-linear and autonomous behavior of interdependent participants, striving for profit maximization.

2.1.3. Platform Strategy

The term 'strategy', is commonly understood as a strategic plan or intention to achieve a dedicated goal. Mintzberg (1994) describes a strategy as a plan or a means of getting from here to there. Porter (1986; 1996) refers to the term as both a plan as well as a position. He argues that strategy is about a company's competitive position, about differentiating in the eyes of the customer, and about adding value through a mix of activities different from those used by competitors. Henderson (1991) considers strategy as the deliberate search for a plan of action to develop a business' competitive advantage. From an engineering-centric perspective, Meyer & Lehnerd (1997) depict a 'platform strategy' as a top-down planning approach, serving to maximize market leverage from a common technology. Platform strategy, thereby, serves as the foundation of product or service strategy, defining the cost structure, capabilities and differentiation of the resulting products (Robertson & Ulrich, 1998; McGrath, 2001; Meyer & DeTore, 2001). Following De Weck et al. (2003), the purpose of implementing a platform strategy is to reduce development time and costs, while maximizing market share and profit. It embraces the systematic bundling of product or service inherent elements as well as the management of the platform within a long-term roadmap. In summary, a platform strategy can be understood as a company's effort to improve customization, while maintaining economies of scale and scope within their manufacturing or development processes. Gains in efficiency and effectiveness are achieved by providing sufficient product and service variety based upon one or more product or service platforms, serving as the foundation of each product or service in the family (Meyer & Lehnerd, 1997). Platform-based product or service development, therefore, is founded upon the principles of modularity and enables companies to build complex products and services from smaller sub-systems that can be designed independently, yet function together as a whole (Baldwin & Clark, 2000).

Throughout this thesis, the opening of dedicated platform interfaces to complementary third party resources is perceived as the logical consequence of this concept, aiming at accelerating the pace of innovation, while balancing the trade-off between appropriating the returns from innovation and platform adoption.

2.2. Paradigm of Open Innovation

Based on the solid understanding of the key terms, the following sections explain the paradigm shift from closed to open innovation and the resulting coordination requirements on the strategic and operational innovation management level. It results that the manner of value creation and capture in open innovation constellations is of particular importance for the management of open innovation efforts (Vanhaverbeke & Cloodt, 2006).

2.2.1. Open Innovation

Throughout the past decades, a considerable amount of literature has accumulated on the subject of innovation, widely perceiving innovation as a major source of a company's sustainable competitive advantage in increasingly saturated markets (Drucker, 1985; Christensen, 1997; Thomke, 2001). Hence, the term 'innovation' lacks a single commonly accepted definition (Adams et al., 2006). The term itself originates from the Latin 'innovare', which means to make something new. Correspondingly, Van de Ven (1986: 591) defines innovation as the "development and implementation of new ideas by people who over time engage in transactions with others in an institutional context". Similarly, Ernst (2001) defines innovation as the conception of an idea up to the introduction of an invention into the market. Garcia & Catalone (2002: 112) define innovation in more detail as "an iterative process initiated by the perception of a new market and/or new service opportunity for a technology-based invention, which leads to development, production, and marketing tasks, striving for the commercial success of the invention". In summary, a successful innovation is considered as an innovation "that returns the original investment in its development plus some additional returns" (Burgelman et al., 2009: 2).

The term 'open innovation', in turn, builds upon these definitions, but rather describes the innovation model as depicted in figure 2. Open innovation is defined as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for the external use of innovation, respectively" (Chesbrough, 2006: 1). Similarly, West et al. (2006: 286) describe open innovation as "both a set of practices for profiting from innovation and also a cognitive model for creating, interpreting and researching those practices". While Chesbrough (2003a) primarily refers to the activities of incorporating technology, licensing technology to others, and launching new ventures to exploit new technologies, Hagel & Brown (2008) add that many different kinds of initiatives fall under the rubric of open innovation. Exemplarily they refer to activities like scanning the external environment for ideas; reaching out to a specialist on a contract basis to solve a particularly vexing research problem; forming a joint venture; licensing technology from a university; or participating in broad networks to coordinate innovation activity. Gassmann & Enkel (2004) suggest further examples of practicing open innovation, such as customer

and supplier integration; listening posts as innovation clusters; applying innovation across industries; buying intellectual properties and investing in global knowledge creation. As such, the open innovation paradigm goes beyond leveraging external sources of innovation, e.g. customers, competitors, and universities and is as much a change in the use, management, and employment of intellectual property (IP) as it is in the technical and research driven generation of IP (Chesbrough, 2003a).

In explaining the new paradigm, Chesbrough (2003a) refers to multiple factors, indicating a shift in how innovation is managed. In particular, he claims that useful knowledge has become widely diffused and companies do not take full advantage of the wealth of information. By emphasizing the importance of the business model that determines the value of an idea or a technology, he emphasizes the increasing presence of venture capitalists and intermediary markets, enabling companies to become active sellers and buyers of IP. These insights led to the development of the open innovation model depicted in figure 2.

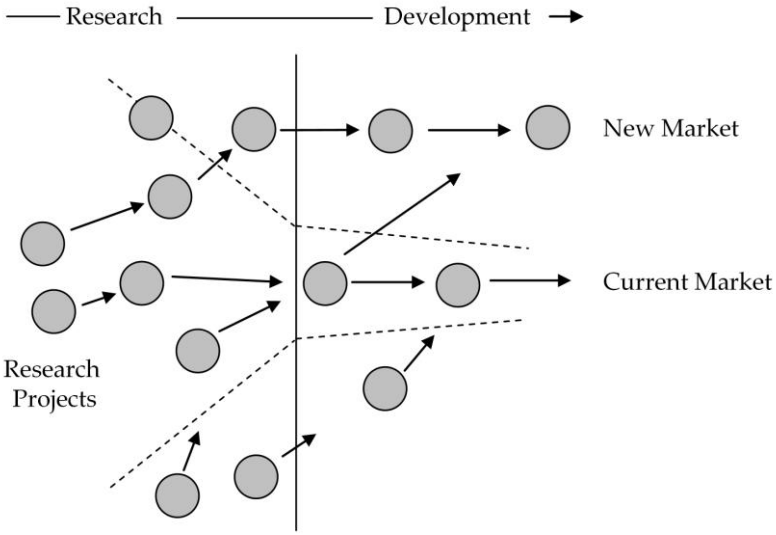


Figure 2: The Open Innovation Model (Chesbrough, 2003a)

Chesbrough (2003a) highlights that the primary rationale of open innovation lies in a competitive disadvantage for companies that still pursue the old paradigm of closed innovation. This indicates that companies do not take the full advantage of the wealth of information available outside the company and are causing wasteful duplications of innovative efforts. This makes internal research and development (R&D) efforts slower to achieve results, and less productive. Companies, thus, are requested not to restrict the internal research function exclusively on inventing new knowledge, but also to assess and integrate external knowledge. In result, the new rational for internal R&D changes towards the capabilities of (Chesbrough, 2003a):

- Identifying, understanding, selecting from, and connecting to the wealth of available external knowledge;
- Filling the missing pieces of knowledge, which cannot be sourced externally;
- Integrating external and internal knowledge;
- Generating additional revenues and profits from selling research outputs to others.

Chesbrough (2003a) concludes that the key challenge for companies remains to figure out, which parts to supply internally and how to integrate external and internal pieces into systems and architectures. In this regard, a respectively phrased business model provides a suitable framework to link technical decisions with economic outcomes.

2.2.2. Archetypes of Open Innovation Processes

Within the paradigm of open innovation, co-development partnerships are of strategic importance as they are almost by definition related to the establishment of ties between innovating firms (Chesbrough & Schwartz, 2007; Vanhaverbeke, 2006). Thereby, the major difference of open innovation efforts to traditional outsourcing processes of innovative capacity is that outside partners are as peers and not as suppliers (Chiaromonte, 2006). Consequently, open innovation networks co-produce value. This leads to the main characteristic of the open innovation paradigm: Innovation processes are distributed among a larger number of actors and do not necessarily take place within the boundaries of a firm. Some authors refer to this as a boundary spanning activity, others describe the borders of the firm as increasingly permeable (e.g. Jacobides & Billinger, 2006; Gassmann & Enkel, 2004).

Despite a large body of literature on open innovation, little has been said on how the process of innovation actually takes place (Fredberg et al., 2008). Gassmann & Enkel (2004) claim that companies are systematically interacting with external innovation sources. Therefore, the locus of innovation - in terms of applying the idea and transforming it into an innovation - is de-coupled from the locus of knowledge creation as well as from the locus of commercialization. In result, Gassmann & Enkel (2004) distinguish three core open innovation processes:

- *The outside-in process:* Enriching the company's own knowledge base through the integration of suppliers, customers and external knowledge sourcing can increase a company's innovativeness;
- *The inside-out process:* Earning profits by bringing ideas to market, selling IP and multiplying technology by transferring ideas to the outside environment;

- *The coupled process:* Coupling the outside-in and inside-out processes by working in alliances with complementary partners.

While not being equally important for every company, each company chooses one primary process, and integrates dedicated elements of the others. Figure 3 represents the archetypes of open innovation processes as proposed by Gassmann & Enkel (2004):

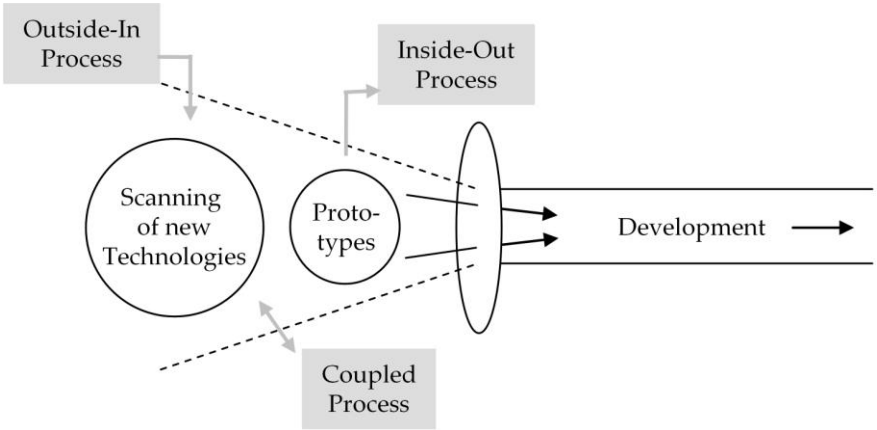


Figure 3: Three Archetypes of Open Innovation Processes (Gassmann & Enkel, 2004)

In line with these authors, Fredberg et al. (2008) conclude that the innovation processes of a firm need to be adapted to the changing characteristics of open innovation activities. In particular, when the innovation process becomes shared between larger numbers of actors, hierarchical modes of coordination seem to be no longer sufficient and require other coordination mechanisms. Recent management and leadership practices, however, make it difficult to harness the full potential of open innovation. As a reason, Hagel & Brown (2008) state that institutions have largely been organized around push models of resource mobilization and on top down models of direction within a framework of compensation and advancement policies specific to that institution.

2.2.3. Management of Open Innovation

Throughout innovation literature, innovation management is defined as the activity of systematically planning, implementing, directing and controlling an organization's innovation activities for the purpose of an efficient and effective realization of innovative ideas (Vahs & Burmester, 2002). In line with this definition, Hauschildt & Salomo (2007) emphasize the dispositive modeling of innovation processes as the primary task of innovation management. Nevertheless, while recent innovation management literature predominantly considers managing the innovation process within the company's boundaries, the paradigm shift to open innovation assumes that value is co-created and appropriated between partners. This implies that the total value created in a network is

dependent on (a) how well the partner's objectives are aligned to each other and (b) on the commitment of partners to invest in complementary assets and offerings (Teece, 1986; Moore, 1991; Vanhaverbeke, 2006).

In result, today's common perception of innovation management is based on the companies' need to open up their innovation processes and combine internally and externally developed technologies to create business value (Bieger & Beltz, 2000; Bernet, 2000; Chesbrough et al., 2006). Useful knowledge is widely disseminated, and so ideas must be used with alacrity. This environment creates a new logic of open innovation, in which innovation processes are characterized by the exploration of opportunities for new and improved products, processes and services outside the boundaries of the enterprise. This fundamental change offers novel ways to create value along with new opportunities to claim portions of that value. However, the existence of external knowledge provides no benefits to the firm unless the firm is able to identify, extract and incorporate its relevant parts. This requires scanning, absorptive capacity, and also the political willingness to incorporate external innovation (Chesbrough, 2003a; Chesbrough et al., 2006). Additionally, these processes as well as the corresponding innovational efforts need to be coordinated both at a strategic as well as on an operational level in order to provide competitive advantage (Teece et al., 1997; Specht & Möhrle, 2002; Hauschildt & Salomo, 2007). Correspondingly, winners in the global marketplace are frequently those companies that can demonstrate timely responsiveness as well as rapid and flexible innovation, coupled with the management capability to effectively coordinate and redeploy internal and external competencies. Teece et al. (1997: 516) refer to this ability as 'dynamic capabilities', defined as "the firm's ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments". In this regard, the term 'capabilities' emphasizes "the key role of strategic management in appropriately adapting, integrating, and reconfiguring internal and external organizational skills, resources, and functional competences to match the requirements of a changing environment" (Teece et al., 1997: 515).

From the perspective of managing open innovation Vanhaverbeke & Cloodt (2006) claim that understanding how value is created and captured in open innovation constellations is crucial. These authors emphasize the importance of interdependencies between companies and claim the necessity of a comprehensive framework, providing a general guideline of how to manage a value constellation. With reference to Iansiti & Levien (2004), they further remark that the value constellation has to be structured and managed in a manner to optimize joint value, while agreements are necessary to share jointly created value.

Boudreau & Lakhani (2009) question whether open innovation efforts should be organized and managed as 'collaborative community' or as 'competitive market'. Both forms significantly differ. While collaborative communities, e.g. in the open source movement, are governed loosely by social norms and rather soft rules to encourage open access to information, transparency or joint development efforts, competitive markets are strikingly different. Therein, external developers create multiple competing varieties of complementary goods, components or services to provide customers or customers with the choice from different offerings. Correspondingly, the authors conclude that members in communities are oriented toward the intrinsic motivation of being part of a larger initiative. Markets, in turn, tend to reward extrinsic motivations, e.g., through financial compensation. In order to choose the appropriate organizational form, companies, hence, have to consider three issues (Boudreau & Lakhani, 2009):

- *The Type of Innovation to be shifted to External Innovators*: Collaborative communities provide considerable advantages, in particularly, when the innovation challenge involves cumulative knowledge, continually building on past advances. In turn, if the innovational challenge is best solved by a broad experimentation across a set of technical approaches, competitive markets are of advantage. Therein, participants have strong financial incentives to differentiate from each other by searching and protecting novel solutions rather than sharing knowledge. Competitive markets, hence, support a heterogeneity targeted at approaching an innovational challenges from different perspectives.
- *The Motivations of External Innovators*: The differing characteristics of collaborative communities and competitive markets are primarily caused by the differing motivations of the participating members: Intrinsic and extrinsic motivations. Extrinsic motivations embrace financial aspects, such as a direct return on investment. They resolve from gaining dedicated benefits, such as access to information, acquisition of skills, or access to customers or customers alike. In turn, participants in collaborative communities are often motivated by intrinsic considerations, such as the enjoyment of an innovational task or the feeling of being part of a larger cause. Given the diversity of motivations, companies striving to open up to external innovation resources need to consider, which organizational approach to devote to their innovation process. In particularly, markets require the implementation of formal and competitive mechanisms to motivate profit-seeking individuals.
- *The Nature of the Platform Business Model*: Opening up dedicated platform interfaces to external development resources transforms the former product into a platform (see also section 2.1.1). Consequently, the nature of the respective business model determines the

platform owner's revenue generation from the platform. Fundamentally, platform business models are differentiated into three categories: The integrated, the product and the two-sided platform business model: In the integrator platform model, the company integrates external innovations and sells the final product to customers. In the product platform model, external innovators build on the platform and sell the resulting products to customers. Finally, in the two-sided platform model, external innovators and customers are enabled to transact, while transactions are facilitated, governed and mediated by the platform owner (see also section 2.3.1).

In summary, Boudreau & Lakhani (2009) claim that a company, when opening up to external development resources, should ensure that both the motivations of the innovators as well as the business model of the platform are conform to the nature of its innovation.

2.3. Open Innovation in two-sided Platform Businesses

Based upon the brief overview on open innovation, the following section focuses on two-sided platform business models and the resulting questions concerning the management of open innovation. In a first step the characteristics of 'two-sided platform businesses' are explained. Then, the implications of indirect network externalities on a platform's market adoption are explored. Finally, the focus has been set on the phenomenon of 'coopetition' in two-sided platform businesses, describing the relationships between platform owner and third party companies. The chapter closes with the identification of resulting research questions.

2.3.1. Two-sided Platform Businesses

Two-sided platform businesses are perceived as platform operating companies that attract at least two user groups in order to create value by mediating them through the platform (Evans et al., 2006). Frequent examples refer to platform owners in eBusiness, operating e.g. web portals or Internet search engines that are connecting viewers and advertisers; auction sites like eBay, connecting sellers and buyers; payment systems such as PayPal, connecting cardholder and merchants; videogame consoles and other software platforms, connecting gamers or software users and application developers (Evans, 2003a). Economic research on two-sided platforms concludes that two-sided platform businesses may arise in any situation, where externalities and transactions costs prevent the platform user groups from solving this externality directly (Rochet & Tirole, 2003; Evans, 2003b; Roson, 2005; Armstrong, 2006).

Within two-sided platform business models a focal platform represents the centerpiece of value creation. Hence, value can only be obtained through a platform intermediating supply and demand between two platform user groups. In contrast to the traditional supply

chain, transactions in two-sided platform businesses entail at least a triangular set of relationships (see figure 4). Therein, the focal platform owner mediates the platform users' interactions, while setting rules such as protocols, rights, and pricing terms to govern transactions (Eisenmann et al., 2006; 2008). Surplus is created whenever these groups interact, so that market success depends upon how well the platform attracts custom from its user groups (Armstrong, 2006). Correspondingly, economic research considers complementing partners and customers each as a separate platform end-user group. Figure 4 provides a simplified perspective on platform-based end-user interactions.

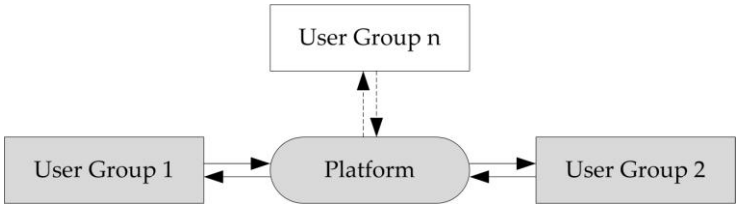


Figure 4: End-user Interaction in Platform Businesses (Evans, 2003a)

The principle setting of two or multiple end-user groups of agents interacting with each other through a common platform is characteristic of two-sided platform businesses. They cause distinct demand patterns of elasticity and platform competition. Economic research, therefore, considers each platform end-user group as separate market, leading to two-sided platform markets. These markets are understood as two-sided, when (Rochet & Tirole, 2003; Chakravorti & Roson, 2006; Church & Gandal, 2008):

- A third party attracts different groups (e.g. customers, product suppliers, advertisers) to different sides of a platform;
- The value obtained by one kind of user increases with the number of the other kind of user due to indirect network externalities being inherent to platform markets; and
- An intermediary is necessary for internalizing the externalities created by one group for the other group.

As a result, two-sided platform businesses differ from traditional single-sided organizations in respect to the amount of markets they serve and for which they have to generate demand (Evans, 2003a).

Platform revenue, in turn, emerges from trade in interactions between the platform's end-users. An interaction, for example, occurs when a buyer, e.g. a platform user uses an application provided by a seller, e.g. an application developer (Rochet & Tirole, 2008). Considering the case that both platform end-users, the buyer and the seller, connect directly

to the platform and not through intermediaries or complementors, the platform owner is able to directly charge both platform user sides dedicated platform access or usage fees.

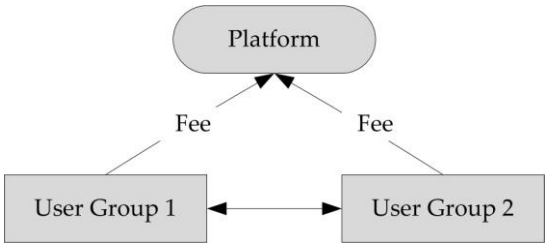


Figure 5: Sources of Platform Revenue (Evans, 2003a)

Two-sided platform businesses, characteristically, sell different products or services to the different sides. They, therefore, face differing demand curves, each depending on the quality-adjusted quantity purchased on the other sides (Evans, 2003a). Economic research on two-sided markets, hence, focuses on investigating the fees to charge each platform side in order to promote platform adoption. Results imply that the gain from trade between the parties generated by the interaction depends only on the total charge levied by the platform owner. This requires a distinction between (a) the price level, defined as the total price charged by the platform to the two sides, and (b) the price structure, understood as the decomposition or allocation of the total price between the buyer and the seller. A platform's price levels are particularly determined by demand elasticity and platform competition, while standard pricing rules may not apply to each side, separately (Rochet & Tirole, 2008). Thereby, the platform's price structure and related profit margin are influenced by the platform owner's goal of profit maximization, platform competition as well as a connection of agents to multiple platforms (multihoming). These interdependences create downward pressure on prices on both sides of the market, while increasing customer welfare (Rochet & Tirole, 2008; Chakravorti & Roson, 2006). These effects are caused by positive indirect network externalities: This means that in platform competition, the elasticity of buyers' demand for a given platform increases, due to their ability to choose and switch to a competing platform. This leads to lower buyers fees and increased buyer welfare. Buyer welfare, again, determines the market size and, therefore, seller utility increases, as more buyers will be active on the market. As a result, the competitive equilibrium is characterized by lower aggregated prices (Rochet & Tirole, 2003). This leads to significant market economic implications for the firm.

2.3.2. Implications of Indirect Network Externalities on Platform Adoption

As already indicated above, network externalities are inherent to two-sided markets and determine a platform's market adoption (e.g. Rochet & Tirole, 2003; Armstrong, 2006). Academic research claims that networks exhibit externalities in that the production or consumption activities of one party connected to the network have an effect on the production or utility functions of other participants in the network (Katz & Shapiro, 1985; Shapiro & Varian, 1999). This effect is principally not transmitted through the price mechanism. Correspondingly, network externalities are defined as positive consumption externalities, in which "the utility that a user derives from consumption of the good increases with the number of other agents consuming the good" (Katz & Shapiro, 1985: 424). David (1985), Farrell & Saloner (1985), and Economides (1996) provide evidence that the demand for a network good is a function of both its price and the expected size of the network. Correspondingly, networks exhibit positive consumption and production externalities (Economides, 1996). This means that a positive or network externality implies that the value of a unit of good increases with the (expected) number of units sold. Thereby, the key reason for the appearance of network externalities is the complementarity between the components of a network.

In two-sided platform markets, however, the difference between direct and indirect network externalities is relevant. Figure 6 exemplifies them graphically.

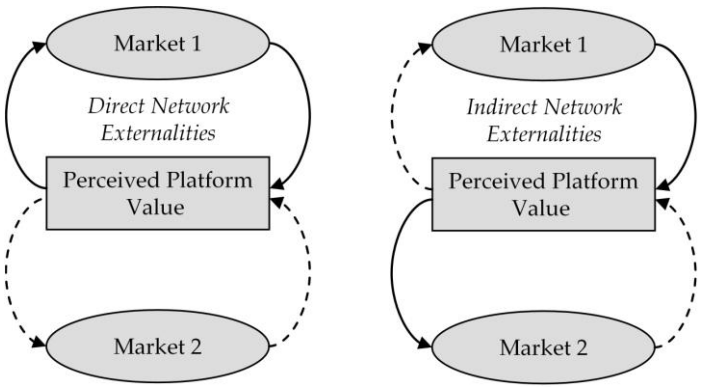


Figure 6: Direct and Indirect Network Externalities in Two-sided Markets (own illustration)

Principally, network externalities are direct, once customers are identified with components, such as in the case of a typical two-way network (local telephone network). "In this n-component network, there are n(n-1) potential goods. An additional (n+1th) customer provides direct externalities to all other customers in the network by adding 2n potential new goods through the provision of a complementary link to the existing links. When there are m varieties of component A and n varieties of component B (and all A-type

goods are compatible with all B-type), there are mn potential composite goods. An extra customer yields indirect externalities to other customers, by increasing the demand for components of types A and B and, thereby, (because of the presence of economies of scale) potentially increasing the number of varieties of each component that are available in the market" (Economides, 1996: 6-7).

In turn, when the network effect is indirect, consumption benefits do not depend directly on the total number of customers who purchase compatible products, but on the number of third party companies providing complementary products and services (Church & Gandal, 2008). Besides the critical mass embracing a significant number of users on both sides of the platform, platform adoption in two-sided markets is explicitly driven by the inherent quality and functions of the platform as well as by the variety of applications that are compatible to the platform (Economides, 2005). It implies that the more buyers are attracted to a platform, the more valuable the platform becomes to sellers and, consequently, the more sellers are attracted to it (Rochet & Tirole, 2003). In turn, the more sellers are offering innovative complementary products and services on top of the platform, the higher the variety and the likelihood to match individual customer requirements. In result, the broader the customer choice of components on top of the platform is the greater is the utility customers are able to derive from the platform (Caillaud & Jullien, 2003; Cusumano, 2008) and the greater the platform's profitability for the platform owner and its complementing partners. This dynamic, in turn, causes more customers to adopt the platform and more complementors to enter the platform ecosystem (Cusumano, 2008).

2.3.3. Coopetition in two-sided Platform Businesses

From an organizational perspective, two-sided platform businesses represent hybrid organizational forms of organizing transactions and interactions between a platform owner and external autonomous partners, supplying complementary products and services. According to Transaction Cost Economics, hybrid organizational forms are characterized as intermediate arrangements, acting in between a free market with the mechanics of supply and demand at its core and the role of prices as the key to adaptation, and the central hierarchy of a firm in making decisions and adjusting them (Williamson, 1979). Particularly, in competitive markets, these organizational forms are chosen as markets are perceived as being unable to adequately bundle the required resources and capabilities (Teece & Pisano, 1994), while integration in a hierarchy would reduce flexibility by creating irreversibility and weakening incentives. Thus, hybrid arrangements such as two-sided platform businesses are systematically oriented towards organizing activities through inter-firm coordination and cooperation, while mixing the characteristics of an integrated firm with the characteristics of a network (Ménard, 2004). Correspondingly, hybrid organizations

require both long term incentives to align and motivate participants as well as new management approaches, i.e.: appropriate ways of coordination within the hybrid organization; a balance of local innovation with global integration; design effective interfaces and action points; and finally, useful performance feedback loops (Hagel & Brown, 2008).

The relationship between platform owner and individual complementors as well as the relationships between individual complementors within the platform ecosystem are characterized by a phenomenon termed 'coopetition' (Brandenburger & Nalebuff, 1996), coined to describe 'cooperative competition'. This term indicates that the participants of a platform ecosystem compete against each other, whilst at the same time cooperating in other areas. Figure 7 represents the setting of coopetition.

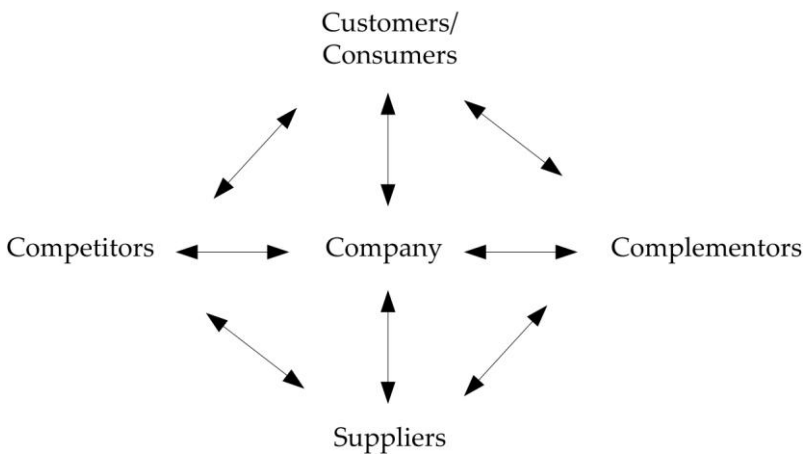


Figure 7: Coopetition in Value Nets (Brandenburger & Nalebuff, 1996)

The duality in relationships leads to win-win and win-lose interactions: The success of most businesses is dependent on the success of others. Yet, they have to compete in order to capture value created in the market and protect their own interests. As a result, in highly competitive environments, competitors can emerge 'over night' from unexpected places, such as traditionally non-competing industries. Besides internal coopetition, platform ecosystems compete against other platform ecosystems. As pooling resources is considered crucial to dealing with market and technology uncertainties, sustaining partnerships and preventing partners from joining competing platform ecosystems is a key issue for hybrid organizations (Ménard, 2004; Cusumano, 2008).

2.4. Resulting Research Questions

The economics of platform markets represent dedicated challenges to the establishment of a successful two-sided platform business. The platform owner's primary challenge, thereby, lies in exploiting indirect network externalities. This requires platform owners to manage and sustain a continuous supply of external innovative complementary products and services (Gawer & Cusumano, 2002) to secure the profitability of their investments into an open modular platform concept. Thus, the platform owner's behavior is characterized by its intention to (a) convince users on both platform sides to use the platform and (b) to carefully balance their two demands as demand on each side vanishes if there is no demand on the other side (Evans, 2002). In summary, a platform's market success and profitability critically depends on the platform owner's ability to strategically orchestrate a value net of complementary innovation resources and capabilities (Scholten & Scholten, 2010). These insights reveal the following research questions:

- How shall a platform owner holistically manage internal and external innovational efforts within the context of its platform leadership strategy?
- How shall a platform owner decide, which innovational efforts to pursue internally and which to steer within the platform ecosystem?
- How shall a platform owner stimulate and control the supply of external complementary innovational efforts in a platform ecosystem of autonomous, however, mutually interdependent partners, striving for own profitability?
- How shall a platform owner model the open innovation process in order to coherently evolve the core platform and platform ecosystem to provide the customer with an adequate variety of high-quality complements?

3. State-of-the-Art Analysis

Previous sections have brought to the fore the significance of integrating external complementary innovations into the platform's innovation process in order to gain competitive advantage in platform competition. These results are in line with Teece's (1986) seminal work on complementary assets as well as with strategy research on innovation appropriation that emphasizes the importance of the ownership of specialized downstream capabilities (e.g. Gans & Stern, 2003; Rothaermel & Hill, 2005; Arora & Ceccagnoli, 2006; Ceccagnoli & Rothaermel, 2008). With dedicated focus on open modular platform concepts, Gawer & Cusumano (2002; 2008) further emphasize the importance of complementary innovations for platform leadership. They explicitly highlight the platform owner's strategic challenge of encouraging the provision of complementary products and services in order to continuously evolve the platform and take advantage of indirect network effects (Shapiro & Varian, 1999; Rochet & Tirole, 2003; Gawer & Cusumano, 2002). Considering the nature of innovations in open modular platform concepts, Chesbrough & Teece (1996) as well as Chesbrough (2003b) emphasize the innovation type of 'systemic innovation'. This innovation type embraces innovations, whose benefits can be realized only in conjunction with related, complementary innovations. As shown in chapter 2, it is explicitly the systemic nature of innovations that challenges platform owners: Due to their dependency on external partners to complement the core platform value proposition, platform owners have to balance interest between appropriating returns from innovation and a wide platform adoption (Gawer & Cusumano, 2002). Hence, the question, which complementary innovation efforts to pursue internally and which to leave to external complementing resources centers the attention of the platform owner. In addition the systemic nature of 'platform innovations' (Sawhney et al., 2006; Chesbrough, 2003b) requires the platform owner to orchestrate external complementary innovational efforts within the context of their platform leadership strategy (Scholten & Scholten, 2010). Particular tensions, however, evolve between the developers of complementary products or services and the platform owner due to the risk that the latter might eventually compete in the partner's market space (Gawer & Henderson, 2007).

Against this background, the purpose of the succeeding state-of-the-art analysis is to obtain a thorough and detailed understanding of recent academic findings on how to manage innovation in two-sided platform businesses, i.e. on how to steer external complementary innovation in the strategic context of platform leadership. Yet, academic literature on innovation management has proposed numerous frameworks and processes targeted at managing innovation within the company (e.g. Kline & Rosenberg, 1986; Wheelwright & Clark 1992; Seidel & Bullinger, 1994; Brockhoff, 1999; Cooper, 2002; Vahs & Burmester,

2002). However, research on open innovation lacks precise innovation process models to manage open innovation efforts both on a company as well as on an inter-organizational level (Hagel & Brown, 2008).

Guided by the research questions identified in section 2.4, the state-of-the-art analysis starts with reviewing related academic literature on a decentralized organization of systemic innovation. Therein, the role of complementary assets in appropriating the returns from innovation is highlighted. Further, related challenges and differing opinions on organizing systemic innovations in a decentralized manner are explored. Next, section 3.2 centers attention on the strategic aspects of integrating external complementary innovations into open modular platform concepts. Therefore, the focus has been set on (a) exploring the strategic principles of platform leadership as well as (b) the resulting conflicts occurring between platform owner and complementing third party companies. Within this context, the major types of platform leadership strategies are explained as well as the platform owner's corresponding entry decisions into complementary markets. Then, in order to explore the principles of platform evolution, the engineering-centric perspective in section 3.3 focuses on modular platform concepts that provide the general framework of platform-based product and service development. Fourth, the managerial perspective centers attention on the management control mechanisms required to implement innovation strategy in inter-organizational relationships. It is shown that academic research on management control primarily considers the intra-organizational perspective, while the increasing control needs of hybrid organizations so far have received less attention. In chapter 3.5 the resulting shortcomings in state-of-the-art research are discussed.

3.1. Decentralized Organization of Systemic Innovation

Throughout the past few decades, it has become widely accepted that innovation is an interactive process involving the innovative firm and its environment (Kline & Rosenberg, 1986). Thereby, the ability to appropriate economic returns from different types of innovation is dependent on different ways of organizing the innovation process. While innovation researchers (e.g. Teece & Chesbrough, 1996) used to argue that companies targeting autonomous or modularized innovations rather benefit from decentralized organization approaches, where coordination primarily takes place through the marketplace, the benefits of systemic innovations are argued to be appropriated best in a centralized organization. Today, this view is seriously challenged. In particular, an improved understanding of the interdependences of innovation activities crossing organizational boundaries as well as the increasing importance of network factors have led to new organizational approaches as well as managerial techniques along the entire innovation process. Correspondingly, this section explores approaches of organizing

systemic innovation. It starts with a brief explanation of the term 'complementary innovation' in a systemic innovation context and explains Teece's (1986) framework of appropriating the returns of innovation. It then proceeds with exploring the organizational aspects of systemic innovation processes. Finally, the 'framework of proactively managing systemic innovation' developed by Maula et al. (2006) is introduced.

3.1.1. Complementary Innovation in Systemic Innovation Context

Throughout academic literature, several types of innovations have been identified, creating dedicated challenges to its incumbents. In particular, Tushman & Anderson (1986) have shown that radical innovations, which change core technical concepts as well as their linkages, create adaptive challenges for their incumbents. In extending this research, Henderson & Clark (1990) have argued that innovations, which change the linkages between core concepts, create similar challenges. They differentiate the following four innovation types:

1. *Incremental Innovation:* Incremental innovations build on existing technological resources, components and architectural knowledge in order to refine traditional product architectures.
2. *Modular Innovation:* Modular innovations require new knowledge for one or more components, while the architectural knowledge remains unchanged.
3. *Architectural Innovation:* Architectural innovations change the linkages among key product components, while the underlying technological assets and components remain the same.
4. *Radical Innovations:* Radical innovations revolutionize both component and architectural knowledge.

In addition to this taxonomy, Christensen & Bower (1996) have introduced the concept of 'disruptive innovations' that address new customer groups and, therefore, embrace different performance characteristics. In summary, these different categories of innovations require different organizational arrangements and innovation processes. Hence, a firm's behavior needs to significantly differ depending on the nature of the respective innovation (Maula et al., 2006).

Considering the fact that innovation in open modular platform environments is characterized by its systemic nature and frequently spans beyond the company boundaries of the platform owner (see section 2.3), a differentiation between systemic and autonomous types of innovation is considered more appropriate for the present work. Initially, Teece (1986) introduced the term 'systemic innovation' as a category of innovation, requiring

specialized complementary assets for the successful commercialization of an innovation. Later on, Chesbrough & Teece (1996) have extended this concept: Contrarily to autonomous innovations, they define systemic innovation as an innovation, whose benefits can be realized only in conjunction with related, complementary innovations. According to Milgrom & Roberts (1995) assets or activities are defined as complementary if their marginal return increases in the level of the other asset or activity. Overall, the concept of systemic innovation and its strong focus on complementary innovations refers to Teece (1986) who argues that a firm's complementary assets and capabilities are crucial for appropriating the returns from innovations. Section 3.1.2 delves into this framework and explains the extent to which an innovator is able to capture innovation rents.

3.1.2. Appropriating the Returns from Innovation

Innovations create opportunities for companies to capture first-mover advantages and temporary monopolies (Hill & Jones, 2007) that enable firms to extract transitory Schumpeterian rents. In consequence, a firm's ability to appropriate rents from innovation determines its performance and continued survival (Ceccagnoli & Rothaermel, 2008). Against this background, Teece (1986) fundamentally argues that invention is a necessary first step to innovation, although it is not sufficient for commercial success. However, innovating firms frequently fail to obtain significant economic returns from an innovation, while customers, imitators and other industry participants benefit. Once the imitation of an innovation turns out easy for a potential competitor, the profits from innovation may accrue to the owners of certain complementary assets, rather than to the developers of the actual intellectual property. This implies that protecting the returns on innovations has become a key strategic challenge in technology-intensive industries, requiring the innovating firm to establish a prior position with regard to these complementary assets. Explicitly, Teece's (1986) seminal treatise on profiting from technological innovation targets this context by focusing on two important factors: first the appropriability regime and secondly, the different types of complementary assets:

- *Appropriability Regime:* The appropriability regime primarily depends on legal and technological factors, i.e. intellectual property rights (IPR) protection by the legal system as well as dedicated characteristics of technology, e.g. the degree of codification, complexity, and ease of reverse engineering, determining the height of barriers to imitation.
- *Complementary Assets:* As the commercialization of an innovation frequently requires that the know-how in question is utilized in conjunction with other capabilities or assets, access to complementary assets determines the degree to which firms profit from their innovations. Thereby, complementary assets are differentiated into to three

different types; generic, specialized, and co-specialized complementary assets. While general purpose assets or efforts do not need to be tailored to the innovation, as they can frequently be contracted for in the market, specialized complementary assets are considered those with unilateral dependence between the innovation and the complementary asset. In turn, co-specialized complementary assets are characterized by a bilateral dependence.

As a result, Teece (1986) concludes that the interaction between the strength of the appropriability regime and the ownership of, in particular, specialized complementary assets determines the degree to which firms profit from their innovations. This means: While a strong appropriability regime is frequently sufficient to capture a positive fraction of innovation rents, a greater degree of specialization in complementary assets corresponds to greater rents for its owner. Correspondingly, when owning these assets, the innovator is able to capture almost all of the value associated with its innovation. In turn, once assets are specialized and owned by different firms, rents have to be shared. A weak appropriability combined with generic complementary assets represents the unfortunate case of many entrepreneurial ventures as customers benefit the most from the innovation. Finally, a combination of a weak appropriability regime with specialized complementary assets typically allows the owners of these assets to capture the lion's share of the value created by the innovation (Ceccagnoli & Rothaermel, 2008). Figure 8 represents Teece's (1986) conceptual framework, summarizing the interaction between the appropriability regime and the complementary assets.

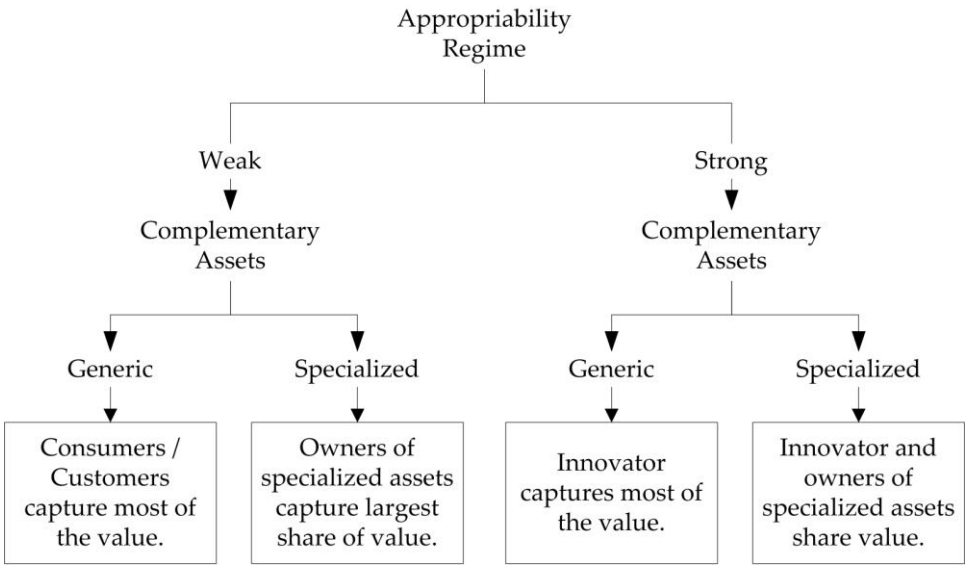


Figure 8: Interaction between the Appropriability Regime and Complementary Assets (Ceccagnoli & Rothaermel, 2008)

These interdependencies raise the question, how innovating companies should leverage their innovation towards commercial success and sustained competitive advantage. Addressing this issue, Ceccagnoli & Rothaermel (2008) summarize related strategic options: First, the innovating company develops and commercializes the innovation itself, if necessary, through forward vertical integration. Secondly, the innovating company develops and commercializes the innovation jointly with a partner; or, thirdly, the innovating company licenses the innovation to another company or companies, and let them develop and market the innovation in exchange for royalties. According to these authors, the optimal strategy to be pursued depends upon:

- *The Availability and Type of Complementary Assets:* The first question the company has to answer is whether it possesses the necessary complementary assets to commercialize the new technology. Assuming that the innovator possesses specialized complementary assets to commercialize the innovation, the next question targets the height of barriers to imitation.
- *The Height of Imitation Barriers and Number of Capable Competitors:* Imitation barriers define the degree of difficulty competitors face when attempting to imitate the innovation. If the barriers to imitation are high, due to a strong appropriability regime, while the number of capable competitors is low, the inventor should pursue a forward vertical integration strategy. The innovator will then be in a position to leverage its complementary assets to extract monopoly rents from the innovation, and barriers to imitation will delay entry. If the number of capable competitors remains low, the innovator might be able to build a sustained competitive advantage. Assuming that the innovating firm does not possess the required complementary assets to commercialize the innovation and barriers to imitation remain high, while the number of capable competitors is rather small, the innovator may profit from the innovation through developing it jointly with the holder of complementary assets. Thereby, the distribution of rents depends upon the relative bargaining power of each party. In case that the innovating company lacks the necessary complementary assets, while the barriers to imitation are low due to a weak appropriability regime combined with a large number of capable competitors, the innovator is advised to license the innovation to at least capture some of the innovation rents. Often, however, major innovations require complementary assets that are unavailable in the market, yet their nature is specialized and requires significant sunk investments to be successfully commercialized. In this case, both the demand for licensing and the potential rents to be realized are low, although the potential commercial success could be high. Thus, the remaining challenge is to find a partner willing to share the financial risks of developing the co-specialized assets. Particularly, in weak appropriability, however, partners may well be unwilling

to share such risks, so that downstream integration remains the only alternative left. Ceccagnoli & Rothaermel (2008) recommend that this option should be pursued only if the investment is expected to yield positive net returns to the innovating firm.

3.1.3. Organization of Systemic Innovation Processes

Given these interdependencies in appropriating the returns of innovational efforts, firms in systemic innovation contexts are required to coordinate both with developers of complementary products and services as well as with direct competitors to ensure the viability of the innovation (Brandenburger & Nalebuf, 1996; Shapiro, 2001; Maula et al., 2006). Hence, the distinction between autonomous and systemic innovation made by Chesbrough & Teece (1996) is fundamental to the choice of organizational design. While in the case of autonomous innovation a decentralized virtual organization is able to manage the development and commercialization tasks, the case of systemic innovation shows that members of a virtual organization are dependent on the other members, over whom they have no control (Chesbrough & Teece, 1996). Correspondingly, both Teece (1986) as well as Chesbrough & Teece (1996) argue that systemic innovations pose a unique set of management challenges, i.e. regarding information exchange or the coordination of innovational efforts. Hence, the "inevitable conflicts and choices that arise as a systemic innovation develops can best be resolved by an integrated company's internal management processes" (Chesbrough & Teece, 1996: 7).

Similarly, Chesbrough & Kusunoki (2001) argue that the character of a technology is not static, but rather evolves from being systemic in the early phases, to being modular, and often back to being systemic again. Hence, the firm's optimal organizational design should evolve with the technology in order to capture value from its innovation activities. Correspondingly, they propose the matrix as indicated in table 1, displaying the link between organizational alignment and technological phase.

	Modular	Integral
Decentralized Organization	- Proper Alignment; - Value realized only within technology layer; - No inefficient interactions.	- Misalignment; - Can't manage interactions; - Insufficient infrastructure.
Centralized Organization	- Misalignment; - Unnecessary internal coordination; - Reduced scale economies.	- Proper Alignment; - Value realized in the system; - Effective coordination of undefined interactions.

Table 1: Technology-Organization Alignment Matrix (Chesbrough & Kusunoki, 2001)

Within this matrix, the upper left quadrant indicates the appropriate alignment of a decentralized organizational strategy. Value can be realized within each technology module, while external markets coordinate the link between modules, avoiding inefficient internal interactions. Correspondingly, the lower right quadrant depicts the appropriate alignment of a centralized organizational approach in an integral technological phase. Value can be realized through the ability of internal coordination mechanisms. The lower left and upper right quadrants, in turn, indicate cases of misalignment, wherein value can be dissipated, owing to an inappropriate organizational approach to the technology (Chesbrough & Kusunoki, 2001).

De Laat (1999), however, seriously challenges these perspectives by arguing that many contemporary systemic innovations are too complex for a single integrated company to manage. He argues that integrating systemic innovation economizes on the cost of coordination, while providing control benefits. According to him, it frequently seems to be infeasible as even the largest company lacks the financial resources to create those complementary innovations that are simultaneously required for market success.

3.1.4. Framework of Proactively Managing Systemic Innovation

Given these yet unresolved questions concerning the appropriate organizational design to successfully coordinate systemic innovation, Maula et al. (2006) introduce the 'framework for proactively managing systemic innovations in industry leading companies'. To the author's best knowledge, this is the only framework explicitly considering the management of systemic innovations in distributed innovation environments such as platform ecosystems. Other studies, such as Abernathy & Clark (1985), Utterback (1994) or Hargadon & Douglas (2001) have frequently taken the evolutionary development process of complementary innovations as given (Maula et al. 2006).

Fundamentally, Maula et al. (2006) claim that in systemic innovation, innovating companies are dependent on other complementary innovations. They, hence, need to proactively lead the development of systemic innovations. At the example of the resource allocation process, Maula et al. (2006) identify the need for creating foresights and shaping the environment over different time zones as primary needs. Therein, the linkages between different activities need to be understood in order to capture the dynamics of systemic innovations. Figure 9 depicts the tools for foresight and shaping, targeted at managing the business environment of the corporation over different time horizons.

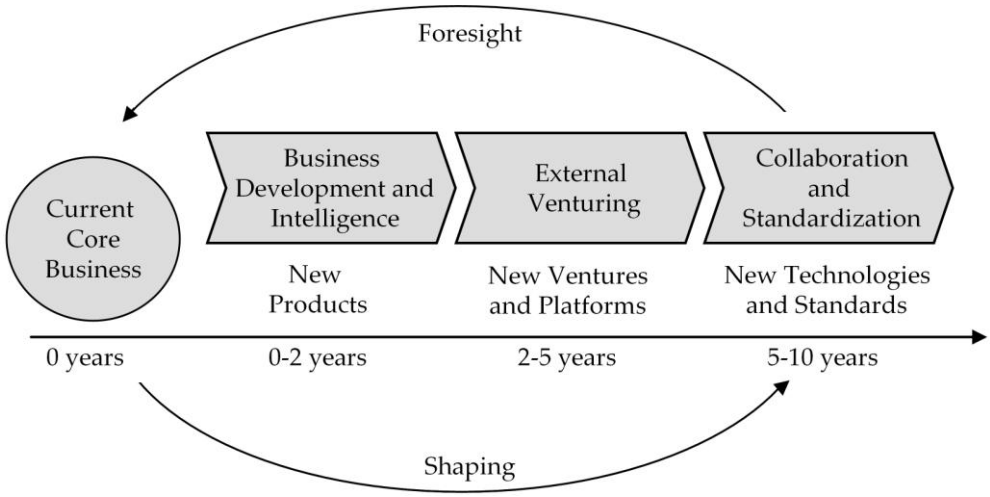


Figure 9: Tools for Foresight and Shaping of Systemic Innovation (Maula et al., 2006)

The framework suggested by these authors consists of the following building blocks:

- *Foresight and Industry Shaping:* Within this building block, firms are requested to draw information about the evolution of technologies and markets as well as about the resource allocation processes of other firms. This information allows the firm to identify the relevant technological and market forces in order to influence internal resource allocation processes. In particular, the complexity of systemic innovation requires the company to monitor the development of multiple innovations simultaneously in order to provide foresight into emerging new business opportunities and allocate resources, accordingly. In parallel, companies are requested to proactively influence the evolution of technologies and markets as well as the resource allocation processes of others in their environment. Correspondingly, Maula et al. (2006) identify three forms of shaping the company's environment: First, providing access to information or financial incentives to support a new technology or to develop complementary products or services. Second, participation in standardization processes in order to drive the standardization of important interfaces. Third, signaling their intention of future development, i.e. through press announcements or informal communications with customers, customers, suppliers or complementors.

- *Time and Company Boundary Spanning Mechanisms:* In systemic innovation, coordination efforts need to start prior to the invention's market introduction. Thereby, early technology development and standardization of technologies underlying systemic innovations frequently predate their broad commercialization by five to ten years. The company is challenged by understanding the evolution of technologies through research in order to influence their development and standardization. Within the timeframe of early commercialization, exploratory commercialization, e.g. corporate

venturing, increases in importance. During this intermediary phase the focal firm participates in early commercialization efforts, however, without committing large-scale resources. These might embrace complementary innovations or require experimentation with product or service configurations, customer groups, or business models. In addition, corporate venture capital investments help shaping the emerging value network forming around the systemic innovation. Similarly, alliances and joint ventures can provide foresights into emerging technologies and support the creation of complementary innovations. During the full commercialization and development stage, the emphasis of organizational mechanisms changes again, focusing on learning about competitive threats through business intelligence, countering competitive moves by competitors and on creating efficient value networks through shaping mechanisms. Within this phase, business development mechanisms such as supplier and customer alliances, joint ventures, and large-scale acquisitions play an important role in providing business intelligence and developing the business system supporting the systemic innovation. In particular, alliances and joint ventures are used to create efficient supply chains, increase commitment from strategically important complementors. Being embedded in a network of relationships with other complementors of a systemic innovation reduces the risk of opportunistic behavior. In particular, the network of partners provides the firm with improved access to information.

With reference to Chesbrough (2003a), Maula et al. (2006) identify particular problems industry leaders are facing when targeting at systemic innovations: Since systemic innovations require the simultaneous development of multiple complementary innovations, business systems often require leadership by a small group of firms, acting as coordinators. These firms are referred to as 'architects' (Chesbrough, 2003a), being described as firms that develop the technical architectures of systems. These firms partition the system's complexity, enabling that other companies can provide pieces of the system, while guaranteeing that these pieces can be integrated (Chesbrough, 2003a). Hence, innovation architects provide leadership to a systemic innovation by establishing the system architecture, communicating it, and enabling others to support and further develop it. Frequently, this role is played by large firms that can provide the emerging innovation legitimacy. Within this context, innovation architects face a different set of challenges, i.e., to balance driving the emerging systemic innovation, while maintaining their existing business base; to attract and retain the commitment of external resource pools; as well as to steer open innovation efforts over different time horizons. These challenges are addressed in detail throughout the second research stream considered relevant to the present work: Platform leadership.

3.2. Platform Leadership

Platform leadership is understood as "the ability of a company to drive innovation around a particular platform technology at the broad industry level" (Cusumano & Gawer, 2003: 53). The related research stream is targeted at understanding how to orchestrate the interactions between platform owner and 'developers or providers of complementary products and services' (Brandenburger & Nalebuf, 1996), also referred to as 'complementors'. Thereby, the primary focus has been laid on technological and business aspects of establishing and growing a platform. By merging earlier research, Cusumano & Suarez (2009) list numerous factors that affect the emergence of a successful platform among competing alternatives, such as: Adequate pricing strategies to generate momentum behind a platform (Eisenmann, 2005); a large set of complementary products that increase the value of a particular platform (Gawer & Cusumano, 2002); the strength of "network effects" often tilting the balance in favor of platforms that can build their installed base faster than competitors (Katz & Shapiro, 1985); as well as technological or design advantages (Suarez & Utterback, 1995).

Within the context of platform markets and their peculiar dynamics (see section 2.3.2), in particular research by Gawer & Cusumano (2002) has uncovered strategic insights on how firms maintain an industry platform and maximize systemic innovation. First, they claim that companies are required to clarify their role: Are they (a) a platform leader, that means a company that drives industry-wide innovation for an evolving system of separately developed pieces; (b) a wannabe, that means a company that intends to become a platform leaders; or (c) a complementor, that means a company that makes ancillary products or services to expand the platform's market reach.

Research on platform leadership concludes that managers in particularly face two major challenges: coordinating internal units and interacting effectively with outsiders. Further, research on platform leadership claims that platform markets "require distinctive competitive strategies because the products are parts of systems that combine core components made by one company with complements usually made by a variety of companies" (Gawer & Cusumano, 2008: 28). Correspondingly, the authors characterize the appropriate strategy for firms operating in disaggregated, modular platform markets as the quest for 'platform leadership'; the objective being to control a central module around which other companies develop complementary technologies, products and services. Within this strategic context, platform leaders are facing three particular challenges (Gawer & Cusumano, 2002):

- First platform leaders have to maintain the integrity of the platform, i.e. the compatibility with complementary products and services in the face of future technological innovation and the independent strategies of other companies.
- Secondly, platform owners have to evolve platforms, while maintaining compatibility with past complements.
- Third, platform leaders are challenged to ensure market leadership in platform environments in order to benefit from network externalities.

As most platform leaders do not have the capabilities or resources to create complete systems by making all the complements themselves, they need to collaborate and innovate openly (Cusumano & Gawer, 2003; Chesbrough, 2003a). This, however, requires dedicated strategies to attract and tie complementary partners.

3.2.1. Strategic Principles of Platform Leadership

In order to appropriately address the challenges explained in previous sections, Gawer & Cusumano (2002) suggest four critical categories of managerial decisions that lead to 'platform leadership'. They embrace the levers of 'firm scope', 'product technology', 'external relations with complementors' as well as 'internal organization'. These so-called four levers of platform leadership have to be implemented in a coherent manner within the platform company to ensure growth and stability of the platform and to successfully influence the direction of innovation in complementary products and services developed by third parties:

- *Firm Scope:* Platform leaders need to determine the scope of the company, explicitly, concerning the decision, which capabilities to create in-house and which to stimulate to be created by complementors. In particular, the decision, which complements to make inside and which to leave to external firms is probably the most important issue, platform leaders have to take. "It is not a one time event because firms innovate continuously on their products and add new functionalities that may well have been performed previously by external firms" (Gawer & Cusumano, 2002: 9-10). Therefore, platform leaders first need to assess how dependent they are on complements. Secondly, they need to determine how to increase demand for their platform. If platform leaders lack the technical, organizational or financial capabilities to compete in relevant markets, they are advised not to develop their own complements. Correspondingly, "a platform leader deciding to work with outside developers should scrutinize others' incentives and capabilities in order to exert influence over the design and production of complements" (Cusumano & Gawer, 2003: 55), e.g. by sharing technical information about their own products and platform interfaces or sending engineers to help

complementors build compatible products. Another strategy refers to a 'rabbit' strategy, which means targeting a promising complementor and assisting it in such a visible way that other companies follow. The approach is supposed to draw the attention of investors and complementors to a potentially lucrative new market, signaling that the platform owner aims to stay out of the complementary market. In addition, venture investments as well as mergers and acquisitions help a platform owner influencing the production of complements. "However, when an acquisition makes the platform leader a competitor of former partners, it can discourage other companies from becoming complementors and can mean less competition - and possibly less innovation" (Cusumano & Gawer, 2003: 55). In summary, Gawer & Cusumano (2002) conclude that there is no simple answer on whether to make complements in-house, although platform products and services depend on complements. Platform owners are, however, advised to have relevant capability in-house, not only for producing complements, but also for providing constructive direction and competition for third parties.

- *Product Technology:* Product architecture is considered to have a profound impact on the structure of an industry as well as on the nature of follow-on innovations (Sawhney, 1998). Explicitly, the product or service architecture determines the type of innovation as well as how much investment in complementary products occurs outside the platform owner's company. Further, modular architecture can reduce innovation costs and encourage the emergence of specialized companies (Cusumano & Gawer, 2003). Therefore, platform leaders need to decide about the architecture of the platform. In particular, they need to decide how much modularity they implement, how open their interfaces should be, and how much information about both platform and interfaces they disclose to outsiders who might become complementors or competitors. Hence, if platform owners aim at stimulating the development of complementary products and services, they provide technical specifications of interfaces to third parties. In turn, if they want to hinder an outsider's ability to make complements, they keep their intellectual property from that company. In conclusion, Gawer & Cusumano (2002) consider keeping control of the architecture as a powerful barrier against companies that might offer a competing architecture with different interfaces. Nevertheless, it's a delicate balance, and disclosing too much information can be dangerous. Hence, "finding ways to stimulate innovation involves a trade-off between secrecy and disclosure" as it "encourages profit-seeking entrepreneurs to innovate on a stand-alone product" (Cusumano & Gawer, 2003: 56).
- *External Relations with Complementors:* Platform owners need to determine how collaborative or competitive they want relationships to be between them and their complementors. Explicitly, platform owners have to work on creating consensus and

handling potential conflicts of interest. To be effective over the long term, they need to (a) seek consensus among key complementors about the technical specifications and standards and (b) influence the partners' decisions. Thus, platform leaders have to pursue consensus and control at the same time. As research results show, consensus among industry players, in particularly, depends on one company driving the process. This company is requested to control the interfaces between components and the platform. From the perspective of platform leadership, dedicated management processes are required to ensure consensus, while maintaining control at the same time. This balancing act of collaboration and competition between platform owner and complementor involves mutual dependency and requires companies to trust the platform owner (Gawer & Cusumano, 2002). Nevertheless, with reference to Brandenburger & Nalebuff (1996) maintaining trust is difficult in platform leadership as it is not always clear if another company acts as a supplier, competitor or complementor, or if today's supplier or complementor will become tomorrow's competitor. Some companies even play multiple roles (see section 2.3.3). In order to manage external tensions and platform leadership, Cusumano & Gawer (2003) conclude that platform owners have to assure complementors that critical technical information remains open and that there would be adequate protection of intellectual property. In addition, by demonstrating to potential complementors that it is acting on behalf of the whole industry, a platform owner can further establish credibility in those technical areas where it wants to influence future designs or standards. Hence, "collaborating with external complementors and championing the public interest, while competing with those complementors when necessary to stimulate a new complements market" (Cusumano & Gawer, 2003: 57) can support the platform owner in balancing interests.

- *Internal Organization:* One way to address the ambiguity of relationships between platform owner and complementors is referred to the platform owner's internal organization. An appropriate internal structure supports the platform owner in managing external and internal conflicts of interest. Organizational options include: First, keeping groups with similar goals under one executive or putting them in distinct departments if they have outside constituencies or potentially conflicting goals; second, addressing organizational culture and processes; and third, improving internal communication of corporate strategy. Due to the ambiguity of innovative, modular industries, a company culture that encourages debate can accelerate strategy reformulation when it's needed. The primary challenge, thereby, lies in creating an internal organization that allows the platform owner to manage relationships with complementors, effectively. Therefore, it is vital to communicate the multiple goals to the whole company and create a process for resolving conflicts. In general, "platform

leaders can appear more neutral if they establish an internal Chinese wall, with different groups playing different roles vis-à-vis third parties" claim Cusumano & Gawer (2003: 57). In addition, they recommend implementing internal processes, such as formal planning and off-site meetings as well as senior executives to arbitrate when conflicts arise among company units. Further, they recommend to foster an organizational culture that encourages debate and tolerates ambiguity.

Despite the recommendations, however, not every company is able to become a platform leader. To have platform potential, a product, technology or service considered as platform is required to (Gawer & Cusumano, 2008):

- Perform at least one essential function in a product, service or combination that execute an increasing variety of tasks;
- Solve an essential technological problem for many players in an industry;
- Be easy to connect to or build upon, allowing the system to be expanded to new and even unintended uses.

Additionally, the authors claim that a dedicated business strategy is required that enables a company to make its technology or service fundamental to an emerging platform and helps the market tip toward that platform. Explicitly, the company needs to create economic incentives that encourage other firms to develop complementary applications for the platform, while at the same time protecting its own ability to profit from its innovations (see section 3.1.2).

3.2.2. Platform Leadership Strategies

Building upon these insights Gawer & Cusumano (2008) as well as Gawer (2009) derive two types of basic platform strategies: First, market coring, referring to the creation of a new platform; and secondly, market tipping, embracing the strategies that help firms to win in a competition between platforms.

In the strategic mindset of a 'coring' strategy, coring embraces the set of activities a company uses to identify or design an element (a technology, a product or a service) and make this element fundamental to a technological system as well as to a market. An element or component of a system is considered as 'core', when it resolves technical problems affecting a large proportion of other parts in the system (Gawer & Cusumano, 2008). Hence, in order to encourage other companies to develop essential complementary applications on top of the platform, "the platform leader has to create economic incentives for ecosystem members to invest in creating complementary innovations and to keep doing so over time. In addition, platform companies need to protect their ability to profit

financially from their innovations" (Gawer & Cusumano 2008: 30). Correspondingly, the balancing act of protecting one's sources of profit, while enabling complementors to make an adequate profit and protect their own proprietary knowledge is perhaps the greatest challenge to platform leadership. They refer to Google Inc. as an example of successful coring in Internet search technology, which managed to establish its proprietary search technology as a foundation for navigating the Internet.

'Tipping', in turn, embraces the set of activities or strategic moves that companies can use to shape market dynamics and win a platform war, when at least two platform candidates compete. These moves cover sales, marketing, product development and coalition building. "As with coring, successful tipping requires actions taken from both the technology and the business side of the platform" (Gawer & Cusumano 2008: 33). With reference to Shapiro & Varian (1999), the authors advise companies to (a) gain control over an installed base; (b) broadly license their intellectual property and (c) facilitate partner investments in complementary innovations. Furthermore, platform leaders should invest in "building brand equity as well as manufacturing, distribution or service capabilities to signal support of the platform" and use pricing strategies as strategic weapons, e.g. by subsidizing one side of the market over the other. "Tipping across markets occurs, when a company crosses over the boundary of its existing market to absorb technical features from an adjacent market and bundle them to extend the company's platform" (Gawer & Cusumano 2008: 33), particularly important in the context of technological convergence. Table 2 summarizes the alternatives, accordingly.

Strategic Option	Technology Actions to Consider	Business Actions to Consider
Coring	- Solve an essential 'system' problem; - Facilitate external companies' provision of add-ons; - Keep intellectual property closed on the innards of technology; - Maintain strong interdependencies between platform and complements.	- Solve an essential business problem for industry players; - Create and preserve complementors' incentives to contribute and innovate; - Protect the main sources of revenue and profit; - Maintain high switching costs to competing platforms.
Tipping	- Develop unique, compelling features that are hard to imitate and attract users; - Tip across markets: absorb and bundle technical features from an adjacent market.	- Provide more incentives for complementors than competitors; - Rally competitors to form a coalition; - Consider pricing of subsidy mechanisms that attract users to the platform.

Table 2: Strategic Options for Platform-Leaders (Gawer & Cusumano, 2008)

3.2.3. Entry Decisions into Complementary Markets

Both types of platform leadership strategies introduced in section 3.2.2 build upon integrating external complementary innovations in order to succeed in platform competition. This section explores state-of-the art research on how platform owners systematically decide upon their entry into complementary markets. These entry decisions are shaped by the belief that platform owners either do not have the necessary organizational capabilities to build the required complements by themselves and that they do not have the capabilities to enter all possible markets (Gawer & Henderson, 2007). In order to facilitate the decision, which markets to enter and which to leave to complementors, Gawer & Henderson (2007) identified intermediate markets, referred to as 'connector' markets. These markets are functionally located between the platform and the applications, being defined as markets "in which the products embody one or more interfaces between the platform and end-use applications" (Gawer & Henderson, 2007: 10).

Based on results gained from case studies at Intel, Gawer & Henderson (2007) suggest that platform leaders frequently enter only those complementary markets that either have implications for control of the platform architecture or those, for which they believe having the requisite capabilities. However, in cases where the interface between the platform and complementary markets is evolving, platform leaders are more likely to enter these 'connector' markets as well. The remaining challenge of the platform owner, however, lies in committing to potential complementors that it would not ex post 'squeeze' complementors. Hence, the platform leader could either attempt to commit never to enter a certain complementary market or it could commit to enter and 'play fair'. Correspondingly, three primary mechanisms have been identified, signaling potential complementors that the platform owner will not 'squeeze' entrants (Gawer & Henderson, 2007):

- The internal organizational structure separates divisions with their own Profit & Loss operations and signals that it expects both the platform owner and its competitors to make money in complementary markets;
- The platform owner attempts to subsidize entry into complementary markets not through direct subsidy, but by lowering the cost of entry for all potential entrants, largely, but not only, by the development and widespread dissemination of intellectual property;
- The platform owner attempts to commit to the stability and security of these subsidies and to the promise, not to change 'the rules of the game'.

In conclusion, Gawer & Henderson (2007) claim that this combination of activities creates considerable tension inside the firm as on one side managers are encouraged to maximize profit within complementary markets, whereas on the other side their colleagues are

actively subsidizing the entry of competitors and publicly refusing to use the platform leader's control of the architecture to advantage internal divisions. In order to further investigate the question of which innovational efforts to pursuit internally and which to coordinate within the platform ecosystem, the following section explains the concept of platform-based product and service development in greater detail.

3.3. Platform-based Product and Service Development

Academic research on platform leadership has drawn important insights on platform leadership, considering a 'thriving ecosystem' as a major success factor for an industry platform to emerge and prosper. As a matter of network externalities as well as fierce platform competition, platform ecosystems have to constantly evolve and re-invent their value proposition to customers in order to face the threats and opportunities in dynamic business environments (Gawer & Cusumano, 2002). This requires a continuous targeted platform evolution, embracing the adoption of new technology as well as the generation of own. Further, it involves reconfiguring product, services, processes or markets. In each case, it involves learning, requiring strategic direction to focus this process (Tidd et al., 2001). Thereby, distributed value creation in two-sided platform businesses bases upon platform concepts, embracing modular product and service architectures, interfaces, and corresponding design rules that allow independent third parties to innovate and develop dedicated system components, which can, in turn, be flexibly recombined into a variety of configurations on top of the platform in order to address individual customer demand (Meyer & Lehnerd, 1997; Sawhney, 1998). These platform concepts have been widely applied likewise to products and services in a variety of industries. They provide an answer on how to strategically evolve a platform from an engineering-centric perspective.

3.3.1. Fundamentals of Modular Platform Concepts

By identifying and exploiting commonalities among different offerings, target markets, and the processes for creating and delivering offerings (Sawhney, 1998), platform concepts are recognized as an option to create variety economically, i.e. in mass customization (Pine, 1993; Halman et al., 2003; Huang et al., 2005). Consequently, the characteristics of platform concepts vary widely across industries and applications, ranging from automobiles to computers, software, medical equipment and service design (Meyer & Mugge, 2001). Through the lens of platform thinking, however, both physical and non-physical products as well as service concepts share a number of conceptual elements. These elements enable a company to reduce the overall development costs and time, while satisfying diverse customer demands and maintaining economies of scale and scope (de Weck et al., 2003). Thereby, it is explicitly the modularity approach inherent to platform concepts that allows for a platform strategy, enabling a high number of new variants to be build based upon a

stable architecture and standardized building blocks (Meyer & Utterback, 1993; Ulrich, 1995; Robertson & Ulrich, 1998; Wheelwright & Clark, 1992).

In this context, platform strategy entails building a central set of components around which new products or services are developed. Hence, a product or service family refers to a set of similar products or services that are derived from a common platform and, yet, possess specific features and functionality to meet particular customer requirements (Meyer & Lehnerd, 1997). Each individual product or service within a family is referred to as a variant or instance, sharing the common structures and technologies of the platform (Erens & Verhulst, 1997). Figure 10 depicts the core elements of platform-based product or service development (Meyer & Lehnerd, 1997):

- The market applications, such as derivative products or services made for various customer groups;
- The product or service platforms;
- The common and organizational building blocks, forming the basis of the product or service platform, such as customer insights, technologies, processes and organizational capabilities.

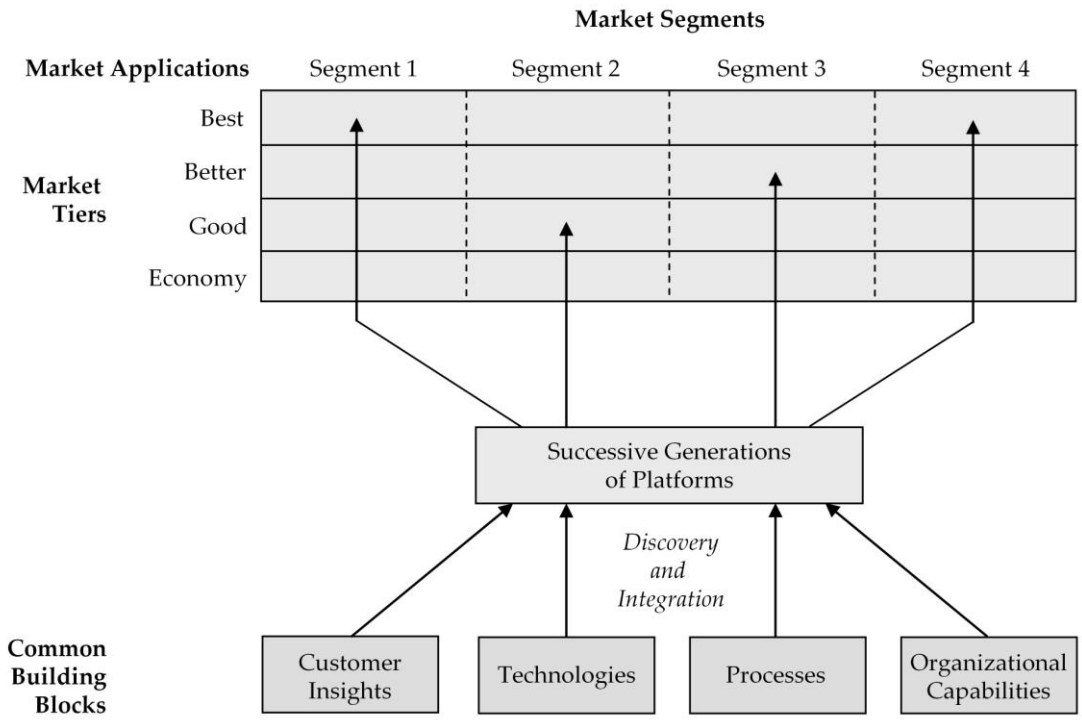


Figure 10: Integrative Model of Product and Process Innovation (Meyer & Lehnerd, 1997)

In particular, market applications take the form of derivative products or services based on a common platform. They target specific customer needs in a dedicated market segments, which are defined in a traditional way, i.e., through a matrix of market segments. Therefore, major market segments and price performance tiers are identified wherein to scale and leverage the platform into different market niches. Correspondingly, figure 11 represents a market segmentation grid to segment respective product or service offerings into dedicated markets. Therein, major market segments are arrayed horizontally and prices performance tiers are following the vertical axis (Meyer & Lehnerd, 1997).

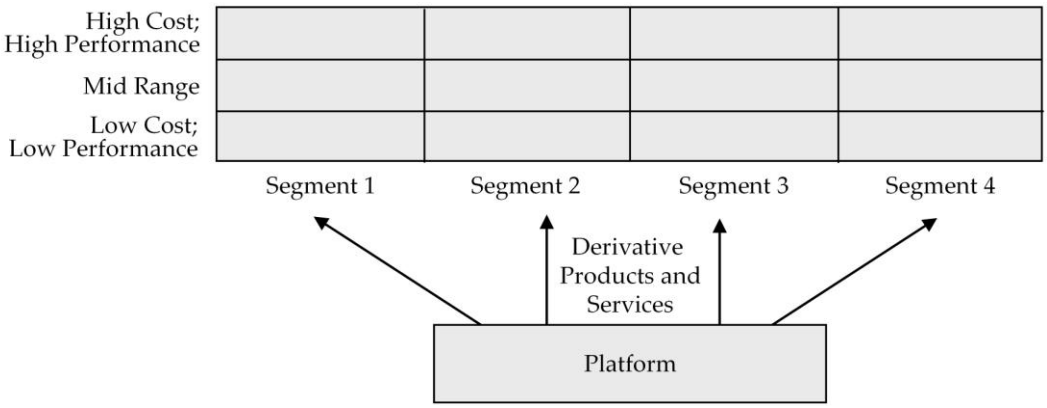


Figure 11: Market Segmentation Grid (Meyer & Lehnerd, 1997)

The market segmentation grid provides the basis for portfolio planning and selective platform leveraging strategies, enabling a platform's unique differentiation. Thereby, differentiation is implemented primarily through the underlying platform rather than the derivative products or services on top of the platform (McGrath, 2001). At incremental cost relatively to the initial investments in the platform itself, the firm can cover different market segments with a single platform by leveraging the platform throughout different market segments and price tiers (Meyer & Lehnerd, 1997).

3.3.2. Platform Leveraging Strategies

Given the underlying modular development approach, platforms can be leveraged through different markets. Correspondingly, Meyer & Lehnerd (1997) differentiate between three 'platform leveraging strategies': Horizontal leveraging, vertical leveraging, and the beachhead approach, which combines both strategic approaches. Table 3 explains how different platform leveraging strategies support companies in extending their reach into new market segments and different levels of price and performance.

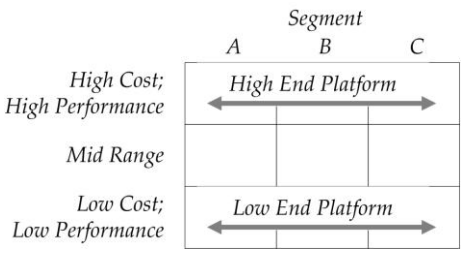
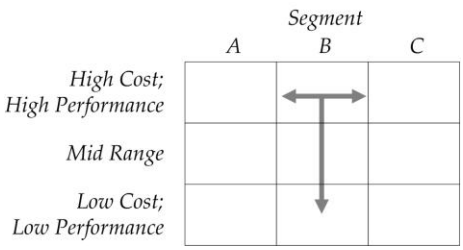
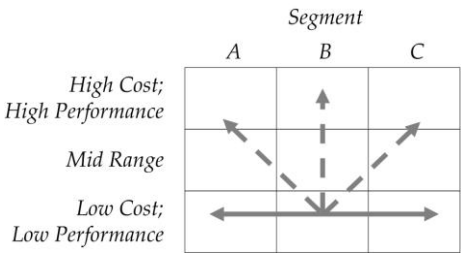
a.) Horizontal Leverage of Key Platform Subsystems:	
	Within a given tier of price performance, a platform, or one of its key elements, is leveraged from one market niche to the next. Leverage occurs to the degree that the major subsystems are adapted for use within different market segments. The company benefits from increased development efficiency and its ability to introduce new products or services across a series of related customer groups based on component reuse. The standardization of key subsystems and related components improves product or service performance and reduces costs.
b.) Vertical Scaling of Key Platform Subsystems:	
	In the context of vertically scaling key platform sub-systems, the company addresses a range of price-performance tiers within a market segment. Therefore, certain functionality is reduced from the high-end product or service to position the platform offering in lower price segments with reduced functionality. Alternatively, low-end product platforms are scaled upward into higher price-performance tiers by adding further functionality. The company is enabled to leverage its knowledge into a particular market segment.
c.) Beachhead Strategy: Horizontal Leverage and Vertical Scaling:	
	In the 'beachhead' strategy an increase in market success is pursued through a combination of horizontal leverage with upward vertical scaling. Therefore, the company develops a low cost, but effective platform as well as corresponding processes for making the platform efficient in one particular segment of low-end users. In order to meet the needs of other segments, the company scales up the platform's performance characteristics and adds additional features. In result, the company is enabled to enter new market niches from a superior cost position.

Table 3: Platform Leveraging Strategies (Meyer & Lehnard, 1997)

In summary, the more consistent the platform concept is defined and implemented, in particular with regard to its parts, components, processes, and customer segmentation, the

more effectively a company can operate in terms of tailoring products or services to the needs of different market segments or customers.

3.3.3. Principles of Platform Evolution

In order to succeed in rapid market and technology change, product or service platforms need to be managed as evolving entities (McGrath, 2001; Gawer & Cusumano, 2002). If a platform is not continuously renewed, the company faces the threat that its derivative products or services will become dated and fail customer needs. Consequently, a platform needs to be periodically renewed by incorporating new functions and components. Prerequisite are stable architectures remaining robust through successive generations. The following figure represents the successive evolution of derivate products or services, platform renewal and new product creation.

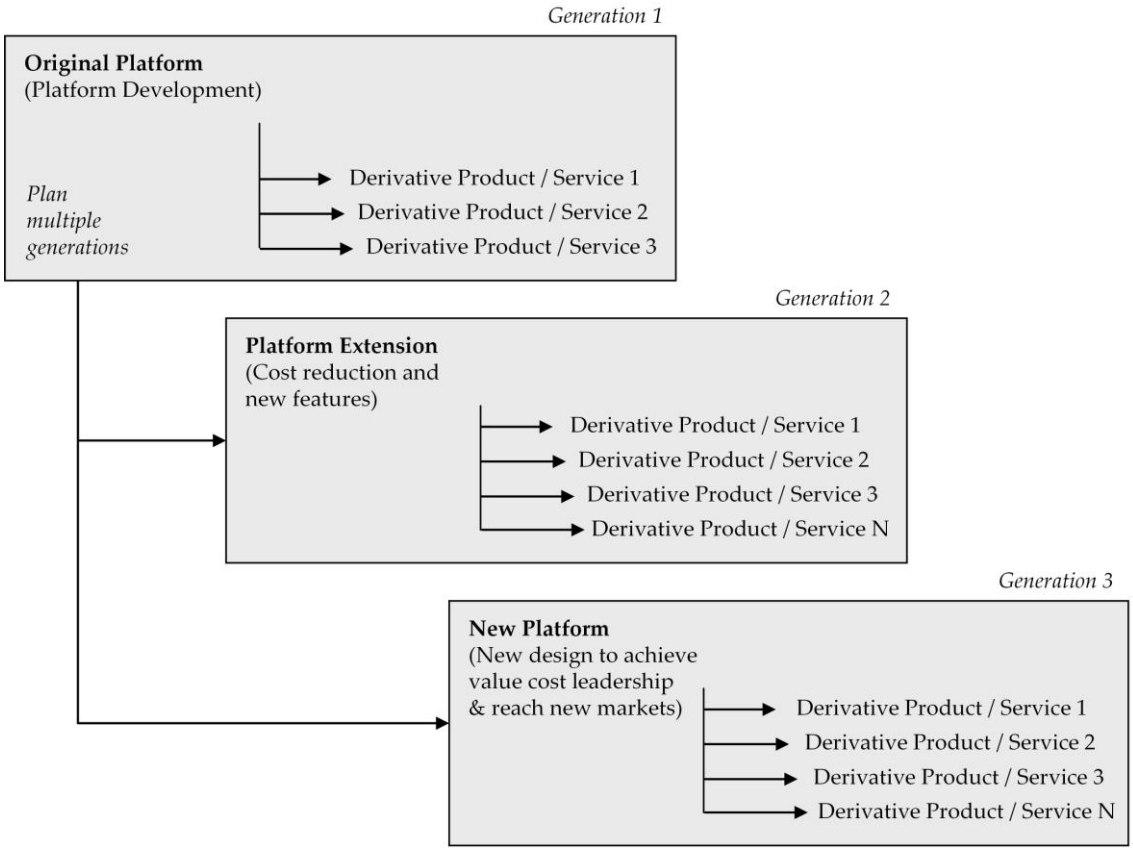


Figure 12: Core Principles of Platform Evolution (Meyer & Lehnerd, 1997)

Successfully managed platforms evolve as new market knowledge and technologies are integrated. A new generation in a product or service family appears when the platform itself undergoes substantial enhancements. Thereby, the number and types of subsystems and interfaces remains constant, but one or more of them undergoes major revisions. In the

case of platform renewal, an entirely new platform is designed, changing its basic architecture, subsystems and related interfaces (Meyer & Lehnerd, 1997).

3.4. Innovation Strategy and Management Control

Previous sections have shown that coordinating open innovation efforts and value creation in platform ecosystems has become critical to the platform owner. Failures can rapidly lead to reputation damage, financial losses and, possibly, even to the platform ecosystem's decline. In particular, the structure chosen to govern an inter-organizational relationship is often argued to be critical to its success (e.g. Ittner et al., 1999; Osborn & Baughn, 1990). Effective governance is even claimed to be a source of inter-organizational competitive advantage (Dyer & Singh, 1998; Ireland et al., 2002).

Against this background, transaction cost economics (Williamson, 1985) provide a common framework for the choice of appropriate governance structures and control mechanisms. Transaction cost economics (TCE) is based on the notion that firms choose efficient organizational forms or governance structures based on transactional issues, such as firm-specific investments, and external or internal uncertainty (Ittner et al., 1999). Correspondingly, governance structures are characterized as one of three forms: markets, hybrids and hierarchies, each relying on different control mechanisms to be successful (Williamson, 1991). According to Williamson (1979), three aspects of transactions determine the appropriate mode of governance: (a) the frequency of a transaction; (b) the uncertainty encompassed in those transactions; and (c) the asset specificity of the transactions, that means the degree to which an asset can be redeployed to alternative use without sacrifice of productive value. It is, hence, assumed that a high level of asset specificity creates dependency between the parties in a relationship, increases switching costs and leads to difficult governance situations (Williamson, 1979; 1991). Nevertheless, building on transaction cost economics and organizational theory, Dekker (2004) identifies two control problems that arise when firms engage in inter-organizational relationships: the management of appropriation concerns and the coordination of tasks. Consequently, the primary purpose of management control in inter-organizational relationships "can be described as creating the conditions that motivate the partners in an inter-organizational relationship to achieve desirable or predetermined outcomes" (Dekker, 2004: 29-30). This definition suggests that managing transaction risks is only part of the control challenges in the pursuit of desirable or predetermined strategic outcomes.

The objective of this section is to explain management control in the innovational context of inter-organizational relationships. In explicit, it explores the control mechanisms through which a hybrid organization such as a two-sided platform business can be controlled in a way that it moves towards its strategic innovation objectives. Explicitly, Simons (1987;

1990) suggests that the management control mechanisms applied should be tailored to support the strategy of the business in order to lead to competitive advantage and superior performance. Descriptions of strategy formulation and implementation, however, frequently imply that strategy is an outcome of a deliberate stream of decisions. In particular, Mintzberg (1987) and Quinn (1980) stress the ambiguous nature of strategic decisions and call for management systems that allow for flexibility and creativity in order to be responsive to emergent strategies (see section 3.4.1). As a result, academic literature frequently considers strategic planning and control as two sides of the same coin, highlighting that planning activities are followed by control activities in order to ensure that the planned activities are actually implemented (Grünig, 2002). Explicitly, it is stated that planning is meaningless without control, while control is not possible without planning (Wild, 1974). In line with Merchant (1985), Küpper (2005) and Hutzschenreuter (2009), the present work considers planning and control as two important management functions in innovation management that share important connection points.

The remainder of this section proceeds as follows: In a first step, the term 'innovation strategy' is defined, followed by a description of the innovation strategy formulation process. The outcomes of innovation strategy are considered to serve as foundation for choosing and applying appropriate management control forms. Correspondingly, in a second step, the term 'management control' as well as its primary categories as to be found throughout academic literature are explained. Section 3.4.3, then, explores state-of-the-art research on management control in inter-organizational relationships, highlighting both the management control mechanisms identified so far as well as the need to further investigate the management control mechanisms as applied in industry practice.

3.4.1. Innovation Strategy Formulation

Although the term 'strategy' has become a key term in management literature, it varies according to the different management schools. Given the definitions of 'strategy' already provided in section 2.1.3, the present work adopts the definition proposed by Sauber & Tschirky (2006: 21): "A strategy sets strategic goals and strategic paths considering the today, the tomorrow and the after tomorrow for setting the company's direction, focusing efforts, allowing the organization to be defined and providing consistency in a balanced manner". The most critical element of strategy, thereby, is to conceptualize a vision about what kind of knowledge should be developed and how to operationalize it (Nonaka & Takeuchi, 1995). In this context, Mintzberg (1987: 13) distinguishes between "deliberate strategies, where intentions that existed previously were realized from emergent strategies, where patterns developed in the absence of intentions, or despite them". From this point of

view strategies are seen to emerge from proactive (planned) and reactive (emergent) strategic decision making.

Concerning the formulation of strategy, Mintzberg & Lampel (1999) have analyzed and clustered ten different schools, highlighting the changing understanding of strategic management throughout the past decades. Therein, examples like the 'stakeholder analysis' (Mason & Mitroff, 1981; Crosby, 1992), the 'resource-based theory of a firm' (Wernerfelt, 1984) or 'dynamic capabilities approach' (Teece et al., 1997) have become hybrids, linking parts of the different schools. In addition, strategies can be differentiated into leadership and followership strategies (Porter, 1985). While the first is targeted at being the first into the market with an innovation in order to gain first-mover advantages, in followership strategy the company enters the market later in the lifecycle. Once demand has grown sufficiently to allow significant economies of scale, cost advantage over competitors can be achieved. Explicitly, Maidique & Patch (1988) claim that individual strategies are not mutually exclusive. Organization might adopt different strategies in different markets at the same time, or different strategies in the same market at different times.

Contrarily to the broad interest on 'strategy,' the term 'innovation strategy' is sparely defined in literature. Schlegelmilch (1999: 106) claims that "an innovation strategy defines the long-term objectives and fundamental directions of the innovation activities of the company and is therefore an integral part of the strategic […] direction of the company". Bullinger & Auernhammer (2003: 29) add the aspect of competitive advantage: "An innovation oriented strategy creates new products and processes as well as new forms of client interaction. The objective is not to pass the competitors on the same path, but to pass them on an innovative way to ensure the company's competitive advantage […]. In the focus of the innovation oriented strategy are not only products, but also production processes and company structures". Faems et al. (2006) claim that innovation strategy is targeted at improving and refining existing technologies, products and services as well as the development of new technologies, products, services and competencies. Sauber & Tschirky (2006: 41) define innovation strategy as to set direction, focus efforts, allow the design of an organization and ensure consistency in the innovation system, "while considering integral innovations, innovation barriers, and the degree of newness of the innovation as well as the required innovation relevant knowledge".

Similarly to the generic strategy formulation process, academic literature on innovation strategy formulation is diffuse. Per definition, "strategy formulation is the process of deciding on the goals of the organization and the strategies for attaining these goals" (Anthony & Govindarajan, 2007: 9). Quinn (1985) states that innovation strategy has to be

integrated into the concept of corporate strategy. Correspondingly, innovation strategy has to define the targeted innovation domains. Dedicated motivation and control systems support the company in developing strategy in a goal-oriented manner. Martensen & Daalgard (1999) claim that innovation strategy is planned by the company's top management in alignment with the company vision and corporate strategy. Hence, strategy formulation embraces a process, wherein opportunities are evaluated in order to identify new business opportunities. Feedback loops are considered an important part of the formulation process. Tschirky (2003) sees the formulation of an innovation strategy as a special issue in the process of formulating corporate strategy, and, hence, parallel to other functional strategies. According to him, the formulation process embraces six steps: (1) Setting strategic objectives, (2) analyzing the environment, (3) analyzing the company, (4) elaborating strategic options, (5) taking strategic decisions and (6) implementing the strategy. Afuah (1998; 2002) introduces the 'strategic innovation process', wherein a firm sets a mission and corresponding goals in a first step. In order to achieve these goals, the company scans its environment and other sources of innovation for opportunities and threats. Next, the company formulates several strategies: In its business strategy, it decides whether the product or service as outcome of the process will be low cost, differentiating or both. In its innovation strategy, it decides whether to follow a leadership or followership strategy. According to Afuah (1998) both business and innovation strategies help driving functional strategies, constituting a strategic direction that drives the following implementation process.

Sauber & Tschirky (2006), in turn, differentiate between the normative, strategic, and operational management level. The authors claim to integrate the innovation strategy formulation process into the company's value defining process. According to Sauber & Tschirky's (2006) framework, primary decisions are to be taken on the normative level, considering the context of the organization's strategic long-term goals. This requires the development of a consistent company policy and the derivation of an innovation policy. On the strategic level, it is important to transpose these policies into comprehensible strategies. Based on the company's strategic intelligence, which on the one side formulates the information requirements and on the other side, analyses these information, the innovation strategy process is triggered. It starts with the 'identification phase', which revises the innovation portfolio for the purpose of understanding the current situation, identifies new opportunity fields and details these opportunity fields in a cyclic manner. In the 'evaluation phase' the innovation opportunities are evaluated by assessing their strategic fit, their qualitative and quantitative key figures and setting the directions for 'make or buy/keep or sell' decisions. As such, the formulation process is finalized, requiring its proper implementation in the next step.

Given these different perspectives on the innovation strategy formulation process, the key managerial challenge relates to the successful implementation of innovation strategy. As noted by Simons (1994: ix) "best-laid plans are worthless if they cannot be implemented successfully". This indicates that - besides the aspects of organizational structure, culture, or human resource management that are not in the focus of the present work - managerial mechanisms of control become apparent to a successful implementation of strategy (Anthony & Govindarajan, 2007).

3.4.2. Management Control

Management control is considered as "the process by which managers influence other members of the organization to implement the organization's strategies" (Anthony & Govindarajan, 2007: 6). The resulting managerial challenge is to induce individual members of the organization to act 'goal congruent', which means, in pursuit of their personal goals in ways that help the organization attaining its strategic goals.

Fundamentally, the term 'control' is used in a variety of contexts to express the influence of an entity on the behavior of other entities in desirable ways (Anthony & Govindarajan, 2007). Frequently, however, the term carries a strong negative connotation, embracing synonyms such as command, dominate, direct, steer, pilot, hold, sway over, rule, exercise power or authority over, govern, manage, lead, conduct, call the tune, guide, oversee, supervise, check, hold back, curb and repress (Collier, 2005). As one of the first definitions in the broader context of management, Fayol (1949) understood control as verification whether everything occurs in conformity with the plan adopted, the instructions issued, and principles established. Explicitly, Anthony (1965) defined the term 'management control' as "the process by which managers ensure that resources are obtained and used effectively and efficiently in the accomplishment of the organization's objectives". Subsequently, this definition limited organizational research to envisage management control as encompassing the largely accounting-based controls of planning, monitoring of activities, performance measurement and integrative mechanisms. It further served to artificially separate management control from strategic control and operational control (Langfield-Smith, 1997). Throughout the past decade, however, it became apparent that the traditional orientation towards accounting controls and accounting information is not sufficiently broad to effectively control an organization (Langfield-Smith, 1997). Hence, the term 'management control', today, rather refers to the Anglo-American meaning of steering, monitoring and execution an organization's behavior (Hutzschenreuter, 2009). In this context, Merchant (1985) emphasizes that 'control' means keeping things on track and to influence proper behaviors of the people in the organization. Correspondingly, Tannenbaum (1968: 5) defines control as a "process in which a person or group of persons

or organizations of persons determines, that is, intentionally affects, the behavior of another person, group, or organization". Emending his earlier definition, Anthony et al. (1989) as well as Simons (2000), today, understand management control as the techniques that effective managers use to set direction and achieve desired goals for the organizations they lead.

Management control can be achieved in many ways, ranging from direct surveillance via feedback systems to social and cultural controls (Simon, 1995). Correspondingly, control forms have been categorized in various ways. In a critical review, Langfield-Smith (1997) lists primary management control mechanisms as suggested by different authors: Formal and informal controls (Anthony et al., 1989); output and behavior controls (Ouchi, 1977); market, bureaucracy and clan controls (Ouchi, 1979; 1980); administrative and social controls (Hopwood, 1996); as well as results, action and personnel controls (Merchant, 1985a). In particular, the differentiation between formal and informal controls has been adopted widely throughout academic literature: While formal controls include rules, standard operating procedures and budgeting systems, informal controls include the unwritten policies of the organization and often derive from the organizational culture (Langfield-Smith, 1997).

3.4.3. Management Control in Inter-Organizational Relationships

While organizational research in the area of management control primarily focuses on the intra-organizational perspective, in particular the past two decades have witnessed a tremendous rise in inter-organizational relationships and hybrid organizational forms (Van der Meer-Kooistra & Vosselman, 2006). In consequence, management control is no longer confined to the legal boundaries of the organization (Otley, 1994). Correspondingly, Dekker (2004) argues that the boundary-spanning forms of organizing economic activities have several implications for the role of management control in and, in particular, between organizations.

Building upon insights from both management control theory and organization theory, Dekker (2004) highlights the importance of formal and informal control mechanisms in inter-organizational relationships. With reference to Larson (1992) and Chiles & McMackin (1996) he argues that transactional cost economics has not been very useful for understanding an inter-organizational relationship's governance as the theory's main ability is to predict the form of governance structure as a function of transaction characteristics (see section 3.4). This prediction, he claims, is insufficient to adequately explain the management and control of inter-organizational relationships due to three reasons: First, due to its singular focus on the notions of opportunism and transaction cost minimization, TCE lacks recognition of the variety of organizational forms in inter-

organizational relationships as well as their differing goals. Second, the static nature of TCE has resulted in a negligence of the organizational control mechanisms applied in the governance of inter-organizational relationships. Third, due to its lack of dynamism, TCE has taken little account of the social mechanisms of governance although inter-organizational relationships are embedded in a rich and influential social context. Concerning the control mechanisms applied in inter-organizational relationships, he concludes that both appropriation concerns as well as the coordination requirements of interdependent tasks between partners become relevant as firms' need to manage the creation of value while safeguarding its appropriation (Dekker, 2004):

- *Appropriation of Value:* Companies are required to make investments specifically for inter-organizational relations and need to safeguard their investments from being appropriated by the potentially opportunistic behavior of others. However, investments are often made in situations characterized by uncertainty so that all contingencies that may arise in future can not be covered in contractual agreements. Thus, they potentially leave room for opportunistic behavior that requires organizational control.
- *Task Interdependency*: The level of interdependence in inter-organizational relationships varies from very low, requiring few coordination efforts, to very high, requiring a continuous communication and decision making between partners. In this context, Thompson (1967) categorized pooled, sequential and reciprocal interdependences: In inter-organizational relationships characterized by pooled interdependence each partner renders a discrete contribution to and, hence, can draw from the common pool of resources. Correspondingly, coordination requirements are low. In inter-organizational relationships characterized by sequential interdependence resources are transferred from one partner to another. Coordination efforts, thus, embrace to ensure an appropriate fit between partners. Finally, in inter-organizational relationships characterized by reciprocal interdependence the partners' activities represent necessary inputs for each other's activities. This requires complex coordination mechanisms for communication and ongoing adjustment.

Concerning the means of management control, research on management control in inter-organizational relationships is inconsistent. In example, Gulati & Singh (1998) propose five types of control mechanisms: Command structures and authority systems, incentive systems, standard operating procedures, dispute resolution procedures and non-market pricing systems. In turn, Dekker (2004) highlights the importance of informal or social control mechanisms in inter-organizational relationships. With reference to Klein, Palmer, & Conn (2000) he states that repeated interactions can cause an inter-organizational

relationship to become embedded in an influential economic and social context, which may strongly influence its formal structure.

In summary, management control is of substantial importance for the performance of inter-organizational relationships. Despite its importance, however, research into the actual structuring, management and control of these relationships and related processes has received less attention (Gulati & Singh, 1998; Sobrero & Schrader, 1998; Dekker, 2004). Grandori (1997) as well as Ireland et al. (2002) claim that in order to understand the management and control of inter-organizational relationships and their consequences, researchers should study and describe the coordination mechanisms and processes used for the management of the respective inter-organizational relationship.

3.5. Critical Evaluation and Shortcomings in State-of-the-Art Research

As shown, recent industry changes towards open modular platforms result in important implications on competitive behavior of two-sided platform businesses. Complementary innovations, in particular, are an important source of indirect network externalities, which support the platform's market adoption. This requires the platform owner to open its innovation process and source external innovations to complement the core platform value proposition. Major obstacles in the pursuit of an innovation goal, however, emerge from the peculiarities of platform ecosystems, being determined by the non-linear and autonomous behavior of interdependent complementors, striving for profitable growth. In result, the peculiarities of two-sided platform businesses place new requirements on managing innovation, in particular, on coordinating external complementary innovations within the context of a platform leadership strategy (Scholten & Scholten, 2010). This indicates that in order to reap the full potential of innovations activities taking place within platform ecosystems, platform owners have to play the architect role (Chesbrough, 2003a), leading the evolution of the overall platform-based value proposition. Therefore, platform owners are required to envision and control the platform' evolution, in explicit, with regard to realizing systemic innovation in decentralized open innovation processes.

When reviewing related literature on open innovation, this research stream reveals a very young field, in which most interest has been put into the subject as such (Fredberg et al., 2008). Still, academic research is focused on explaining the importance of the open innovation phenomenon and why to open up the innovation process rather than focusing on its operational implementation. Nevertheless, state-of-the-art research on open innovation perceives inter-organizational networks crucial to open innovation, in particular, when creating 'systemic innovation' (Chesbrough & Teece, 1996). In consequence, the innovation process is considered to become increasingly open and collaborative, requiring companies to take a wider perspective to innovation management

and adopt new governance modes appropriate to managing value creation and appropriation, in particular in the context systemic innovation (Maula et al., 2006). Despite the importance of systemic innovation for the platform's overall success (Teece, 1986, Gawer & Cusumano, 2002; 2008), as well as the growing interest in open innovation (Chesbrough, 2003; Chesbrough et al., 2006), little light has yet been shed on related open innovation processes on a company or an inter-organizational level as well as on the respective management control techniques to gain competitive advantage, ensure focus and value capture of open innovation efforts (Hagel & Brown, 2008). Explicitly, the peculiarities of managing open innovation in the context of a platform leadership strategy lack academic attention (Scholten & Scholten, 2010). Reviewing related state-of-the-art research revealed further significant shortcomings in academic research.

3.5.1. Organizational Perspective

From an organizational perspective, academic literature concludes that different types of innovations require different organizational arrangements and innovation processes (e.g. Henderson & Clark, 1990; Christensen & Bower, 1996; Chesbrough & Teece, 1996). While most research focuses on incremental, radical or disruptive innovations and their organizational requirements, only a few authors consider the innovation type of 'systemic innovation' and its corresponding organizational arrangements (e.g. Chesbrough & Teece, 1996). Thereby, research targeted at the organization of systemic innovational efforts primarily focuses on organizing systemic innovation in a centralized manner. This view, however, has been severely challenged as many contemporary systemic innovations are too complex for a single company to manage (De Laat, 1999). Given this challenge, Maula et al. (2006) have proposed the 'framework for proactively managing systemic innovations in industry leading companies', emphasizing the activities of foresight and active industry shaping. Compared with the research purpose and related research objectives of this thesis (see sections 1.2 and 2.4), their framework, however, lacks explicit considerations of (a) the peculiarities of two-sided platform businesses, (b) platform leadership aspects as well as (c) dedicated management control mechanisms to effectively drive systemic innovation, attract and retain the commitment of external resources.

3.5.2. Strategic Perspective

Concerning the strategic perspective, a growing community of researchers on platform leadership examines how platform owners can encourage third-party complementors to contribute to platform success by stimulating indirect network effects (e.g. Gawer & Cusumano, 2002; 2008; Gawer & Henderson, 2007; Iansiti & Levien, 2004). Of particular concern is the fine line that platform owners have to walk between maximizing profits and leaving sufficient residual profit opportunities to encourage external complementary

innovations. Thereby, important insights on platform leadership have been drawn, considering a 'thriving ecosystem' as a major success factor for an industry platform to emerge. Explicitly, four levers of platform leadership have been identified in order to drive industry-wide innovation (Gawer & Cusumano, 2002). Further, it has been argued that it is generally in the interest of a platform owner to enter complementary markets, but that such entry must be balanced against the costs of discouraging entry by new firms (Gawer & Henderson, 2007). Hence, the need to maintain cooperative relationships with complementors has been identified as specific challenge to the platform owner, especially as platforms evolve. In this context, Gawer & Henderson (2007) explore the topic of market entry into complementary markets, making explicit its organizational structure and processes as commitment mechanisms to maintain the complementors' innovation incentives. As a result, research on platform leadership emphasizes the importance of platform evolution. However, existing literature on platform leadership lacks explicit guidance on how to manage internal and external innovational efforts in a holistic manner. In particular, the implications of a platform leadership ambition on the platform owner's innovation management have not been explored. Thus, recent literature on platform leadership rather addresses innovation strategy and planning aspects, but lacks operational considerations concerning the innovation process and related management mechanisms in order to integrate external complementary innovations and foster a thriving ecosystem.

3.5.3. Engineering-centric Perspective

With regard to the engineering-centric perspective, a sizeable body of research on product family design and platform-based product and service development has been reported over the last decades (Simpson, 2004). In particular, in the manufacturing and automotive context, many researchers have focused on product family development practices in order to provide sufficient variety to the market, while maintaining the economies of scale and scope within their manufacturing capabilities (Robertson & Ulrich, 1998). In particular, Jiao et al. (2007: 5) conclude that "the literature involves many, if not all, aspects of product fulfillment within a manufacturing enterprise. Product family design and development has been tackled from various perspectives […], such as the areas of business strategy, marketing, manufacturing and production, customer engineering, information technology, and general management". Nevertheless, this research stream focuses on the intra-organizational perspective, and lacks explicit considerations on how to evolve a platform in the inter-organizational context of a two-sided platform business model.

3.5.4. Managerial Perspective

State-of-the-art research on management control primarily considers the intra-organizational perspective, focusing on controls that are directed at employees to influence their behaviors in desirable ways. However, the past two decades have witnessed a tremendous rise in hybrid organizational forms (Van der Meer-Kooistra & Vosselman, 2006), recognizing that management control is no longer confined to the legal boundaries of the organization. In this context, Dekker (2004) provides insights from management control and organization theory, arguing that inter-organizational relationships require both formal and informal control mechanisms. While formal control embraces e.g. contractual obligations, service level agreements, structural arrangements, planning procedures, performance monitoring and reward systems, informal control also refers to mechanisms of encouraging self-regulation (Berry et al., 2009). Particularly, studies on informational control are geared towards the notion of trust between collaborating parties in order to coordinate interdependent tasks and manage appropriation concerns (Dekker, 2004). Therein, trust is frequently referred to as an expectation, based on the experience that a partner will not behave in an opportunistic manner (Tomkins, 2001). With reference to section 4.3, the aspect of trust, however, is only one facet of managerial control in successful platform leadership, which rather requires an adept combination of different management control mechanisms. Yet, the increasing control needs in inter-organizational forms have received less attention. With reference to Berry et al. (2009) it is concluded that there appears to be a gap in the theory and practice of management control for new organizational forms.

3.5.5. Shortcomings in State-of-the-Art Research

Firm competencies of two-sided platform businesses need to be understood in terms of their organizational structures and managerial processes that support productive activity and value creation (Teece et al., 1997). Thereby, the essence of competences and capabilities is embedded in organizational processes although, "the content of these processes and the opportunities they afford for developing competitive advantage […] are shaped significantly by the assets the firm possesses (internal and market) and by the evolutionary path it has adopted/inherited" (Teece et al., 1997: 518). Correspondingly, the present work argues that a key competence of two-sided platform businesses lies in coordinating and integrating internal and external innovation efforts along the entire innovation process within the context of their platform leadership strategy. Yet, academic research has not addressed this topic with the consequence of the absence of:

- A fundamental understanding of (a) the implications two-sided platform business models place on innovation management as well as (b) the resulting tasks of innovation management within this strategic context;
- A related innovation management cycle, supporting the platform owner in formulating, implementing and adapting innovation strategy;
- Guiding principles for innovation planning and decision making concerning internal and external innovational efforts to be pursued in the context of the platform leadership strategy;
- A related management control model, supporting the platform owner in implementing its innovation strategy within the platform ecosystem;
- A concrete innovation process model, guiding the platform owner in managing open innovational efforts within the context of a platform leadership strategy.

4. Requirements Elicitation

Based on existing literature, a profound understanding of two-sided businesses and recent shortcomings in managing open innovation within these businesses has been gained throughout chapter 2 and 3. Within chapter 4, the present work advances state-of-the-art knowledge by deriving the requirements that two-sided platform businesses place on innovation management. The requirements elicitation process starts with a literature review, analyzing the peculiarities of value creation in two-sided platform businesses. Based on these insights, the challenges and implications on innovation management are discussed from an internal perspective in interviews with SAP senior executives as well as in focus groups with corporate strategists and innovation experts at SAP. From an external perspective, phase 3 entails an observational study, exploring the sub-processes, decision gates and means of control leading platform owners in the ICT industry have implemented to steer the development of external complementary innovation. These insights provide a profound base to derive the requirements that two-sided platform businesses place on innovation management.

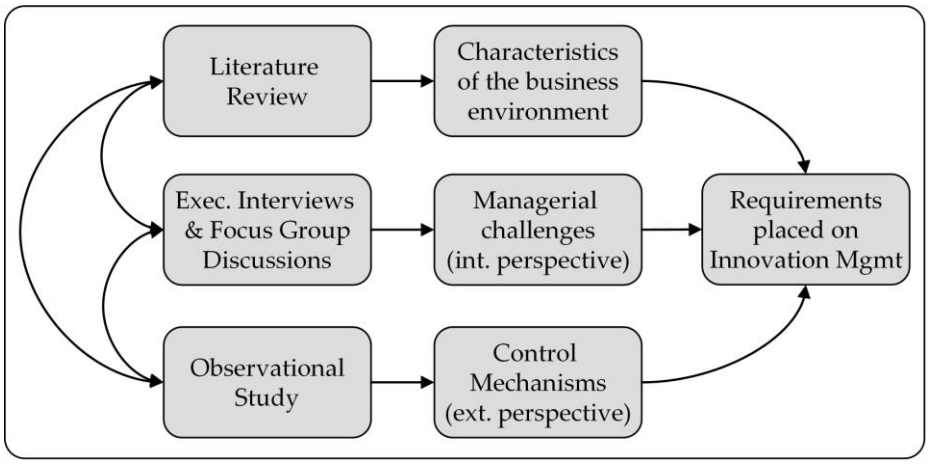


Figure 13: Requirements Elicitation Process (own illustration)

As indicated in section 1.3, the collected data has been analyzed in a stepwise approach: In a first step, the collected raw data has been reviewed from a neutral perspective in order to identify emerging themes. Then, the data has been analyzed and the requirements placed on innovation management in two-sided platform contexts have been derived. The chapter closes with an explicit call for a dedicated 'platform-based innovation management' approach, targeted at managing open innovation in the context of a platform leadership strategy.

4.1. Phase 1: Literature Review

A key point of departure for exploring the peculiarities of value creation in two-sided platform businesses resolves from the pervasive migration from vertically integrated enterprises towards specialized enterprises interoperating to flexibly co-create end-to-end value to their customers (Scholten & Scholten, 2010). As highlighted in chapter 1, these transformations alter traditional supply chains, while centering on customers and their need for individual end-to-end solutions (Basole et al., 2008; Kagermann et al., 2008; Cherbakov et al., 2005; Li et al., 2002). In the sequel, the shift from rigid supply chains to customer-centric business networks is reviewed, emphasizing the implications of changing value creation processes on the platform owner's capability to innovate and create sustainable customer-added value.

4.1.1. Data Collection and Analysis

In order to identify recent characteristics of value creation in two-sided platform business, a literature review has been conducted. It reviews current knowledge in the area of 'On-Demand' businesses as well as service-oriented architectures (SOA) and Web Service technologies in order to draw conclusions on the platform owner's required managerial capabilities to create customer added value in platform markets. Conclusions have been drawn by exploring the characteristics of the business environment and analyzing their implications on the platform owner's managerial capabilities.

4.1.2. Findings

The driving force behind recent business transformations is the customers' demand for "product and service customization, speed and high levels of quality of service, all in a seamless fashion and preferably from a single provider (see also chapter 1). In consequence, the relationships among companies as well as their corresponding business models change. Value nets emerge, being defined as "a digital supply chain to achieve both superior customer satisfaction and company profitability" (Bovet & Martha, 2000: 8).

4.1.2.1 On-Demand Businesses

These inter-organizational value constellations represent an entirely new class of business design, wherein enterprises seamlessly collaborate with other enterprises empowering customers to design their own products and services by choosing from a set of components and service options (Bovet & Martha, 2000). These dynamic systems are able to recognize change as it is occurring and to react appropriately, ahead of the competition in order to keep pace with the demands of their customers. Cherbakov et al. (2005) refer to these businesses as 'on-demand' business, considered being equivalent to achieving total

business flexibility to fulfill customer demands. The enablers of an 'on-demand business' are based upon the notion of 'service orientation' as well as upon the concept of modularization, in an organizational context referred to as 'deconstruction' or 'unbundling' (Hagel & Singer, 1999) as well as 'componentization' of a corporation (Cherbakov et al., 2005). The concept of modularization or componentization "allows an enterprise to deconstruct, analyze, and then reconstruct into value nets, in which partnerships with customers and suppliers operate in a network supported by real-time information flows and integrated IT systems", realized through business components, which correspond to distinct business functions (Cherbakov et al., 2005: 654). In turn, a seamless integration of business components across the value net is achieved through the notion of service orientation. Therein, "each business component serves a unique purpose and provides one or more business services for consumption by other business components. The component that consumes a business service offered by another business component is oblivious to how the provider creates the business service. Interactions between business components are governed by business-level agreements and contracts, which cover items such as cost structures, service levels, and so on" (Cherbakov et al., 2005: 654).

With focus on the ICT industry, both service-oriented architecture (SOA) and Web Service technologies have proven to be well-suited to realize the 'On-Demand' business: Customers are enabled to compose the service combinations that best suit their needs by mixing and matching multiple modular product and service components (Baldwin & Clark, 2000) with the base value of a platform offer. This approach allows for sophisticated, cost efficient composite solutions driven by customer choice, in the following referred to as "customer-driven composite solutions" (Scholten & Scholten, 2009). While the traditional supply chain approach develops products and pushes them through distribution channels in a cost-efficient manner with acceptable service (Bovet & Martha, 2000), customer-driven composite solutions are built based on flexible, loosely coupled supply chains, provided by an open pool of autonomous complementors (Cherbakov et al., 2005) on top of a focal platform. Thus, platform owners often do not have to cope with one layer of complementary service providers only, but with flexible networks of interconnected autonomous complementors.

4.1.2.2 Peculiarities of Value Creation

Platform-based value nets develop due to the mutual benefits autonomous partners gain in linking their investments. In doing so, they accept reciprocal dependences, which, in turn, lead to strong implications on economic value creation and capture in distributed ownership. Within this setting, the platform owner offers its customers the core platform, complemented by core applications and services, and the flexibility to modify or extend the

core offering through complementary products and services (Scholten & Scholten, 2010). Correspondingly, figure 14 depicts the principle setting of value creation in two-sided platform businesses, wherein a focal platform becomes the centerpiece of value creation. Of particular importance is the platform ecosystem, embracing (Scholten et al., 2009):

- The platform owner, providing the platform and core platform offerings;
- Autonomous, but interdependent product or service complementors enabling the 'whole' customized solution;
- The customers, composing the solution that best suits their needs.

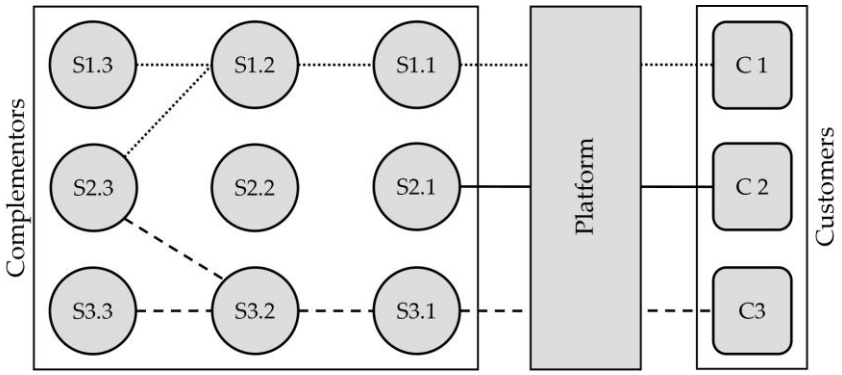


Figure 14: The Principle Setting of Value Creation in Two-sided Platform Businesses (Scholten et al. 2009; 2010)

For further clarification, the principle setting of value creation in two-sided platform businesses is explained in the context of 'customer-driven composite solution' in the ICT industry: The setting consists of a platform, that is – according to actual customer preferences - complemented by a first tier of services. Principally, a first tier service (S1.1, S2.1, S3.1) may be either a basic service (S2.1) or a complex service (S1.1, S3.1), aggregated from multiple sub-services (e.g., S1.2). On the one side, this modular approach enables customers to compose the solutions or service combinations that best suit their needs, on the other side, this approach allows the platform owner to provide sophisticated, cost efficient composite solutions driven by customer choice (Scholten et al., 2009). This example emphasizes the temporal aspect inherent to the nature of customer-driven composite solutions: These solutions are provided by loosely coupled value chains, forming on demand through individual customer choice. They emerge through customer choice and for the time of value creation. These temporary "service value nets" (Fischer & Scholten, 2009) can be considered as primary value enablers within the overall platform ecosystem. They are defined as instances of the platform ecosystem, consisting of individual complementors, the intermediating platform owner, the customers as well as their

respective relations within one period of composite generation and consumption (Fischer & Scholten, 2009). Correspondingly, the resulting customer added value creation is determined by the platform owner's capability to:

- Provide a core platform offer, aggregated with a mix of complementary third party products and services in order to dynamically react with the customers' evolving demand;
- Mediate demand between customers and the supply of complements;
- Facilitate and mediate ever new combinations of complementing products and services that dynamically arise from the interaction between autonomous complementors, seeking for profit.

4.2. Phase 2: Expert Interviews and Focus Group Discussions

Based on the identified peculiarities of value creation in two-sided platform businesses, interviews with SAP executives as well as discussions with focus groups have been conducted in order to derive the challenges and implications on innovation management. By discussing the topic in numerous interviews and related focus group discussions, the risk of missing important aspects concerning the management of open innovation in two-sided platform contexts can be mitigated.

4.2.1. Data Collection and Analysis

Throughout the timeframe of the present work, about 50 semi-structured interviews have been conducted, complemented by discussions with focus groups. The interview partners and participants of the focus groups embraced senior executives, corporate strategists and innovation experts at SAP, eliciting the author's understanding of the challenges a leading platform owner in the ICT industry faces with regard to managing open innovation within the context of its platform leadership strategy. In order to identify the related challenges and requirements placed on innovation management, the following questions have been derived from Tidd & Bessant's (2009: 44) innovation process model.

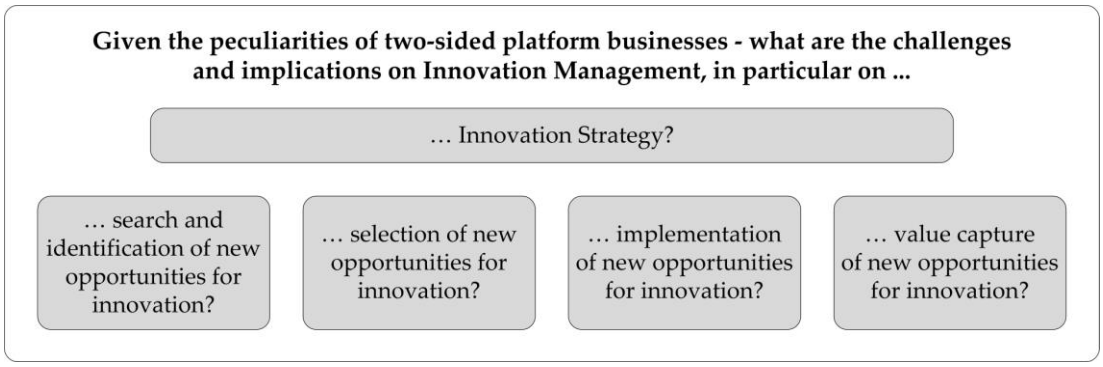


Figure 15: Primary Questions guiding Interviews and Discussions
(own illustration adopted from Tidd & Bessant, 2009)

4.2.2. Findings

Both the interviewees as well as the focus group's participants acknowledged the strategic importance of nurturing a platform ecosystem that continuously supplies complementary innovations. Due to indirect network externalities inherent to platform markets, they confirmed that their platform's market success would critically depend on the company's ability to strategically orchestrate a value net of complementary capabilities. As a result, figure 16 depicts the challenges placed on managing innovation in the context of two-sided platform businesses that have been identified throughout the interviews and discussions.

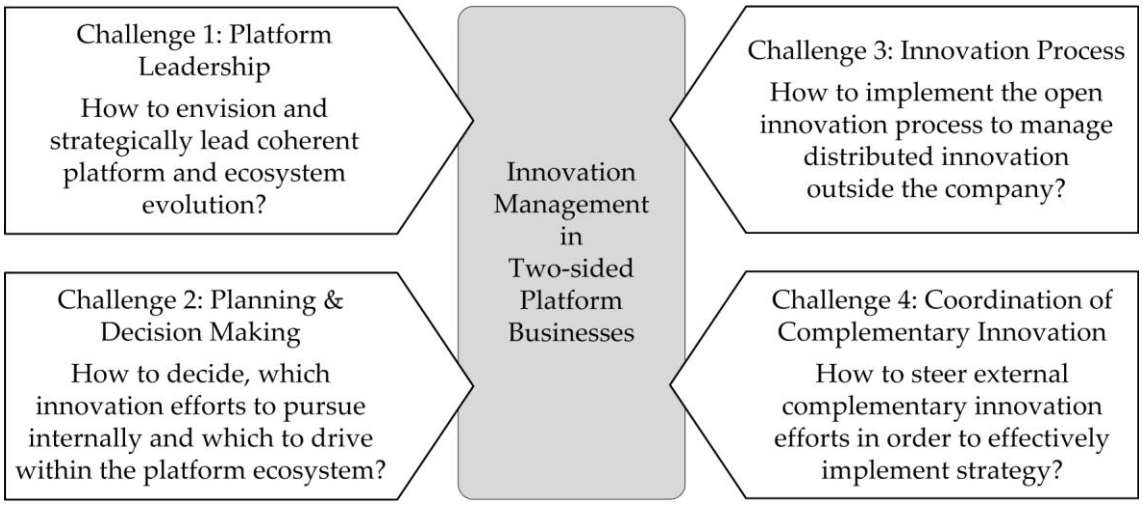


Figure 16: Managerial Challenges placed on Innovation Management (own illustration)

In the sequel, these challenges are described:

- *Challenge 1 - Platform Leadership:* Platform ecosystems evolve around a core platform offer, being initiated by the opening of dedicated platform interfaces to external complementary resources. They evolve in accordance with the strengths of indirect network externalities inherent to the platform's market adoption. Explicitly, the interviews and focus group discussions underline the relevance of Gawer & Cusumano's (2002; 2008) findings: The explicit dependency from autonomous third party companies to complement the overall platform value proposition requires the platform owner to shape a platform ecosystem of complementary capabilities and drive external complementary innovation on top of the platform. In result, this holds the platform owner responsible for leading a continuous, efficient platform evolution, while ensuring that external complementary products and services provided by the platform ecosystem evolve simultaneously and coherently with the platform.
- *Challenge 2 - Comprehensive platform-based Innovation Planning and Decision Making:* The mutual dependences between platform owners and their platform ecosystems make clear that the performance of the single company is increasingly dependent on constant innovation. Correspondingly, the interviewees and discussions partners claim that the platform owner has to decide about the core innovation activities to be pursued in-house as well as about the complementary innovation efforts to be initiated and coordinated within the platform ecosystem. With regard to the implementation of new business opportunities they affirm that strategic innovation planning and decision making has to follow the principle of shared value, whereas choices must benefit the platform owner as well as the complementor. Correspondingly, the platform owner has

to balance interest between appropriating the returns from innovation investments and the platform's market adoption.

- *Challenge 3 - Organization of Open Distributed Innovation Processes:* The innovation process in two-sided platform businesses becomes increasingly open, distributed, and coopetive, while being located to a great extent outside the platform owner's company boundaries. In line with recent results on open innovation in inter-organizational context (Chesbrough et al., 2006; Fredberg et al., 2008), the interviews and focus group discussions highlighted the need for implementing an internal and an external innovation process, both closely interlinked. Explicitly, extrinsic means of control to motivate profit-seeking complementors to co-innovate on top of the platform have been recommended to control the external complementary innovation process.
- *Challenge 4 - Coordination of Complementary Innovational Efforts:* The systemic nature of innovation in open modular platforms raises specific attention to the complementarity of innovational efforts as complementarity gives raise to indirect network externalities, determining platform market adoption. In conclusion, the interviewees and participants agreed that steering external complementary innovation explicitly embraces the requirements of (a) exploiting indirect network externalities in order to drive market adoption and (b) fostering and coordinating external complementary innovation efforts, while enhancing the core platform offer. Correspondingly, they confirm that platform owners are forced to adopt new modes of control in order to foster complementary innovation on top of the platform.

In summary, these key challenges lead to 5 basic implications for innovation management in two-sided platform businesses:

- *Nurture an environment for innovation:* The systemic character of innovation in open modular platforms causes innovations to arise from the collective expertise of participants within the platform ecosystem. Thereby, complementary relationships base upon past managerial decisions to create or attract certain resources and capabilities to the platform ecosystem. Innovation management in two-sided platform businesses, therefore, is required to carefully consider incentives to attract complementors and investors to the platform.
- *Lead:* An essential challenge to innovation management in two-sided platform businesses is to strategically lead, coordinate and integrate both internal and external complementary innovation efforts within the context of a platform leadership strategy. Therefore, innovation management in two-sided platform businesses is required to envision both the platform's as well as the platform ecosystem's future evolution. Explicitly, innovation management has to develop a sharp understanding, which

innovational efforts to pursue in-house and which complementary innovation efforts to initiate, accept and coordinate within the platform ecosystem, while ensuring the complementors' goal congruence throughout the entire innovation process. Overall, innovation strategy becomes a primary means of proactively envisioning and guiding both the platform's and the platform ecosystem's evolution.

- *Leverage Open Innovation:* Based upon the strategic innovation goals, innovation management is required to manage proprietary and non-proprietary innovational efforts. Explicitly, the innovation process is separated into an internal and an external channel of searching and selecting new business opportunities that need to be closely interlinked. Dedicated management control mechanisms need to be implemented in order to integrate external complementary innovations coherently into the overall platform-based value proposition.
- *Control:* Major obstacles in the pursuit of an innovation goal emerge from the peculiarities of platform ecosystems, being determined by the non-linear and autonomous behavior of interdependent complementors, striving for profitability. Ensuring that the goals of the participating members within the platform ecosystem are consistent with the innovational goals of the platform owner is of strategic importance. Hence, innovation management is required to stimulate and source external complementary innovation, while controlling the integrity, quality, and continuous optimization of complements.
- *Exploit and share benefit:* The ability to exploit the benefits of platform innovation depends to a great extend on the platform owner's capability of balancing competition and collaboration with complementors. Therefore, innovation management has to define core innovational efforts, while committing to complementors to respect their complementary markets and remain important interfaces open. Overall, the two-sided platform business model has to ensure the complementor's returns on innovation.

4.3. Phase 3: Observational Study

In order to complement the findings gained so far, the observational study explores the external complementary innovation processes and key control mechanisms established platform owners have implemented to steer external complementary innovation efforts within their platform ecosystems. Explicitly, numerous of today's leading platform owners have introduced degrees of decentralized control and autonomy to their platform ecosystem's participants in order to control the evolution of platform-based products and services. For comparison consider a web-shop owner in eBay or Amazon who is to a great extent the master of its product or service mix and pricing, being fully responsible for the choice of his sub-supply chain to complement the core platform offer. These approaches represent alternative mechanism to strategically coordinate external complementary innovation activities: By setting appropriate objectives and development rules that delineate decision and control rights of the platform owner the behavior of the complementor is influenced. Thus, complementors are free to strive for profitability within the limits set by the platform owner's rules (Scholten et al., 2009).

4.3.1. Data Collection and Analysis

The observational study has been done by studying the external complementary innovation processes of leading platform owners within the ICT industry. The set of platform owners embraced: Apple, Inc., eBay, Inc., Facebook, Inc., NetSuite, Inc., Salesforce, Inc., and Microsoft Corporation. The data has been collected throughout 2009 by means of intense Internet investigations. In a first step, the platform business models have been analyzed, indicating the platform business' two- or multisidedness. Based on the common external complementary innovation process characteristics found, the focus of analysis has then been set on the mechanisms of management control. These insights have led to a categorization of control mechanisms, established platform owners have implemented to direct external complementary innovational efforts. Fundamentally, these categories confirm the results of Dekker (2004) who claims that both appropriation concerns as well as the coordination requirements of interdependent tasks between partners become relevant for the choice of control mechanisms (see section 3.4.3). Finally, the 'external complementary innovation reference process' is derived, showing major sub-processes and decision gates as well as primary means of control to steer external complementary innovation efforts within the context of a platform leadership strategy.

4.3.2. Findings

The set of platform owners considered has in common the two-sided platform business model. As shown, these platform owners have opened dedicated Application

Programming Interfaces (API) of their platform to external development resources, while having implemented dedicated external complementary innovation processes to source external complementary innovations. In turn, these platform owners are obliged to attract different user groups to the different sides of the focal platform. Therefore, they provide the infrastructure and rules to connect, mediate and coordinate the multiple groups' transactions on its top in order to charge either one or both sides for accessing the platform or using its services.

4.3.2.1 Platform Owners and their Business Models

The majority of platforms analyzed can be characterized as two-sided platforms, mediating demand between customers on the one side and third party companies on the second side. Facebook.com represents the only case of a 'multisided' platform, embracing the platform customers, third-party companies and developers, as well as advertisers. Figure 17 depicts this principle setting of the investigated platforms.

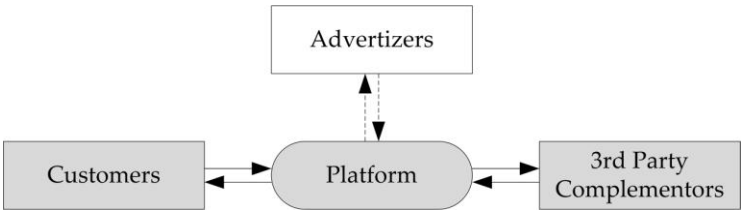


Fig. 17: Principle Setting of the Platforms Analyzed
(own illustration adopted from Evans, 2003a)

This setting indicates that the platform's profitability depends on the fees the platform owner is able to charge each side for using or accessing the platform (see section 2.3.1). Correspondingly, the set of platform examples shows different pricing models that have been implemented by the platform owners in order to attract customers and third party developers to the platform.

- *Apple, Inc.:* Apple, Inc. is an American multinational corporation that designs and manufactures customer electronics and computer software products. The company's best-known hardware products include Macintosh computers, the iPod, and the iPhone. Besides numerous Apple retail stores, Apple Inc. owns and operates the online Apple store, selling Apple Macintosh personal computers and software, iPods, iPhones, third-party complements, and other customer electronics such as the Apple TV. Apple Inc. offers dedicated iPhone Developer and Mac Developer Programs to third party complementors. Both programs provide a complete and integrated process for developing applications for Apple's multiple platforms. Apple Inc. charges for participating in one of its development programs.

- *eBay Inc.:* eBay Inc. is an American Internet company that manages the platform 'eBay.com', with focus on online auction and shopping, where people and businesses buy and sell a broad variety of goods and services, worldwide. Open eBay Apps allow developers to create and deliver tailored applications and embed them directly within My eBay for US sellers on eBay.com
- *Facebook, Inc.:* Facebook, Inc. operates a social networking platform, providing features and services in a trusted environment to support people's social communication. Facebook, Inc. creates economic value by delivering customer targeted advertisements to Facebook users and, therefore, charges special provisions to advertisers. Facebook, Inc. offers external developers restricted free of charge access to the Facebook platform. Hence, they are enabled to provide the end-user group described above with third-party applications and, thus, build up its own business on top of the Facebook platform. Further, Facebook Inc. offers advertisers dedicated advertisement services as well as targeted advertising space within a community of over 200.000.000 active Facebook users. Due to their extensive rights to analyze "application, content, and data for any purpose, including commercial (such as for targeting the delivery of advertisements and indexing content for search)" (Facebook, Inc., 2009) given by the end users, Facebook, Inc. is enabled to run dedicated social data analyses and deliver customer targeted advertisements to Facebook users, which in turn, increases the efficiency and effectiveness of the advertiser's advertisement campaign.
- *Microsoft Corporation:* Microsoft Corporation is a multinational computer technology corporation that develops, manufactures, licenses, and supports software products for computing devices. Microsoft enables third party developers to build complementary Windows Phone applications and distribute them via the Windows Marketplace for Mobile.
- *NetSuite, Inc.:* NetSuite, Inc. is a vendor of on-demand, integrated business management software suites for mid-market enterprises and divisions of large companies. NetSuite's hosted online business software is an integrated suite that includes accounting, customer relationship management (CRM), enterprise resource planning (ERP) software, e-commerce and Web site development. At NetSuite, the 'SuiteFlex Developer' Program provides third party developers, solution providers and systems integrators with the resources required to create, customize, extend, and integrate new functionality using the SuiteFlex Platform built into the NetSuite application.
- *Salesforce, Inc.:* Salesforce, Inc. is an online 'software-as-a-service' (SaaS) company distributing business software, in which access to business software is purchased on a subscription basis and hosted offsite. It is best known for its Customer Relationship

Management (CRM) products, which it delivers to businesses over the internet using the SaaS model. With Force.com platform, Salesforce, Inc. enables third party developers to create custom applications or customize existing Salesforce applications.

4.3.2.2 Sub-Processes and Decision Gates

When analyzing the platform owners' external complementary innovation processes it becomes apparent that they reveal common characteristics. Figure 18 depicts the major sub-processes and decisions gates from the third party complementors' perspective.

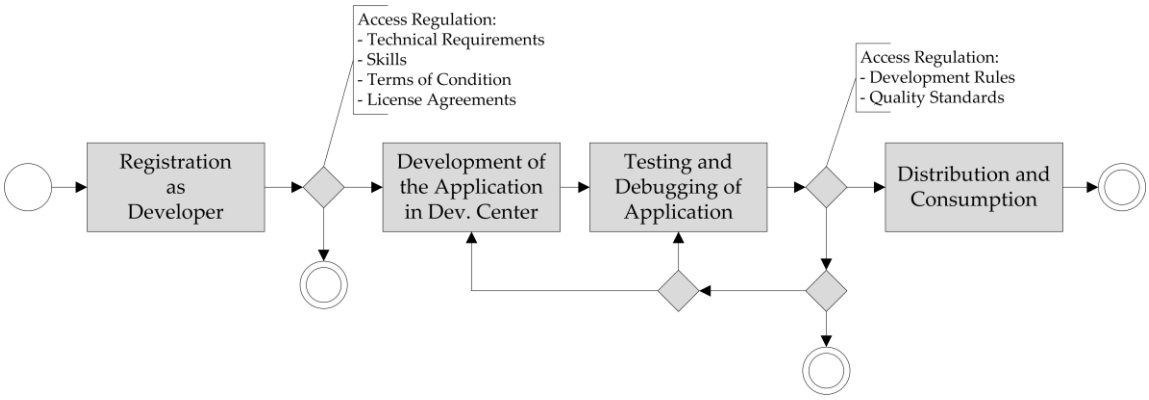


Figure 18: Sub-Processes and Decision Gates in the external Complementary Innovation Process of Established Platform Owners (own illustration)

Commonly, in a first step, third party complementors have to sign up as 'registered developer' in order to gain access to the platform specific development center. Therefore, complementors have to (a) comply with the technical requirements set by the platform owner and (b) have to agree to the platform's terms of conditions and license agreements. The various platform specific development centers, then, provide complementors with technical resources, tools and information on developing applications on top of the respective platform. The role of these development centers is predominantly to ensure the proper technical integration of third party applications into the platform architecture. A dedicated testing and debugging step, then, forces the complementors to comply with the quality standards and development rules set by the platform owner. Having past these gates, third party complementors are allowed to offer their applications via the platform owner's distribution channel to the platform's customer base. In result, the typical external complementary innovation process represents a stage-gate process. Therein, complementors have to pass distinct stages, separated by decision gates prior to proceeding to the next stage.

4.3.2.3 Means of Managerial Control

Further, the industry cases reveal a wide range of control mechanisms implemented by platform owners to orchestrate the development and supply of external applications complementing the core platform offer. Explicitly, these mechanisms move beyond the focus of pricing as a means to regulate platform adoption and, hence, affirm research results gained on platform leadership (see section 3.2). Contrarily, it seems that financial means such as pricing are either of motivational or restrictive nature. In result, the following six categories of control mechanisms can be derived (Scholten & Scholten, 2010):

- *Market Regulative Control:* The primary goal of market regulative control is to inform customers and to put pressure on complementors, as their performance is made publicly visible and will impact the complementor's financial success. In example: Through customer-based verification and auditing as well as the respective publications, the platform owner releases aspects of the complementors' performance. This provides "an incentive for good behavior and, therefore, tends to have a positive effect on market quality" (Audun et al., 2007). Correspondingly, many platform owners apply so-called 'reputation systems'. In these systems, aggregated ratings about a given party are used to derive a trust or reputation score (Audun et al., 2007). Whereas some systems are limited to a quantitative scoring approach, others like Amazon or Force.com allow descriptive reviews for services or products offered. At eBay, high-performers, i.e. those who get a 98% score in feedback, receive a 'power seller' status, which increases visibility and perceived trustworthiness. In a more formalized approach, platform owners such as Salesforce, Inc. offer paid-for, annual reviews leading to a displayed certification for the offered applications. Alike, Facebook, Inc. offers a paid-for verification service rewarded with an attractive 'badging', which is an icon, proving that those applications meet Facebook's quality principles. On top of that, platform owners like eBay have also established advanced, reactive procedures, where complementors are sanctioned, if their scores are too low. In this case, market regulative control is put in a sequence with sanctional control (see below).
- *Co-regulative Control:* Through implementation of development rules and tools, a coherent and observable application quality is ensured. Co-regulative control also includes the legal framework. In all of the successful platforms analyzed, complementors are required to develop their offerings with proprietary tools, interfaces and according to development guidelines that allow the platform owner to observe the application's function and performance in detail. In all stated cases, it also includes the mandatory hosting of applications on the platform owner's infrastructure. This enables the platform owner to ensure the transactional qualities like availability, sufficient replication or computing performance. It further simplifies monitoring the performance

of third party applications. These guidelines always go hand-in-hand with escalation routines, which allow rapid reaction after automated notification on failure, underperformance or disrespect of rules. They are regularly set in sequence with restrictive control, meaning that an application is only published if it is compliant to the rules.

- *Restrictive Control:* These mechanisms apply pro-actively to the supply of an application. Most of the platform owners regulate platform access in accordance with rules set in co-regulative control. This way, initial coherence with the platform owner's goals is ensured. Correspondingly, all leading platforms require automated entrance assessment methods, where each platform owner has to run through an automated link-in procedure. Applications, thus, are only published once the assessment has been successfully accomplished. In general, quality aspects and interoperability-features, but also conformity to rules and policies, are verified. In example, Microsoft applies rigorous testing mechanisms for quality and suitability of 'user experience' (Kretschmann, 2009). Apple even shows a strategy-driven restrictive product range management to avoid conflicts with its own base value contribution or with its own core products. Offerings like Google Voice were refused in July 2009 as it seemed to be in conflict with Apple's business model on mobile communication (Chen, 2009). Explicitly, unauthorized applications are technically blocked in the iPhone environment.
- *Sanctional Control:* Exceeding the commercial and psychological pressure, exerted in market regulative methods, sanctional control acts directly on the complementor. Many platform owners apply sanctional procedures, including the removal an offering from the platform, if specific rules or guidelines are not met. In eBay's 'Verified Rights Owners' program for instance, the platform owner enables rights "to easily report and request removal of listings offering items or containing materials that infringe their intellectual property rights" (eBay, 2009). Further, eBay has established policies and rules for vendors, including prohibition and restrictions of items and listing practices and performance guidelines. Violation will lead to sanctions, e.g. listing cancellation, forfeit of eBay fees on cancelled listings, limits on account privileges, loss of power seller status or account suspension. In Facebook's 'statements of rights and responsibilities', Facebook explicitly reserves the right to analyze and audit third party applications, content, as well as data for any purpose, to limit developers' and operators' access to data and to stop providing all or parts of Facebook in case of violation of rules and policies (Facebook, 2009a).
- *Motivational Control:* This control approach includes measures to indirectly control the behavior of the platform ecosystem through extrinsic or intrinsic motivations. The scope

ranges from development support, community building or even funding. All leading platform owners have set focal activities on community building as they are highly scalable through automation and self-paced by the community itself. In example, NetSuite offers technical and marketing support to their 'Select' and 'Premier' development partners (NetSuite, 2009). Only few platform owners also try to pursue goal congruence through targeted incentives. Facebook for instance offers seed funding of $25k to $100k per approved idea (Facebook, 2009b). In addition, through 'Facebook Connect', Facebook loosely ties market players to the platform and tries to establishing first relationships with non-allied complementors through offering complementors added value. This strategic approach has been termed as 'contextualization of the environment' (Scholten & Scholten, 2010), which means, that the platform owner motivates complementors to loosely connect with the core platform offer. The reason is that non-allied partners represent a large potential for the platform owner to unlock in order to tie them closer to the platform, gain influence over their behavior, and, finally, benefit from indirect network externalities.

- *Informative Control:* In this approach, information on customer behavior, platform evolution and dedicated value creation opportunities are communicated to the complementors. Many platform owners, today, provide basic direct feedback, e.g. on errors. However, statistical feedback is rare: NetSuite has just launched a premier partnership approach, where 'premier partners' have access to sales leads or even to joint roadmap-planning. According to Scholten et al. (2010) and Fischer et al. (2009; 2010), this kind of information could stimulate the self-regulatory processes and emergence within the ecosystem, as complementors suffer from 'information asymmetry' (Williamson, 1981): Being positioned in a dyadic relation in the shadow of the platform owner or the next tier complementor constitutes a significant limitation of accessible market and customer information (information asymmetry). In consequence, applications may run out of phase with the actual market demand, risks of bull-whip effects are high. Provided with suitable information on unsatisfied customer demand or required steps for better response to customer utility would drive them towards optimized solutions, if this promises a sustainable increase of the expected profits due the intrinsic goal for 'profitable growth'.

4.3.2.4 External Complementary Innovation Reference Process

Based on this categorization, the various management control forms can be related to the corresponding sub-processes and decision gates of the external complementary innovation process as depicted in figure 18. In result, an 'external complementary innovation reference process' can be derived, showing both major sub-processes and decision gates as well as

primary means of control to steer external complementary innovation efforts within the context of a platform leadership strategy. Correspondingly, figure 19 depicts the reference process associated with the control mechanisms indicated by the letters in brackets.

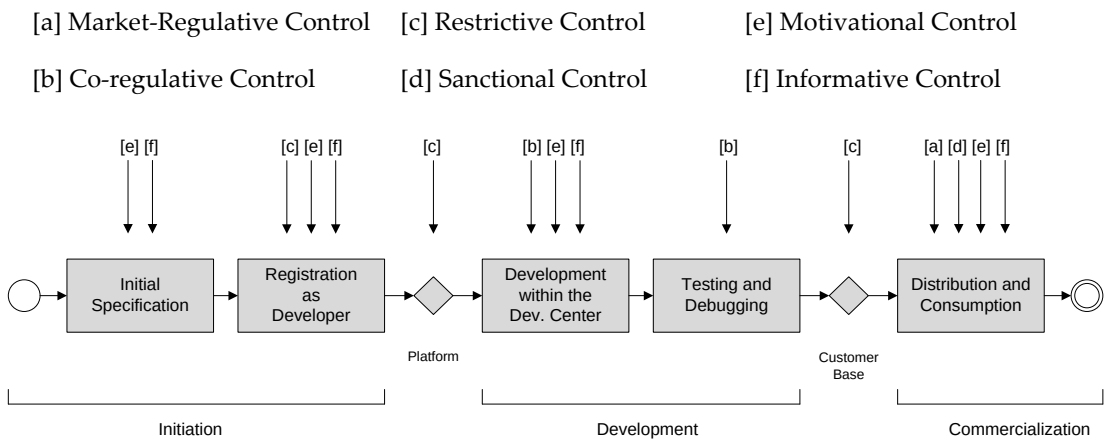


Figure 19: External Complementary Innovation Reference Process (own illustration)

From the platform owner's perspective, the external complementary innovation reference process consists of three major phases:

- *Initiation:* This process phase embraces the activities of ideation, initial application specification and platform choice, combined with the complementors active registration as developer;
- *Development*: This phase includes application development, testing, and ensurance of compliance with platform rules;
- *Commercialization:* This phase is targeted at distributing and continuously optimizing the application as precondition for sustainable consumption and return on investment.

While at the first glance, the platform owner due to its bargaining power seems to rule the innovation process and major decision gates, the strong dependencies on a continuous flow of complementary applications become obvious, when considering the control mechanisms applied: Most fundamentally, it is the complementor deciding, which platform to support. This choice is predominantly determined by the expected return on investment (ROI) within the commercialization phase, so that the platform owner has to carefully balance its interest in appropriating the returns from innovation with those of the complementors in order to foster broad platform adoption. Correspondingly, dominating means of control such as restrictive or sanctional controls are applied very selectively at the decision gates as well as throughout the commercialization phase to ensure the complementor's congruence with strategic platform goals.

4.4. Specification of Requirements

Based on the in-depth understanding gained throughout the elicitation process, the requirements that two-sided platform businesses place on innovation management can be derived. Thereby, established practices found in the ICT industry provide first insights into decentralized innovation processes and corresponding control mechanisms leading platform owners have implemented to manage open innovation efforts in the context of their platform strategy. As a result of the elicitation process the author claims that two-sided platform businesses require a dedicated 'platform-based innovation management' approach, targeted at addressing the peculiarities of managing open innovation within the context of a platform leadership strategy. Within this strategic context, the platform owner's innovation management function is required to:

- Lead platform and platform ecosystem evolution by holistically envisioning and orchestrating internal and external innovational efforts within the systemic innovation context of a platform leadership strategy;
- Continuously attract and tie related resources and capabilities to the platform ecosystem in order to nurture an environment for innovation;
- Strategically determine, which innovational efforts to pursue as internal core efforts and which external complementary innovation efforts to steer within the platform ecosystem;
- Facilitate the implementation of innovation goals both within the company as well as within the platform ecosystem in order to evolve partner capabilities in the platform ecosystem simultaneously and coherently with the core platform value proposition;
- Empower complementors through high degrees of freedom to co-innovate on top of the platform, while considering the platform owner in the architect and gate-keeper role;
- Exploit and share the benefits of platform innovation in order to maintain a continuous supply of complementary products and services;
- Continuously monitor behavior within the platform ecosystem in order to feedback relevant information, providing the basis of decision-making to (a) ensure innovation strategy implementation, (b) the complementors' goal congruence to the platform owner's strategic innovation goals by appropriately applying the respective means of managerial control; and (c) to adapt innovation strategy as a consequence of system changes or emerging strategies in the platform ecosystem.

5. Platform-based Innovation Management Framework

The requirements elicitation process in chapter 4 has brought to the fore the necessity of a dedicated platform-based innovation management approach. In order to detail the required innovation management approach, the 'Platform-based Innovation Management Framework' is developed. Therefore, this chapter starts with the definition of the term 'platform-based innovation management'. The proposed definition results from mapping Vahs & Burmester's (2002) definition of innovation management with the identified requirements placed on innovation management in two-sided platform contexts. Taking this definition as guiding frame, then, allowed formulating the primary tasks of innovation management in two-sided platform businesses. Based on the definition and tasks of platform-based innovation management three core elements are proposed in order to address the challenges two-sided platform businesses place on innovation management:

(a) *Platform-based Innovation Management Cycle:* The 'Platform-based Innovation Management Cycle' supports the platform owner in holistically managing internal and external innovational efforts within the systemic innovation context of a platform leadership strategy. It guides the platform owner in formulating and implementing innovation strategy within a platform ecosystem, characterized by the autonomous behavior of external complementors striving for own profitability;

(b) *Guiding Principles of Innovation Planning and Decision Making:* The 'Guiding Principles of Innovation Planning and Decision Making' provide the platform owner with different layers to systematically envision, plan and lead the overall platform and ecosystem evolution, while deciding, which innovational efforts to pursue internally or externally;

(c) *Platform-based Management Control Model:* The 'Platform-based Management Control Model' is targeted at monitoring and controlling external complementary innovation efforts pursued by third party complementors. Considering the platform owner in the architect and gate-keeper role provides the complementors with high degrees of freedom and creativity. Further, the Platform-based Management Control Model facilitates innovation strategy implementation within the platform ecosystem in a manner that partner capabilities can be evolved simultaneously and coherently with the core platform value proposition. Finally, a continuous monitoring of external complementary innovation efforts and feedback loops of relevant information provide the platform owner with a basis for consistent decision-making in order to (a) ensure innovation strategy implementation and (b) the complementors' goal congruence with the platform owner's strategic innovation goals by appropriately applying the

respective means of managerial control; and to (c) adapt innovation strategy as a consequence of system changes or emerging strategies in the platform ecosystem.

Interlinking these core elements allows modeling the 'Platform-based Innovation Process' in section 5.5.

5.1. Definition of Platform-based Innovation Management

As innovation management literature yet provides little systematic guidance for managing innovation in the strategic context of two-sided platform businesses that particularly demands open innovation, flexibility, quality and variety, a definition of platform-based innovation management is proposed. Explicitly, the definition considers that innovation management in two-sided platform businesses is required to address two dimensions, differing in strategic planning as well as managerial control mechanisms:

(a) Proprietary core platform and application innovation, targeted at fostering industry-wide innovation to sustain and maximize return on platform investment;

(b) External innovation on complementary products and services, targeted at providing variety to the core platform offer and driving the platform's market adoption, while ensuring complementarity, high quality, consistency, and strategic fit.

Both dimension need to be managed in a holistic manner, ensuring coherence and integrity throughout the overall platform value proposition to the customer. This requires the platform owner to (a) develop a sharp understanding of core competences and platform evolution, providing the basis for external complementary efforts and (b) to actively decide, which innovational efforts to pursue internally and which to source externally.

With reference to the definition of innovation management as proposed by Vahs & Burmester (2002), platform-based innovation management is considered as an ongoing process that:

- Systematically identifies, evaluates, and defines the strategic goals of proprietary and external complementary innovation;
- Implements innovation strategy both within the company as within the platform ecosystem;
- Monitors, controls and aligns strategy implementation.

In particular, innovation strategy implementation is targeted at exploiting innovation opportunities, while motivating complementary third party companies in an extrinsic manner (see section 2.2.3). Therefore, platform-based innovation management embraces both the management of internal innovational efforts targeted at evolving the platform

architecture and core complementary offerings as well as related activities to steer, monitor, control and align external complementary innovational efforts on top of the platform. Hence, it does not only foster the realization of new ideas, but also the recombination and optimization of existing platform components to benefit from commonality and reuse in order to satisfy and create customer demand. Primary tasks of a platform-based innovation management embrace (Scholten & Scholten, 2010):

- Envisioning and leading the overall platform and platform ecosystem evolution;
- Empowering and stimulating economic value creation activities of autonomous third party companies to enhance the platform's overall value proposition;
- Encouraging goal congruence of autonomous partners;
- Evaluating information about the overall system evolution as well as about emerging opportunities and threats within the ecosystem;
- Ensuring strategic coherence and appropriability of returns by maintaining control over platform and ecosystem evolution.

5.2. Platform-based Innovation Management Cycle

The platform owner's need for a holistic innovation management approach, integrating both internal and external innovational efforts requires a platform-based innovation management cycle, which links innovation strategy and operations. Therefore, the 'Platform-based Innovation Management Cycle' is derived from Kaplan & Norton's (2008) closed-loop management system, proposed as a comprehensive framework for the management process related to executing strategy. This management framework has been chosen as foundation of the platform-based innovation management cycle as it is one of the most widespread adopted management frameworks in industry. Their management cycle supports companies in keeping operations linked to strategy and adapting strategy when required.

5.2.1. Closed-Loop Management System

Fundamentally, Kaplan & Norton (2008) refer to the term 'management system' as an integrated set of processes and tools that are used by companies to develop their strategy, translate it into operational actions, and monitor and improve the effectiveness of both. Explicitly, they emphasize that successful strategy execution follows two basic rules: First, understanding the management cycle that links strategy and operations, and secondly, knowing what tools to apply at each stage of the cycle. Hence, the major management challenge addressed is considered in balancing the tensions between strategy and operations. Therefore, management systems are targeted at supporting a company in

setting clear strategic goals, allocating resources consistent with those goals, setting priorities for operational action, recognizing the operational and strategic impact of those decisions, and, if necessary, updating the original strategic goals. Kaplan & Norton's (2008) framework consists of five phases: The first phase embraces strategy development. This phase involves applying tools, processes, and concepts such as mission, vision, and value statements; SWOT analysis; shareholder value management; competitive positioning; and core competencies to formulate a strategy statement. In a second phase, the strategy statement is translated into specific objectives and initiatives, using dedicated tools and processes, including strategy maps and balanced scorecards. During strategy implementation, strategy is linked to operations with a third set of tools and processes, including quality and process management, reengineering, process dashboards, rolling forecasts, activity-based costing, resource capacity planning, and dynamic budgeting. Continually, internal operational data and external data on competitors and the business environment are reviewed in order to periodically assess the strategy, updating it when required (Kaplan & Norton, 2008).

5.2.2. Platform-based Innovation Management Cycle

Given this fundamental understanding as well as the dedicated tasks of platform-based innovation management highlighted in section 5.1, the 'Platform-based Innovation Management Cycle' can be derived and further detailed. As emphasized earlier, platform-based innovation management is understood as an ongoing process that systematically develops innovation strategy, cascades the strategic innovation goals of platform and ecosystem evolution; implements innovation strategy both within the company as well as within the platform ecosystem, and, finally, monitors and controls innovation strategy implementation, while adapting strategy when required.

Due to the dyadic relation between proprietary and external, non proprietary dimension of platform-based innovation management, the most obvious difference to a conventional innovation management framework, lies in splitting the innovation process into an internal and external channel of generating innovations within the systemic innovation context of an open modular platform. This causes different modifications to the overall innovation management cycle that links innovation strategy and operations. Figure 20 depicts the platform-based innovation management cycle.

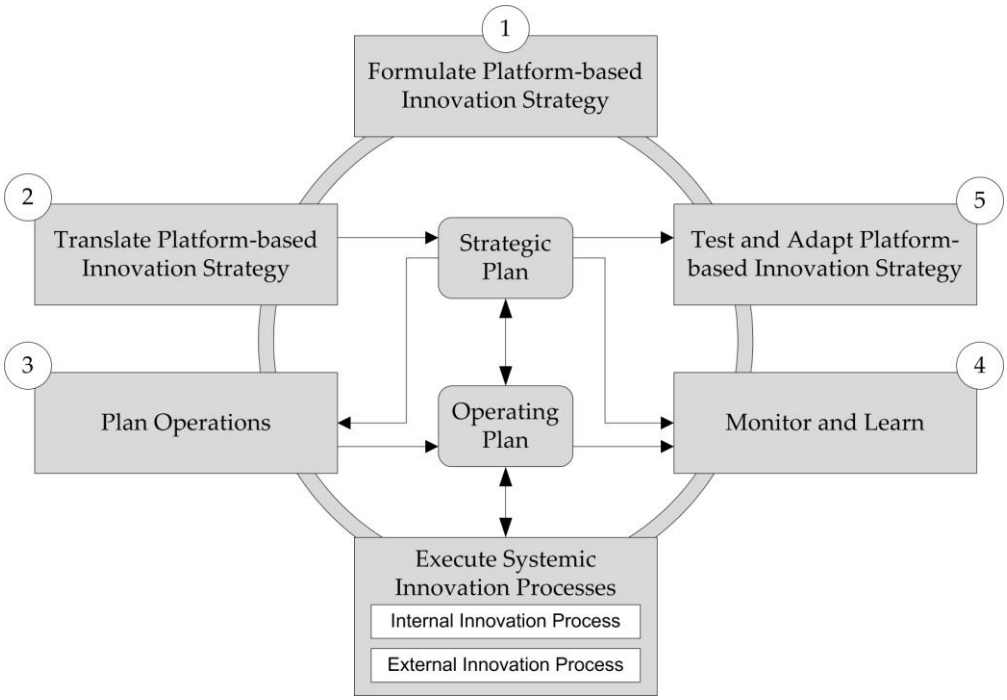


Figure 20: Platform-based Innovation Management Cycle
(own illustration adopted from: Kaplan & Norton, 2008)

Applying Kaplan & Norton's (2008) closed-loop management system to the subject of matter of the present work allows determining the core phases of a platform-based innovation management: Fundamentally, the 'Platform-based Innovation Management Cycle' starts with developing the platform-based innovation strategy. Importantly, decisions about the company's future core competencies have to frame the strategic decision of what will be done internally or externally. Next, the strategic statement is translated into dedicated innovation objectives and dedicated internal and external innovation initiatives, becoming part of the platform owner's strategic innovation plan. Guided by this plan, the platform owner is able to plan operations, including internal budged and resource allocations for proprietary internal innovation initiatives. Explicitly, budged and resource planning has to consider external innovation management efforts required to stimulate, direct and potentially fund external innovational efforts. Additionally, in order to implement a platform-based innovation strategy dedicated mechanisms of managerial control have to be applied (see section 4.3.2.3). Strategy implementation in platform ecosystems further requires continuous monitoring as well as dedicated regulation efforts to ensure the strategy's successful implementation. Finally, the platform owner's strategic innovation management function has to periodically assess the platform-based innovation strategy, ensuring that emergent strategies, e.g. arising within the ecosystem, are taken into account.

5.3. Guiding Principles of Innovation Planning and Decision Making

Splitting the innovation process into an internal and an external channel requires the platform owner to actively determine the scope of proprietary 'core' and external 'complementary' innovation activities from a holistic perspective. With reference to the 'Platform-based Innovation Management Cycle', the platform owner is required to develop innovational goals for the platform organization and for the platform ecosystem as well as strategies and initiatives for attaining these goals in order to be successful. Correspondingly, the platform owner has to actively decide, which innovation activities to pursue internally and which to drive within the platform ecosystem. However, as new innovation opportunities are constantly appearing, this is not a one time decision, but rather a continuing strategic innovation opportunity assessment, which requires balancing the tensions between appropriating the returns on innovations and platform adoptions (see also section 2.3.2 and 3.1.2). In particular with regard to entering complementary markets (see section 3.2.3), the platform owner has to be extremely careful as external complementors will not continue their support if they feel constantly threatened.

5.3.1. Factors influencing Decision Making

Open modular platform concepts support platform owners in achieving performance improvements and extend the platform owners market reach in a cost-efficient manner. As shown in section 4.3.2 leading platform owners succeed in mobilizing thousands of external development resources to build complementary products and services on top of their platforms. These organizations benefit greatly from the creativity and specialist capabilities of third party companies. Leveraging external complementary capabilities of more capable complementors, therefore, allows the platform owner to delegate dedicated efforts into the platform ecosystem, while enhancing internal core capabilities that drive competitive advantage. In order to facilitate the decision making process concerning which innovational efforts to pursue internally and which to pursue within the platform ecosystem, figure 21 outlines primary factors influencing decision making in the innovation context of two-sided platform businesses. They have been derived from insights gained throughout the state-of-the-art analysis.

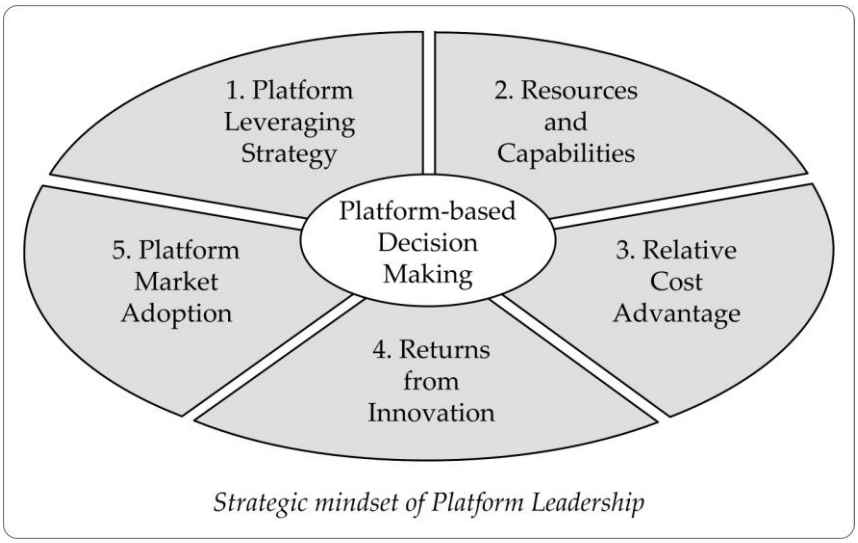


Figure 21: Factors influencing Decision Making in two-sided Platform Contexts (own illustration)

- *Platform Leveraging Strategy:* Due to their modular development approach, open modular platform concepts can be leveraged through different markets (see section 3.3). Leverage occurs to the degree that major sub-systems and components are adopted for use within different market segments. When envisioning the platform's future evolution, the platform owner has to decide, which platform leveraging strategy to apply. As platform owners do not have the capabilities of entering all markets, the platform owner has to determine core innovational efforts to pursue internally and complementary innovational efforts to coordinate within the platform ecosystem (see section 5.3.2 for further details). This decision is fundamentally influenced by the following factors:
- *Resources and Capabilities:* With reference to the resource-based view of a firm (RBV) and in particular with regard to the dynamic capabilities of a firm (Teece et al., 1997) the decision of delegating development efforts into the platform ecosystem is influenced by the platform owner's ability to develop the respective capability and sustain a superior performance position relative to competitors. Further, the decision is influenced by the platform owner's interest in gaining competitive advantage and occupying connector markets, being functionally located between the platform and its applications (see section 3.2.3).
- *Relative Cost Advantage:* In addition to deciding about the strategically required resources and capabilities, the platform owner has to consider the relative cost advantage of delegating activities into the platform ecosystem. According to transaction cost economic, the platform owner will make the decision based on reducing

development and transaction costs. While development costs refer to the direct costs involved in creating the platform, including labor and infrastructure costs, transaction costs include the costs of selecting complementors, negotiating prices and contracts, monitoring performance as well as the potential for opportunism. By offering standard contracts to complementors, a certain amount of transaction costs can be reduced. The bargaining power of the platform owner, thereby, depends on the platform's market adoption, i.e. the size of the platform's customer base.

- *Returns from Innovation:* Protecting the returns from innovation has become a key challenge in most industries. According to Teece (1986) it is the interaction between the strength of the appropriability regime (e.g. protection of intellectual property rights or the ease of imitation) and the ownership of specialized complementary assets that determines the degree to which the platform owner profits from its investments into innovation (see also section 3.1.2). This requires the platform owner to determine the required type of complementary assets; (a) generic, (b) specialized or (c) co-specialized assets. While generic assets do not need to be tailored to the invention or innovation, they can be sourced out to the platform ecosystem. In case of required specialized or co-specialized assets the platform owner has to decide whether he possesses the necessary complementary asset to commercialize the invention or innovation. The decision whether to build the complementary asset internally or to delegate the task into the platform ecosystem depends on the height of imitation barriers, the availability of respective capabilities in the platform ecosystem as well as the number of capable competitors being able to imitate the innovation.
- *Platform Market Adoption:* Indirect network externalities have been identified being an important source of value creation in platform markets (see section 2.3.2). Therefore, platform owners have to provide a sufficiently high variety of complementary products and services to enable customers to build the solution that best suits their needs (see section 4.1.2). In order to drive platform adoption in two-sided platform markets, the platform owner is required to respect and secure the profitability of external complementary investments. The platform owner, hence, has to provide win-win situations to complementors in order to sustain a continuous supply of complementary products and services on top of the platform.

In summary, platform owners have to assess their capabilities across a range of factors as they are increasingly dependent on the performance of their platform ecosystem, co-creating the platform's overall value proposition. This means that they have to prioritize their efforts in certain core markets, where they possess strengths and leave other complementary markets to third party companies. Complementors are expected to extend

the platform's value proposition and market reach, whilst at the same time ensuring congruence to the platform owner' strategic goals. However, the platform owner has to carefully balance its interest in appropriating the returns from innovation against the potential for opportunism in the platform ecosystem.

5.3.2. Layers of Strategic Innovation Planning and Decision Making

Fundamentally, figure 22 is targeted at envisioning platform evolution at different layers, while ensuring that innovation opportunities, emerging within the platform ecosystems are adopted and become part of the platform-based innovation strategy. The key question the platform owner has to answer from a strategic perspective is how to leverage the platform into different market and/or price segments (see section 3.3.2 and 5.3.1). Correspondingly, the suggested layers of innovation planning and decision making base upon the fundamentals of the platform-based product and service development concept as discussed in section 3.3.

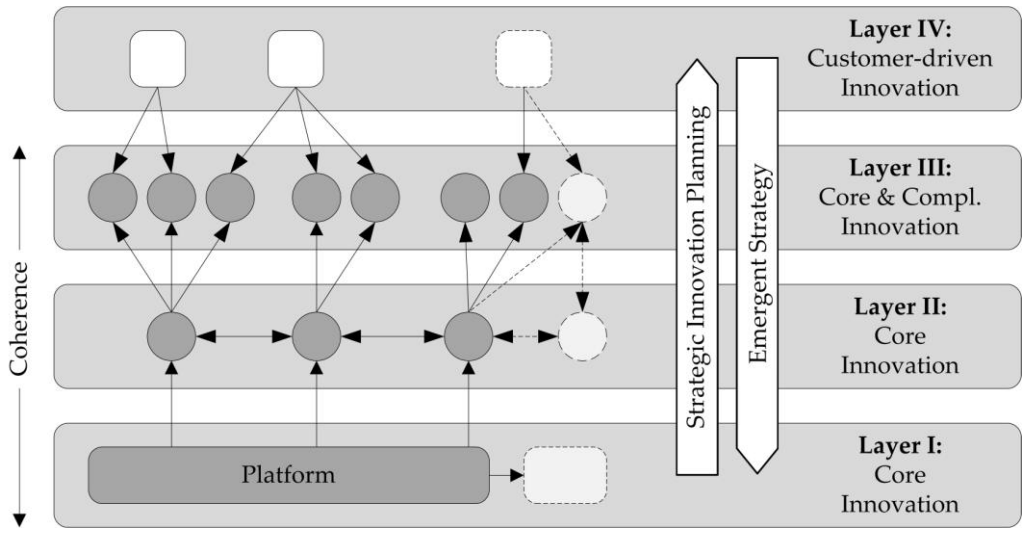


Figure 22: Layers of Innovation Planning and Decision Making
(own illustration)

The following paragraphs explain the proposed layers of Innovation planning and decision making:

- *Layer I:* The first layer embraces the development of platform critical components, targeted at advancing the core platform functionality. The innovational efforts in this layer are to be pursued internally by the platform owner as they concern the platform owner's core competencies and, therefore, determine its competitive advantage in platform competition. The single strategy applicable to this layer is to invest and

develop the respective capabilities to evolve core platform functionality in order to sustain a superior performance position relative to competitors.

- *Layer II:* The second layer embraces core applications, leveraging the core platform functionalities into different market and price segments. Frequently, these applications represent specialized or co-specialized assets, providing potential entry points into complementary markets. Therefore, the platform owner is advised to occupy these connector markets and build the required capabilities internally in order to sustain its returns on innovation. In case, the platform owner does not possess the required capabilities to build the required application and acquire the connector market, the platform owner might set up a strategic partnership with a certain complementor to extend the platform's market reach. Nevertheless, the platform owner is advised to develop fundamental capabilities in order to be able to steer the development of respective complements.
- *Layer III:* The third layer predominantly embraces complementary innovational efforts that are planned to generate variety economically and flexibly to satisfy the customer's demand in layer IV. Within this layer the platform owner is advised to stimulate and seed creative innovational efforts within the platform ecosystem. Thereby, the key challenge remains to source and tie those complements that are congruent to the platform owner's strategic goals (see section 5.5.2). In turn, by allowing high degrees of freedom within the platform ecosystem, the platform owner may benefit from external impulses and innovations that advance its innovation strategy (emergent strategy).
- *Layer IV:* Finally, layer four contains customer-driven innovations targeted at enabling customers to compose the solutions or service combinations that best suit their needs. These customer-driven innovations base upon an individual combination of value chains as explained in section 4.1.2.1, allowing the customers to compose the solution that best suits their needs. The platform owner, hence, is advised to actively mediate demand between customers and complementors in order to sustain the supply of complements. Further, the platform owner is advised to facilitate ever new combinations of complementary products and services that dynamically arise from the interaction between autonomous complementors, seeking for profitable growth. These activities represent a valuable source of innovation and future platform growth.

Most fundamentally, these four layers represent a consistent approach to the platform owners strategic innovation planning and decision making process. As shown, innovative strategies might also emerge within the platform ecosystem. As not all trends are worth pursuing, the platform owner has to actively decide, which trends to pursue and when to adapt innovation strategy.

5.4. Platform-based Management Control Model

Given the 'Platform-based Innovation Management Cycle' as well as the 'Guiding Principles of Innovation Planning and Decision Making', the remaining challenge to be solved in this section lies in developing a management control model that supports the platform owner in (a) implementing the platform-based innovation strategy within the company as well as within the platform ecosystem and (b) in strategically controlling external complementary innovation efforts. Therefore, the platform owner has to induce both employees within the company as well as autonomous complementors striving for own profitability to act in pursuit of their personal goals in ways that support the platform owning company attaining its innovation goals (see section 3.4). While accountability, tight project management as well as corresponding incentives are primary means of achieving goal congruence and continuous improvement within the company, the means of coordination and managerial control applicable to innovation management in platform ecosystems significantly differ (see section 4.3).

Fundamentally, ensuring goal congruence in self-organizing platform ecosystems is at the heart of the innovational challenges two-sided platform businesses are facing when implementing strategy. Paying respect to the high dynamics in platform ecosystems as well as to the autonomy of complementors, participating in the platform ecosystem, this section makes use of system theory in order to develop an appropriate management control concept. System Theory as pioneered by researchers such as Wiener (1948), von Neumann (1966), Luhmann (1975) or Prigogine (1977) is targeted at capturing complexity, self-organization, connectionism or system adaptivity in systems. Explicitly, the term 'system' refers to social, biological, organizational or technical systems. System theory, therefore, provides a starting point to describe the dynamics of platform ecosystems, which classical linear process models are unable to capture.

In the sequel, system theory is applied in order to shed further light on the control flows and processes applicable to steer external complementary innovational efforts in the context of a platform leadership strategy. In particular, platform ecosystems are modeled as 'controlled systems', a system-theoretical concept to apply feedback in control engineering (Föllinger, 1990). The particular challenge in managing external complementary innovation in platform ecosystems relates to their self-organizing and emergent nature. Consequently, platform ecosystems can neither be centrally nor directly controlled or optimized by a platform owner. Thus, management control mechanisms are proposed that take into account the platform ecosystem participant's autonomy as well as the platform owner's need to steer open innovation efforts and platform evolution (Scholten et al., 2009).

5.4.1. Principles of Feedback Control as applied in Control Engineering

Most fundamentally, control engineering focuses on modeling dynamic systems and designing corresponding controllers or regulators that cause predominantly technical systems to behave in a desired manner. Therefore, continuous system observation or monitoring as well as feedback loops, feeding back to the system, which adjustments to initiate in order to adapt system behavior, are of particular importance. Beyond the technical examples frequently referred to in control engineering literature, feedback regulatory mechanisms are central to the operation of biological systems, communication networks, national economies, and even human interactions (Anthony & Govindarajan, 2007)

Within this context, a control system is understood as "an interconnection of components forming a system configuration that will provide a desired system response" (Dorf & Bishop, 2008: 2). The basis for system analysis relates to the foundation provided by linear system theory, which assumes a cause-effect relationship for the components of a system. Thus, a component or a process to be controlled can be represented by a block and the corresponding block diagram. The input-output relationship represents the cause and effect relationship of the process, which, in turn, represents a processing of the input signal to provide an output signal variable. Of fundamental importance is the differentiation between 'open-loop control systems' and 'closed-loop control systems': An open-loop control system embraces a controller and an actuator to obtain a desired response. In contrast to a closed-loop system, feedback is not applied. In turn, closed-loop control systems use feedback signals as an additional measure of the actual output to compare it with the desired output. Correspondingly, figure 23 represents a simple closed-loop feedback control system. "A feedback control system is a control system that tends to maintain a prescribed relationship of one system variable to another by comparing functions of these variables and using the difference as a means of control. With an accurate sensor, the measured output is a good approximation of the actual output of the system" (Dorf & Bishop, 2008: 3).

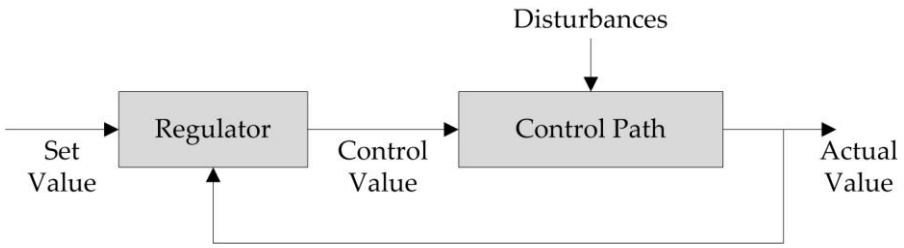


Figure 23: Feedback Control System in System Theory (Dorf & Bishop, 2008)

The principle of feedback control systems represents a function of a prescribed relationship between the output and reference input to control the process. Hence, the difference between the process output and the reference input is used to control the process in a way that the difference can be continually reduced. Thereby, the difference between the desired output and the actual output is equal to the error, which is then adjusted by the controller. Correspondingly, the output of the controller causes the actuator to modulate the process in order to reduce the error (Dorf & Bishop, 2008). Against this background, it becomes clear that control engineering depends on taking a holistic viewpoint: The elements to be embodied in a typical control design, therefore, include the process or plant to be controlled, the dedicated objectives of control, the identification and specification of the controller, sensor and actuator, as well as the controller (Föllinger, 1990).

Given these introductory considerations, the concept of feedback control is applied to the context of platform ecosystems, likewise constituted by the interconnected entities 'control path' and 'regulator'. Thereby, the present work primarily focuses on the formal aspects of the management control function and describes the various steps, in particular, the information that is collected and used in each step and the principles that govern the system's operation as a whole. Encountering situations not contemplated in the formal system, dependent in particularly on the skills and personalities of people involved. They can not be described in an appropriate way and are neglected within the context of this work. Nevertheless, it is recognized that informal processes are of particular importance and are strongly affected by the way the organization's formal control systems are designed and operated.

5.4.2. Applying the Concept of Feedback Control to a Platform Ecosystem

From a control engineering perspective, designing control in platform ecosystems requires that both system entities 'control path' and 'regulator' are interconnected and a sensor is put in place (see section 5.4.1). In the sequel, the 'platform regulator' acts on the 'platform ecosystem's control path' in a way that it adheres as closely as possible to the desired behavior. As depicted in figure 24, the control path (CP) of the platform-based feedback control system consists of the complementors, providing added value through complementary variety, as well as the customers of the overall platform offering. The platform regulator is represented by the platform owner. Finally, an analysis function represents the sensor, monitoring and reporting the state of the system (Scholten et al., 2009).

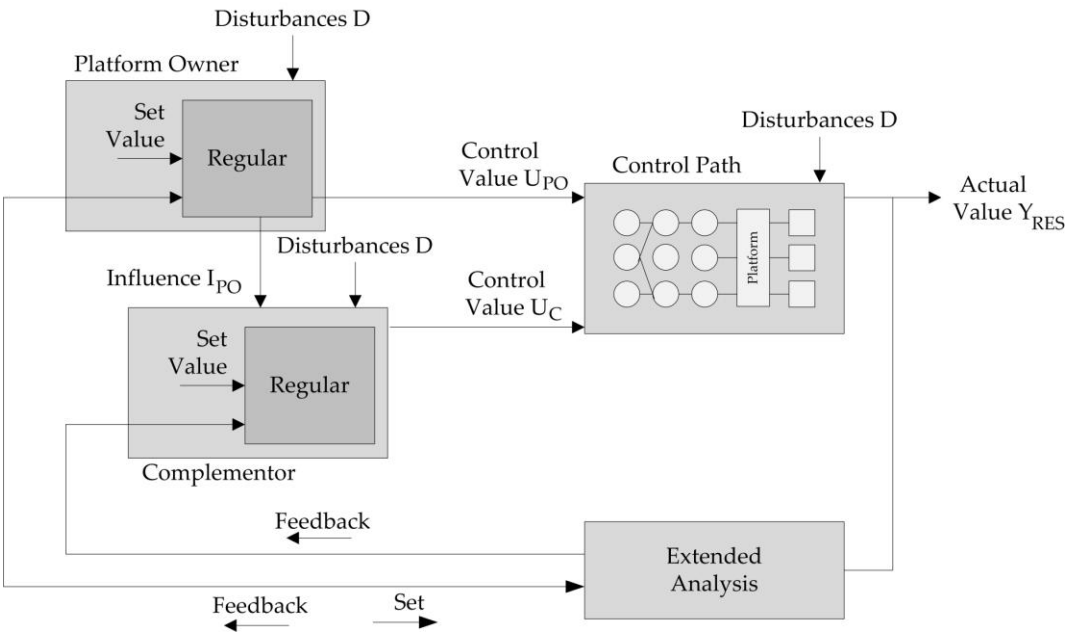


Figure 24: Platform-based Innovation Management Control Model
(Scholten et al., 2009; Fischer et al., 2010)

In pursuit of the control engineering methods (e.g. Föllinger; 1990, Dorf & Bishop, 2008) the control system described above aims at adapting the actual value to the level of the 'set value' by leveling the 'control path'. This is done by the sensor, monitoring the 'actual value Y', tapped at the end of the control path. Then, the regulator deducts the 'actual value Y' from the given 'set value', resulting in a modified 'control value U'. Based on the newly adjusted control value the new 'actual value' is tapped again and the feedback loop is closed. Since disturbances may influence the control path by random noise or a dynamic change in the external environment, the 'actual value' may be disturbed. In these cases, the feedback to the platform regulator allows for re-leveling 'actual value' and 'set value' (Scholten et al., 2009).

With this control infrastructure in place, the key remaining question pertains to the controller's behavior. That means: If the platform regulator detects a deviation from the desired output response, how should it command to get the system back on target? Translated to the case of managerial control in platform ecosystems, this means: What are the strategic and operational means of acting on the control path to control outputs to desired values, thus, ensuring a desired level of performance? In the sequel, the control elements of platform-based control systems are described more detailed.

5.4.3. The Platform Owner's Role of a Regulator

The platform owner plays a leading role within the platform ecosystem, occupying both strategic tasks of 'setting system value' and 'regulating system behavior'. In addition, the platform owner possesses a configuring power on the system sensor. Due to its central role in platform-based value creation, the platform owner may also exert direct or indirect control mechanisms on individual complementors as identified in section 4.3.2.3. With regard to figure 24, the platform owner's influence is indicated as the influencing arrow pointing from the platform owner to the complementors. It is not linked directly with the regulator like the feedback-loop, but acts upon the single complementor. The reason is that it might impact the complementors' 'set values'. Hence, the external influence is summarized in control theory as disturbance, a term that describes an impact causing a deviation from an original set, but which is not meant pejoratively. Disturbances can be influences from outside the system, such as changes in market conditions or through outside stakeholders. They take effect upon the control path as well as upon the actors (Scholten et al., 2009).

5.4.4. The Control Path

Within the context of the platform-based management control concept, the control path is understood as a core process of platform-based value creation. Throughout this process, the platform's base value is aggregated with complementing products and services to provide the customers with the 'whole solution', provided by the platform ecosystem (see section 4.1.2.1). Thereby, the platform owner offers and configures the core platform value proposition as base value. In addition, the platform owner enables external complementors to access the platform and build complementary products and services on top of the platform. The complementors, in turn, identify emerging value creation opportunities to be added to the platform's overall value proposition, while providing and configuring their offerings in dependence on the information available. The customers, finally, choose the core platform offer and compose the 'whole solution' in dependence on their individual needs, pay and consume the whole platform-based solution. Correspondingly, figure 25 represents the control path modeled as stage-gate process.

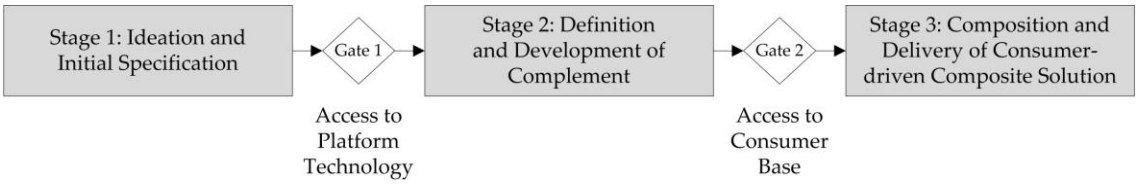


Figure 25: External Complementary Innovation Process to be controlled from the Complementors' Perspective (own illustration)

Fundamentally, the external complementary innovation process starts with the complementor's efforts of ideating new business opportunities and ends with the complement being chosen by the customer and becoming part of the customer-driven composite solution. Similarly to the stage-gate process developed by Cooper (2008), this process embraces a series of activities (stages) and decision points (gates). Each stage is actively influenced and controlled by the platform owner, applying a savvy combination of means of control (see also section 4.3.2.3 as well as section 5.5.2).

- *Stage 1:* Within the first phase of the process, the complementors identify potential business opportunities and generate new ideas to complement the core platform value proposition. After an initial specification and business case building, the respective complementor chooses the platform that best satisfies its profitability interests and registers as developer at the respective platform in order to gain access to the platform-specific development center. Due to indirect network externalities inherent to platform markets (see section 2.3.2), the success of this phase is determined by the platform's overall attractiveness to both customers and complementors as well as the platform owner's efforts to actively involve complementors to co-innovate on top of the platform, e.g. through communicating actual customers needs or stimulating external complementary innovational efforts. These activities base upon the platform owner's strategic decision, which innovational efforts to pursue internally or externally, respectively (see section 5.3).
- *Stage 2:* In the second process stage, the complementor has successfully passed the first gate (see decision gate 1 below) and has gained access to the platform specific development center. Therein, the complementary application is developed, tested and debugged to ensure that the complement meets the integrity, quality and continuous optimization requirements set by the platform owner. This phase is ruled by the platform owner, determining development techniques, rules and quality standards in order to ensure the complement's consistent integration into the platform technology.
- *Stage 3:* Having met the required development rules and quality standards, the complement becomes part of the complementary product and service portfolio. Through dedicated distribution channels owned by the platform owner, the complementor gains access to the platform's customer base to offer its complement. Once chosen by the customer, the complement is consumed. Depending on the corresponding 'terms of conditions' and 'license agreements' signed by the complementor when registering as developer (see decision gate 1 below), the complementor is rewarded. It results that in order to attract and tie complementors to co-create the platform's overall value proposition, the platform owner has to carefully

balance its interests of fostering a wide platform adoption in the market and appropriating the returns from innovations.

Preceding each stage is a decision point or gate, serving the platform owner in its gate-keeper role as 'go or deny' decision point.

- *Gate 1:* The first gate is targeted at regulating the relationship between complementor and platform owner, while deciding upon the complementor's access to the platform technology. Therein, complementors have to agree on complying with the technical standards applied by the platform owner as well as on the platform's terms of conditions and license agreements. 'Go or deny' decisions are made by the platform owner based upon the complementor's willingness to accept the platform's terms of conditions and license agreements.
- *Gate 2:* The second gate is targeted at controlling access to the platform's customer base, while ensuring the integrity, quality and continuous optimization of the overall platform-based value proposition. 'Go or deny' decisions, therefore, base upon (a) the complement's strategic fit to the overall platform value proposition and the platform owner's intents of appropriating the returns on innovation; (b) the integrity, quality and continuous optimization of complements as well as (c) upon the complementor's goal congruent behavior to the platform owner's strategic goals. Through continuous monitoring efforts (see also section 5.5.2), the platform owner in its role of a regulator (see section 5.4.3) is enabled to apply sanctional means of control throughout the entire value creation process and exclude complementors, once they do not confirm to the rules set by the platform owner.

5.5. Modeling the Platform-based Innovation Process

Having developed the core elements of platform-based innovation management allows modeling the platform-based innovation process in a next step. The purpose of this section is to interlink the core platform-based innovation management elements and to define the platform-based innovation process model, which guides the platform owner in holistically steering external innovational efforts within the context of its platform leadership strategy. With reference to the process requirements identified in chapter 4.4, the following design principles are applied to model the platform-based innovation process:

- Holistic innovation management cycle, integrating the internal and external innovation perspective into innovation strategy planning and related operations within the systemic innovation context of a platform leadership strategy;
- Comprehensive decision making concerning internal and external complementary innovation efforts;
- Integration of a variable mix of management control mechanisms to be flexibly applied throughout the external complementary innovation process;
- Empowerment of complementors through high degrees of freedom to co-innovate on top of the platform, while considering the platform owner in the architect and gate-keeper role;
- Continuous monitoring of the platform ecosystem, i.e. the customers and their consumption behavior, the complementors and their supply behavior as well as the mix of complements available to the customer, in order to feed back relevant information that provide the platform owner with a basis of decision-making. These feedback processes enable the platform owner to ensure the complementors' strategic goal congruence as well as a continuous innovation strategy adaptation as a consequence of system changes or emerging strategies in the ecosystem.

5.5.1. Fundamentals of Business Process Modeling Notation

The standard Business Process Modeling Notation (BPMN) has been developed by the Business Process Management Initiative (BPMI). Its primary goal is to provide a notation that is understandable by all business users, from the business analysts that create the initial drafts of the processes, to the technical developers responsible for implementing the technology that will perform those processes, and finally, to the business people, who will manage and monitor those processes. Fundamentally, BPMN allows defining business process diagrams (BPD) based on a flowcharting technique. Correspondingly, a business process model is understood as a network of graphical objects, embracing activities and the

flow controls that define their order of performance (White, 2004). In turn, a process is defined as "an activity performed within or across companies or organizations" (BPMI, 2009: 32), depicted as a graph of flow objects, which are a set of other activities and the controls that sequence them. The concept of processes is intrinsically hierarchical, wherein three types of processes are differentiated: the process, the sub-process, and the task. Each process is graphically depicted by the same rounded rectangular symbol, while the use of different nouns simply reflects the hierarchical relationships between them (Owen & Raj, 2003). The following table briefly describes the elements relevant to the process model in figure 26.

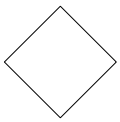
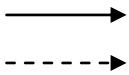
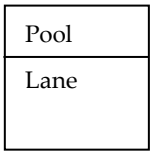
BPMN Elements		
Event	An event is represented by a circle. These events affect the flow of the process and usually have a cause or an impact. BPMN differentiates between three types: Start, intermediate, and end.	
Activity	An activity is represented by a rounded-corner rectangle. The types of activities embrace tasks and sub-processes. The sub-process is distinguished by a small plus sign in the bottom center of the shape.	
Gateway	A gateway is represented by the familiar diamond shape. It determines traditional decisions as well as the forking, merging, and joining of paths.	
Connections	A sequence flow is used to show the order in which activities are performed in a process. In turn, a message flow is represented with a dashed line, used to represent messages flow across organizational boundaries, i.e. between pools.	
Pool and Lane	A pool represents a participant in a process. It also acts as a graphical container for partitioning a set of activities from other pools. A lane is a sub-partition within a pool and extends the entire length of the pool, either vertically or horizontally. Lanes are used to organize and categorize activities.	

Table 4: Set of BPMN Elements Applied (BPMI, 2009)

5.5.2. Platform-based Innovation Process Model

Based on these fundamentals, figure 26 depicts the platform-based innovation process. From the platform owner's perspective, it describes the flow of activities, control mechanisms as well as related interactions with customers and complementors. It is targeted at guiding the platform owner in driving industry-wide innovation, while directing external complementary innovation efforts in order to co-create the platform's overall value proposition. Each of the activities depicted by a rounded rectangle represents a process, containing further sub-processes and tasks. They are connected through

sequence flows, showing the principle order of activities to be performed within the process. Due to reasons of complexity temporal interrelations between different activities within the process have not been modeled. Further, complementors and customers are represented as rectangles, while message flows and interactions across organizational boundaries, such as means of managerial control, are depicted as a dashed line. For the ease of understanding the platform-based innovation process model, the following sections are structured along the platform-based innovation management cycle as depicted in figure 20 (Scholten & Scholten, 2010):

- Phase 1: Formulation of platform-based innovation strategy;
- Phase 2: Translation of platform-based innovation strategy;
- Phase 3: Platform-based operational innovation planning;
- Phase 4: Execution of the internal and external innovation process;
- Phase 5: Strategic monitoring and learning;
- Phase 6: Adaptation and testing of platform-based innovation strategy.

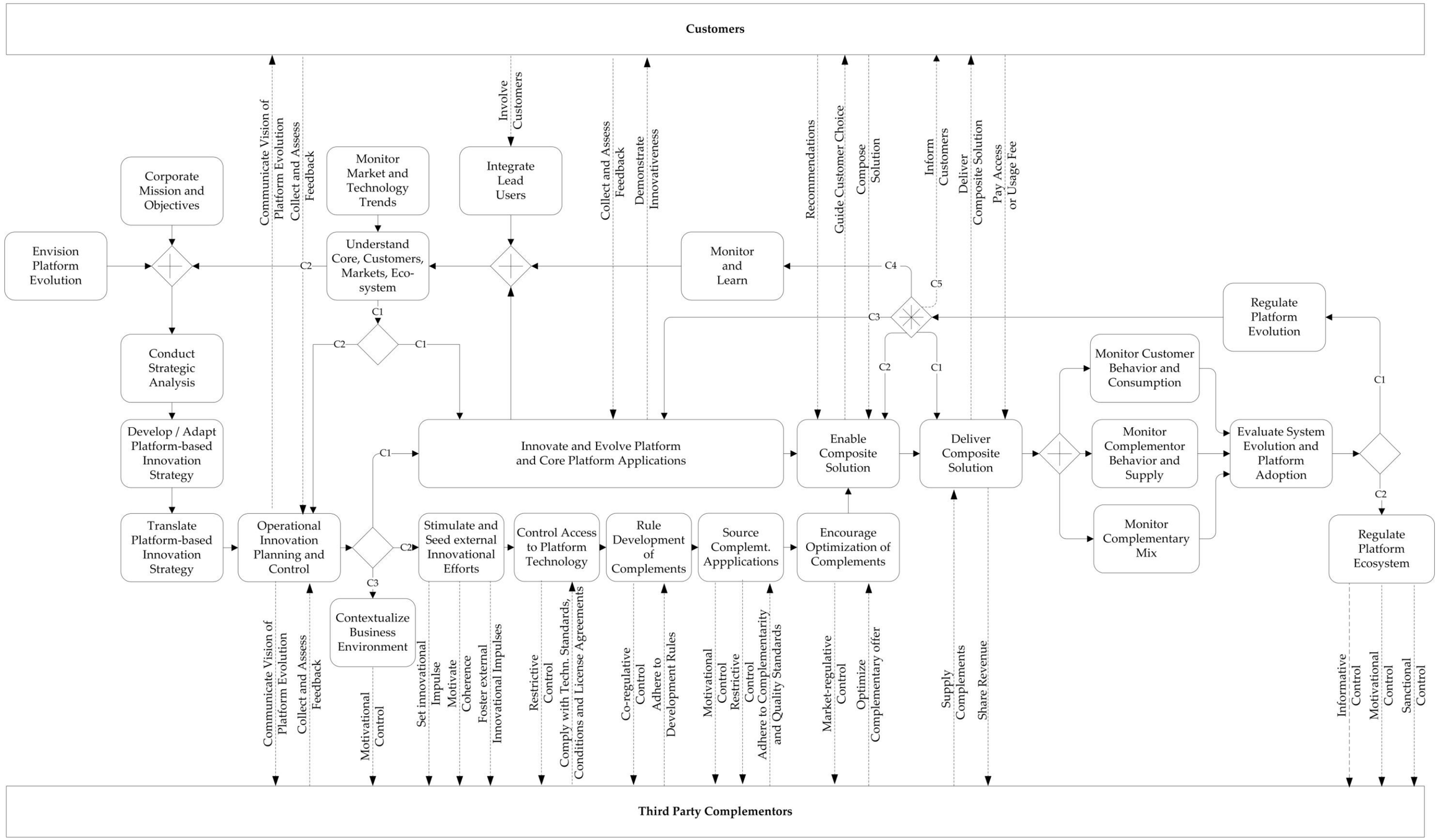


Figure 26: Platform-based Innovation Process Model (Scholten & Scholten, 2010; 2011)

Phase 1: Formulation of Platform-based Innovation Strategy

The sub-processes and tasks of the first phase represent the tasks of systematically identifying opportunities for platform evolution. Further, they include deciding on and formulating the innovation strategy by setting respective goals for both the internal evolution of the core platform offer as well as the evolution of external innovations, complementing the core platform offering. This phase is considered as an ongoing process of developing and revising strategic goals, which allows the platform owner to achieve its objectives, while taking into account its capabilities, constraints, and the environment, in which it operates.

Fundamentally, the platform owner's innovation assumptions, platform competition, customer requirements, market and technology trends as well as the platform ecosystem's capabilities are reexamined in a strategic analysis, while considering existing corporate mission and objectives. Key to this phase is the envisioning of the future platform evolution. Mirrored against an assessment of the platform owner's internal capabilities and performance as well as the platform ecosystem's capabilities and performance, the platform vision allows the platform owner to define the platform's future customer value proposition. It further enables the platform owner to decide, which innovational efforts to pursuit in-house and which to stimulate within the platform ecosystem. This decision is based on the "Guiding Principles of Innovation Planning and Decision Making" (see section 5.3). This analysis reveals numerous innovation issues to be addressed within the platform-based innovation strategy, e.g.: which new innovation fields to be explored, which complementary innovation efforts to be stimulated, which innovation capabilities to develop in-house or within the platform ecosystem. Finally, the platform owner has to decide, which complementary markets to develop or to enter (see section 3.2.3), and has to behave accordingly towards third party companies, who are complementing the platform's value proposition to the customer. In considering the platform's two-sided market's peculiarities, the essential target that should guide platform owners in this decision is not primarily whether an invention maximizes their own ROI, but whether an invention maximizes the value of the overall system, and, therefore, maximizes its profits indirectly. Finally, the platform-based innovation strategy is formulated and approved by the platform-owner's executive management. In the pursuit, the platform-based innovation strategy provides the frame for decisions to be taken in operational innovation activity.

Phase 2: Translation of Platform-based Innovation Strategy

Once the platform-based innovation strategy has been formulated or adapted and approved, it needs to be translated into dedicated innovation objectives and platform-based innovation initiatives, detailing targets, tactics and measures in the light of a two-

sided platform market. Due to the systemic character of innovation and the autonomy of autonomous third party complementors, implementing the innovation strategy within the platform ecosystem is particularly challenging for the platform owner. Therefore, the platform owner is required to translate the platform-based innovation strategy into dedicated internal and external innovation goals; taking into account the degree of control the platform owner is able to exert in order to implement its strategic goals. Importantly, the strategy maps for the internal operating and functional units driving internal innovation need to be interlinked with those internal operating and functional units that orchestrate external innovational efforts within the platform ecosystem. In addition, the platform owner might consider innovation initiatives to 'contextualize the business environment' as a dedicated means of motivational control. With reference to the Facebook example (see section 4.3), this means that the platform owner enables customers and complementors to interlink the overall platform offering with other complements available in the market that are yet not related to the platform. This way, the platform addresses a wider community, increasing the potential of future platform users.

Phase 3: Platform-based Operational Innovation Planning

After having the internal and external strategic innovation targets, initiative and metrics in place, the platform owner is required to develop the operational plan that further details internal and external activities to accomplish the strategic innovation objectives. This phase embraces the prioritization of initiatives as well as the allocation of resources and budget. As already indicated in section 5.2.2, this phase has to explicitly consider budget and resources required to stimulate, coordinate and control external innovational efforts, including the potential funding of external innovational efforts important to implement the platform-based innovation strategy. Dashboards may be used to monitor critical success factors, enabling the platform owning company to intervene and regulate the complementary innovation process, whenever required.

Phase 4: Execution of the internal and external Innovation Process

While internal innovation goals and initiatives can be implemented within the company through traditional means of hierarchical control, external innovation initiatives require dedicated control mechanisms as identified in chapter 4.3. However, as innovations in platforms tend to be generated through the interplay of loosely coupled network participants, it becomes evident that with an increasing number of platform complementors, complexity rises rapidly to a degree, which is difficult to be centrally controlled by the platform owner. To handle this, platform owners need to introduce degrees of de-centralized control and autonomy to the complementors. In consequence, directing the development of external complementary innovations, regulating access to

platform and customer base as well as ensuring the complementary product or services' congruence to strategic platform goals, such as quality and integrity, moves into the center of the platform owner's attention. This embraces stimulating external innovational efforts, controlling access to platform technology, ruling the complementor's development efforts, sourcing and tying of external complementary innovations as well as continuous improvements and finally, delivering and capturing value:

- *Stimulate and Seed External Innovational Efforts:* Based on the strategic innovation goals cascaded from the platform-based innovation strategy, the platform owner sets innovational impulses within the platform ecosystem to motivate external complementors to initially specify complementary offering. Relevant control mechanisms refer to motivational and informative means of control.
- *Control Access to Platform Technology:* The platform owner in its architect and gate keeper role has to guarantee the quality and consistency of the overall platform-based solution, while ensuring the appropriation of own innovation returns. In order to define the relationship between complementor and platform owner, the complementor, in a first step, has to agree to the platform's terms of conditions as well as to the license agreements in order to gain access to the platform's development center. The 'go or deny' decision taken by the platform owner represents a restrictive control mechanism (see also section 5.4.4).
- *Rule Development of Complementary Applications:* In order to ensure the integration of complementary offerings, the platform owner sets guiding principles and provides development rules and tools for a coherent and observable supply of complements. Co-regulative, restrictive and informative controls can be applied.
- *Source Complementary Applications:* Sourcing complementary applications is primarily achieved by regulating access to the platform's customer base. Granting platform access by deciding, which complementary innovations to absorb and, which to foster or deny due to e.g. the missing congruence with strategic platform goals is of crucial importance. Granting or denying access is, therefore, the strongest means of the platform owner's mechanisms of control. It represents a restrictive control mechanism.
- *Encourage Optimization of Complements, e.g. by Ranking and Certifying Complements:* Ensuring a continuous improvement of complementary innovations is one of the primary tasks in platform-based innovation management. Corresponding control mechanisms are market regulative and motivational control mechanisms to motivate complementors to regularly optimize their complementary offerings in accordance to current customer demand.

- *Enable Customer-driven Composite Solution.* Enabling customer-driven composite solutions represents the core of value creation in platform ecosystems (see chapter 4.1.2). Therefore, the platform owner mediates products and services complementing the core platform offer. Based on the ranking and certification of complements achieved in sub-process, the platform owner is able to guide customer choice to compose the whole solution that best suits their needs. As the platform owner remains the single point of contact to the customer, restrictive means of control apply.
- *Deliver Composite Solution.* This process entails the transactions on top of the platform. While the platform owner delivers the solution to the customer and receives its access or usage fees, it is up to the platform owner's bargaining power as well as to the degree of platform competition, how to share revenue with complementary complementors. In particular, the impact of indirect network externalities has to be considered (see chapter 2.3.2). Thus, market-regulative and restrictive controls apply.

In addition, ecosystem regulation plays a crucial role in implementing strategy and managing open innovation efforts in two-sided platform contexts. It embraces the platform owner's efforts and activities to ensure that (a) the behavior of the platform ecosystem and the decisions made by autonomous complementors are consistent with the overall objectives and strategies set by the platform owner, and (b) that the platform owner strategically responds to important opportunities and threats emerging from the platform ecosystem, resulting in emergent platform-based innovation strategies. The decisions taken to regulate both platform and platform ecosystem evolution are based upon the information provided by platform intelligence.

- *Regulate Platform Ecosystem.* In order to enforce and stimulate the optimization of complementary platform offerings, the platform owner feeds back dedicated information to the complementors. Enforcement is accomplished through sanctional control of concerned complementors. As described in the eBay example (see section 4.3), sanctional control is applied as a staged process, starting with a request for improvement and leading to exclusion in case of unsatisfactory reaction. Stimulation, on the one hand, can be accomplished through motivational control as seen in the Facebook example, where promising complementors are financially supported. A strong and scalable approach, however, is the application of informative control, feeding back customized information, stimulating self-optimization efforts of each complementor.
- *Regulate Platform Evolution.* In order to allow for a reactive strategic platform-based innovation management, opportunities and threads from the ecosystem are fed back to the platform owner's operational platform development process as well as into the strategic planning process of the platform-based innovation strategy. An illustrative

example for emergent strategy and reactivity on disruptive ecosystem innovation refers to Apple's reaction on the emergence of Pod Casts, when including them into the overall platform offer.

Phase 5: Strategic Monitoring and Learning

Characteristically for a thriving platform ecosystem is that innovative strategies might emerge within the platform ecosystem. While not all trends are worth pursuing, the platform owner has to decide which trends to pursue and when to adapt strategy. Correspondingly, the platform owner has to continuously monitor the initiatives implemented to execute innovation strategy and learn from their results. Therefore, a dedicated strategy management is required to review related key performance indicators of internal and external innovation initiatives in order to assess progress and identify barriers to strategy execution. Further, the performance of the platform-based innovation strategy itself needs to be assessed and adapted, if necessary. In this context, the implementation of dedicated platform intelligence efforts supports the platform owner throughout the decision process. Correspondingly, platform intelligence can be considered as an ongoing process to provide the platform owner with information relevant for strategic innovation planning and decision making throughout the entire innovation process. It collects, analyses, and applies information for the purpose of decision support. Thus, platform intelligence targeted at the needs of platform-based innovation management has to collect data on customer preference patterns and the related performance of composite products and services. The data then needs to be aggregated and analyzed. Through these procedures, the platform owner gains information on customers, important consumption clusters, the provision of complementary products and services as well as the ecosystem's capacity to respond to important needs, opportunities and threats. Further the platform owner is enabled to locate goal incongruence as well as under- or oversupplied complementary segments. With regard to the large amount of data that is to be analyzed, data needs to be automatically collected, interpreted and customized. According to the different information purposes, the procedural design needs to base on feedback loops as shown in section 5.4.

Phase 6: Adaptation and Testing of platform-based Innovation Strategy

Once the platform owner identifies challenges or threats flawing the actual platform-based innovation strategy, the platform owner is required to reexamine and adapt the strategy. Based on the analyses, information gained through platform intelligence, actual market and technology trends, the competitive platform environment as well as emerging opportunities, the platform-based innovation strategy is adapted, launching another platform-based innovation management cycle.

6. Evaluation of Research

Given the findings gained throughout previous chapters, this chapter is targeted at assessing and establishing their 'trustworthiness' (see section 1.3). In explicit, the chapter's focus has been set on establishing the 'interpretive rigor' (see section 1.3.2) of the present work. The 'methodological rigor', by nature, runs as common theme through the entire work and has been specifically addressed in sections 1.3.1 and 1.4.

6.1. Case Study Approach to Establish Interpretive Rigor

In order to establish the present work's interpretive rigor, the single case study approach as introduced by Eisenhardt (1999) has been applied. This approach enables the author to provide the reader with the required 'dense description' of a concrete platform setting, namely the SAP Business Process Platform. Within this platform setting, the findings become transferable, showing their 'applicability' at the case of a leading platform owner in the ICT industry. Further, demonstrating and discussing the research findings at a concrete platform setting allows drawing conclusions and providing recommendations to the platform owner. Within the context of the present work, detailed recommendations have been provided to the SAP Board by means of a white paper. Due to reasons of confidentiality, this paper can not be made publicly available - with exception of the recommended co-innovation process depicted in section 6.2.3. Related presentations and discussions have led to concrete transfer efforts to implement the present work's findings in the context of the company's platform business. These efforts demonstrate the consistency and neutrality of research efforts as well as their industry relevance.

6.2. Innovation Management in the Context of SAP's Platform Leadership Strategy

The following case study has been done in a qualitative manner; primarily being developed by data collection methods of interviews with senior executives, corporate strategists and innovation experts at SAP as well as discussion with focus groups, literature reviews and Internet searches. Due to reasons of non-disclosure, all confidential information from this case study remains unpublished. Correspondingly, all company as well as platform related information provided are publicly available. Results from expert interviews and focus group discussions, especially with regard to strategic implications, are presented as coarse-grained summaries, which neither exceed the information level that is publicly available.

6.2.1. Initial Situation

SAP is ranked as the world's largest provider of business software. Today, customers in more than 120 countries run SAP applications, from distinct solutions addressing the needs of small businesses and midsize companies to suite offerings for global organizations. Founded in 1972, SAP operates sales and development locations in more than 50 countries worldwide and is listed on several exchanges, including the Frankfurt Stock Exchange and NYSE (SAP AG, 2010a).

Within its industry, SAP faces customers increasingly demanding holistic and tailored solutions as they started to re-organize their value creation processes towards a joint provisioning of goods and services through flexible IT-based value constellations rather than through rigid supply chains (Basole et al., 2008): While focusing on core competencies, complementary, but non-core activities and assets of partners are leveraged. That way, the resulting network implies the ability to 'rapidly pick, plug, and play' business processes (van Heck & Vervest, 2007). Conte et al. (2009) refer to the software industry as a prime example for this trend: As a consequence, software vendors turn into service providers, benefiting from the capabilities of Internet standards and interoperability. They increasingly modularize their core competencies in platform ecosystems in order to offer joint complex product and service offerings, which meet specific customer requests. In response to this trend, SAP has established a business process platform (BPP), which offers process knowledge, while providing connections to downstream systems (SAP AG, 2010b).

6.2.1.1 Co-Innovation with Customers and Partners

The SAP Enterprise Services Architecture was developed with the goal to create software applications targeted at individual customer needs; extend or change existing applications; and integrate SAP and non-SAP applications and services. By defining interface standards and allowing independent software vendors (ISVs) to develop new, highly specialized business applications, SAP has attracted a large platform ecosystem of partners to build solutions on top of its technology platform. Within this context, the Business Process Platform represents a Web-services-based platform, consisting of a collection of software technologies, tools and content, allowing customers to integrate composite applications developed by third parties (Frederico & Burgelmann, 2006). Correspondingly, a close collaboration with customers and partners, referred to as co-innovation, plays a key role in SAP's growth strategy: In 2010, SAP "continues to invest in its partner ecosystem to support the development of solutions built on the SAP NetWeaver technology platform and leverage partner sales forces to address the various market and customer segments" (SAP AG, 2010b). Globally, more than 9.000 companies

participated in SAP's various partner networks, and 1.2 million individuals in SAP's online communities (Hagel & Brown, 2008).

6.2.1.2 The Business Process Platform

With the SAP Business Suite 7.0, SAP has accomplished the shift from the traditional architecture to an enterprise services-oriented architecture (eSOA), enabling customers to flexibly compose business processes based on a stable core of standardized processes (Snabe et al., 2009). This modular architecture allows SAP to implement a platform leadership strategy, providing the core Business Process Platform functionality to enable customers to complement SAP solutions with individual 'crown-jewel' processes (SAP AG, 2009). Figure 27 represents SAP's shift to service-oriented architecture.

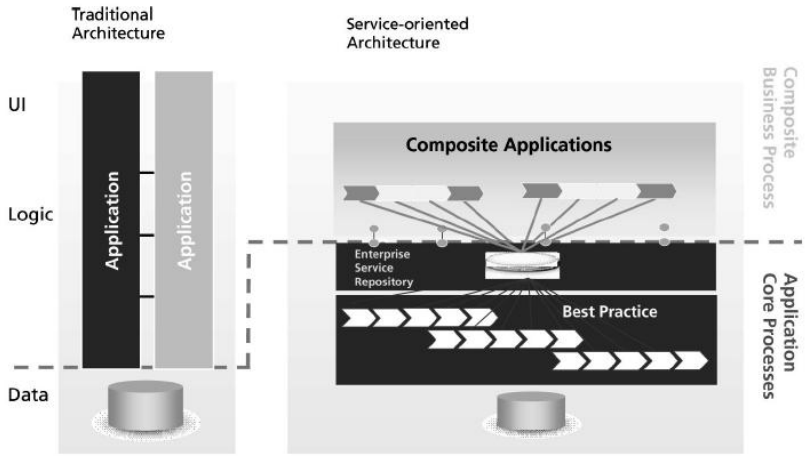


Figure 27: Shift to an Enterprise Services-oriented Architecture (Snabe et al., 2009)

Therein, the differentiation between 'Application Core Processes' and 'Composite Business Processes' is decisive (Snabe et al., 2009):

- *Application Core Processes:* As part of the SAP Business Suite application core processes are delivered via SAP's business application. They represent the pre-defined and packaged core business functionality in SAP applications. These packaged processes are exposed as reference content in the Enterprise Service Repository (ESR) and SAP Solution Manager, providing process insight and transparency into the company's business operations. Explicitly, application core processes represent business process best practices.
- *Composite Business Processes:* Composite business processes, in turn, are driven by a company's functional business requirements and specifications. Their primary goal is to provide added business value, speed and quality of exception handling, and delivery on the promise of innovative business ideas to improve efficiency and have a

sustainable process improvement impact. Therefore, composite business processes enable business process composition at the edge of the application core. Contrarily to application core processes, composite business processes need to provide ad-hoc capabilities to react quickly and flexibly to changes in the business or critical business events.

6.2.2. Primary Challenges to Innovation Management

Considering these company insights, the importance of external complementary innovations on top of the Business Process Platform becomes apparent. From the perspective of SAP in its role of a platform owner, it is particularly the ecosystem's effectiveness, flexibility and cost-efficiency to deliver whole solutions that determines success. The interviews and discussions conducted with senior executives and different focus groups acknowledged this perspective: SAP in its role of a platform owner fundamentally depends on continuous external innovational efforts in parallel to the core platform evolution. In particular, it became obvious that the company is required to:

- Maximize its profits and market share, while at the same time enabling and motivating the platform ecosystem to innovate and evolve in ever-better ways around the platform;
- Create win-win situations with autonomous partners, participating in the ecosystem;
- Continuously evolve the platform and ensure that complementary capabilities evolve simultaneously;
- Maintain integrity and coherence of the overall platform value proposition;
- Sustain market and platform leadership in platform competition.

Against this background, SAP has to find new ways to tackle innovation in order to (a) foster the ecosystem's productivity and, in particular, its ability to consistently transform inventions into lowered costs, new services, and functions; and (b) to create new, valuable functions and diversity on top of BPP. These changes require SAP to move from the 'not invented here' syndrome to open innovation. In particular, the discussions with focus groups have highlighted the following challenges to innovation management:

- *Maintain Heterogeneity:* SAP has to encourage experimentation, foster diversity and competition within the ecosystem in order to maintain a pool of participants working on innovational challenges. Correspondingly, if external efforts are successful the benefits should accrue to them.
- *Drive Platform Adoption:* SAP has to maintain and increase the platform's 'installed base' and its readiness to buy new process functionality in order to benefit from

indirect network externalities. Therefore, SAP has to ensure a continuous portfolio optimization.

- *Ensure Platform Attractiveness to Individual Software Vendors (ISVs) and external application developers:* SAP has to attract ISVs and external application developers to the platform. The attractiveness of the licensing model, developer support or dedicated information on customer needs is of relevance. Further, a savvy mixture of extrinsic and intrinsic motivations to control individual value creation activities is required.
- *Source Complementary Innovations:* SAP has to define its innovation requirements in order to steer innovational efforts within the platform ecosystem. Therefore, external innovation efforts need to be motivated 'bottom-up', whilst at the same time, absorbing emerging innovation opportunities within the business ecosystem. Also, external innovation efforts need to be monitored with alacrity, ensuring that emerging trends within the ecosystem are considered in strategic decision making.

In summary, understanding innovation management as systematic planning, implementing, directing and controlling of an organization's innovation activities for the purpose of an efficient and effective realization of innovative ideas (Vahs & Burmester, 2002) requires SAP to envision the overall platform evolution and determine the scope of 'core' and 'complementary' innovation activities from a holistic perspective. This requires SAP to actively decide, which innovation activities to pursue internally and which to drive within the platform ecosystem. However, as new innovation opportunities are constantly appearing, this is not a one-time decision, but rather a continuing strategic innovation assessment. Explicitly, SAP needs to balance the tensions between its interests in appropriating the returns on innovation and platform adoptions. In particular with regard to entering 'complementary markets' SAP has to be extremely careful as external complementors will not continue their support if they feel constantly threatened.

6.2.3. Recommended Co-Innovation Process

In reaction to the identified challenges, the Platform-based Innovation Management Framework as developed in chapter 5 has been recommended to the company. This framework provides the background to the external complementary innovation (co-innovation) process that is further detailed in the sequel. The output of the process is a pool of complementary products and services to be integrated into the platform portfolio. Figure 28 represent the co-innovation process within its contexts.

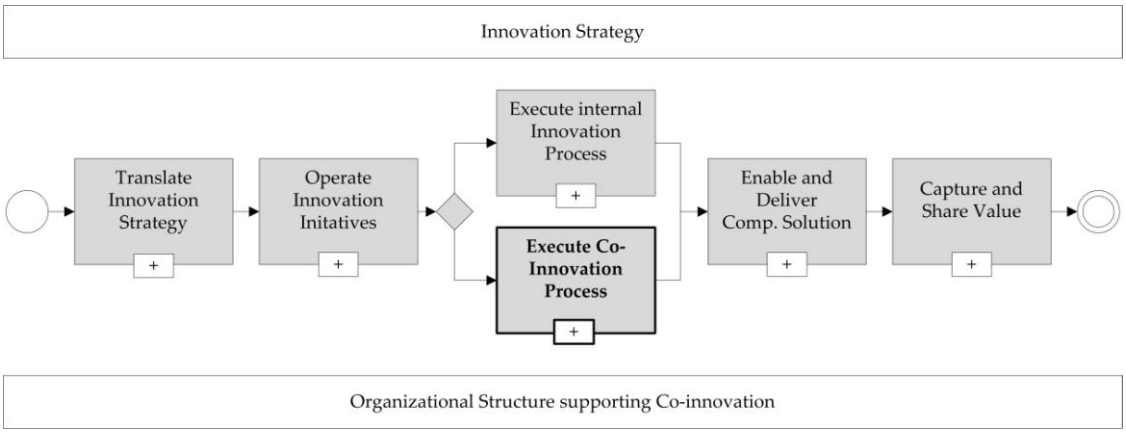


Figure 28: Co-Innovation Process within its Context (own illustration)

Explicitly, the co-innovation process model bases upon the following design principles:

- The process is modeled as an integrated phase of the overall Platform-based Innovation Management Cycle, entailing a comprehensive decision making about core and co-innovation efforts;
- Complementors are empowered with high degrees of freedom to co-innovate;
- The process is modeled as stage-gate process with SAP in the gate-keeper role;
- A continuous monitoring of innovational activities ensures the strategic goal congruence between the platform owner and the participants of the ecosystem;
- Innovation Strategy adaptation is considered as a consequence of system changes or emerging strategies in the ecosystem.

Correspondingly, the co-innovation process depicted in figure 29 embraces three major sub-processes as well as related support processes and tasks:

- *Phase A:* Stimulate Ideation and Initial Specification of External Complementary Innovational Efforts
- *Phase B:* Direct Development of External Complementary Innovational Efforts
- *Phase C:* Source External Complementary Innovations
- *Support processes:* Managing the co-innovation process requires additional processes for planning, governing and monitoring. They embrace the processes 'Planning complementary innovation initiatives'; 'Governing and controlling ecosystem evolution' as well as 'Monitoring and evaluating the behavior, activities and supply of third party complements on top of the platform.

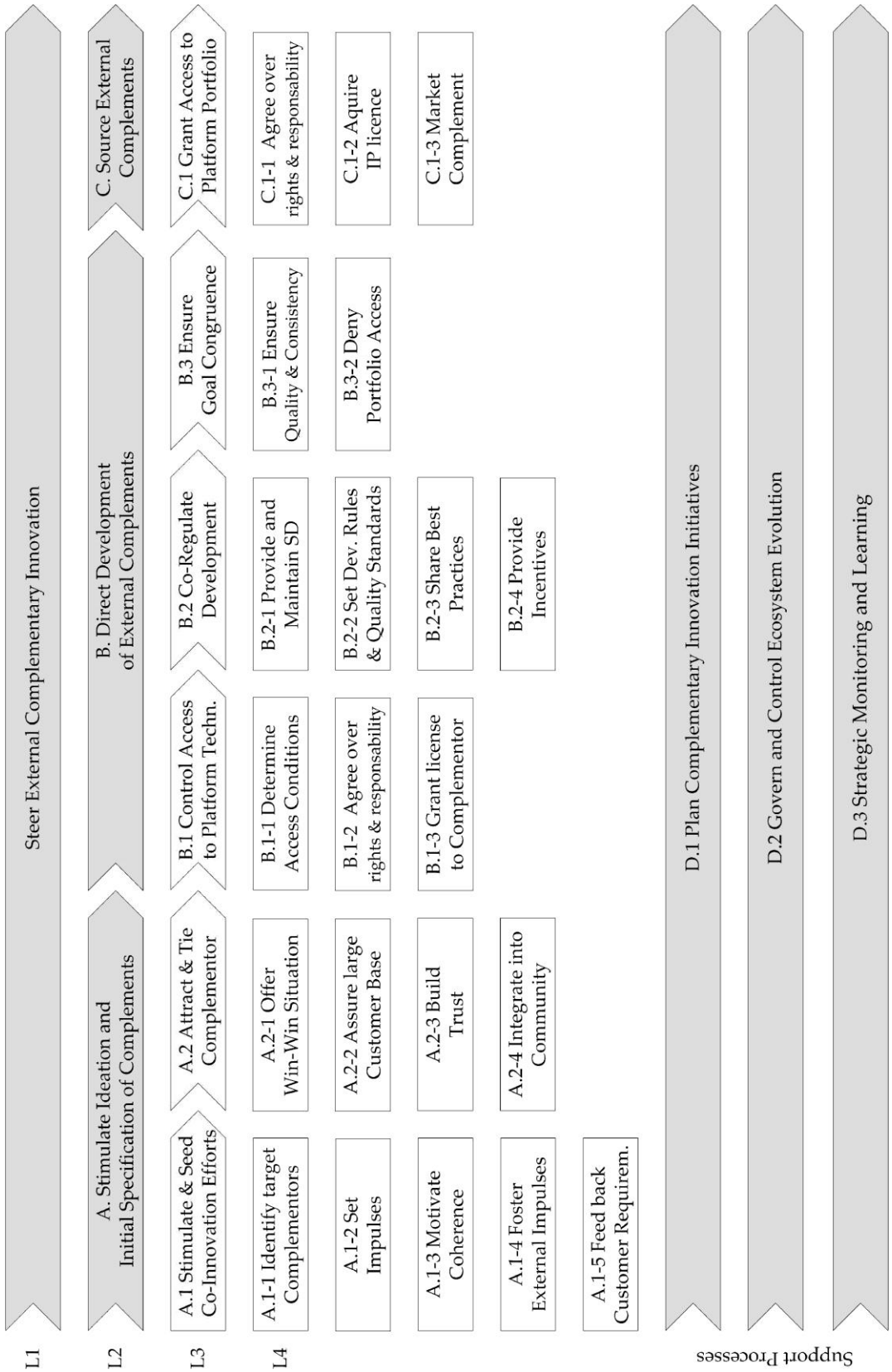


Figure 29: Process Model of the recommended Co-Innovation Process (own illustration)

Phase A: Stimulate Ideation and Initial Specification of External Complementary Innovational Efforts

The first phase embraces the sub-process of stimulating ideation and initial specification of external complementary innovational efforts. The goal of the sub-process is to foster external creativity, targeted at achieving the platform owner's innovational objectives. Thereby, the innovation initiatives focus on well defined innovation objectives and context. They may target either specific groups of complementors or anybody within the platform ecosystem. The sub-process contains further process steps and tasks:

A.	Stimulate Ideation and Initial Specification of External Complementary Innovational Efforts		
	A.1	Stimulate and seed co-innovation efforts: Within this phase, the platform owner actively stimulates and seeds innovational efforts within the platform ecosystem.	
		A.1-1	*Identify target group:* In a first step, the target group is identified that is expected to be interested in identifying potential new business opportunities. Awareness of the new initiative needs to be created.
		A.1-2	*Set impulses:* Concrete impulses need to be set by the platform owner, e.g. exclusive information or dedicated funding may be given about inventing a new business opportunity within a dedicated innovation field. In certain cases, the platform owner may also provide funding options or set up communities to solve a dedicated challenge.
		A.1-3	*Motivate coherence:* Importantly, the platform owner has to motivate coherence between new business opportunities to be invented to complement the core platform and the core platform value proposition.
		A.1-4	*Foster external impulses:* In addition to setting innovational impulses based on the platform owner's innovation strategy, the platform owner should also foster and absorb external innovational impulses within the platform ecosystem in order to benefit from external creativity and opportunities that have yet not been considered within the company.
		A.1-5	*Feed back customer requirements:* Customer feedback offers valuable information and hints to identify new business opportunities. It further optimizes existing complements in accordance to actual customer needs. Therefore, the platform provider has to implement dedicated feedback processes to close the loop between the ideation phase and day-to-day operations of the platform-based solution.

	A.2	Attract and tie complementors to the platform: This phase is targeted at attracting and tying complementors to the platform.	
		A.2-1	*Offer win-win situation:* By determining the platform revenue share the two-sided platform business model becomes crucial to attracting complementors to the platform. Driven by own profitability interests the complementor will only develop complements on those platforms, whose platform owner guarantee the profitability of its efforts in the end. By implementing dedicated partner programs, complementors may be tied to the platform, e.g. offering various incentives when achieving a predefined stage in the partnership.
		A.2-2	*Assure large customer base:* Most fundamentally, the size of the platform's customer base and, therefore, the revenue potential, determines the platform's attractiveness to the complementor. The more attractive the platform to the complementors is the higher the revenue share the platform owner may claim for mediating external complements on top of the platform. Correspondingly, the platform owner has to continuously tie customers to the platform in order to attract complementors – and vice versa.
		A.2-3	*Build trust:* Trust is one of the most important aspects in the relationship between platform owner and complementor. By building platform-specific complements on top of a dedicated platform, the complementor needs to be sure that its investments will be secured.
		A.2-4	*Integrate into community:* Of major importance are the platform owner's efforts to build a vivid community around their platform in order to foster creativity, communication, identity and cohesiveness of the participants, while tying them closer to the platform. These communities and their members need to be actively managed and integrated into the organizational context in order to be successful.

Table 5: Phase A of the recommended Co-innovation Process (own illustration)

Phase B: Direct Development of External Complementary Innovational Efforts

The second phase embraces the sub-process of directing the development of external complements. The goal of the sub-process is to ensure the complementor's congruence with the platform owner's strategic goals. Therefore, the platform owner acts as gate-keeper, determining development rules, quality standards and access to the platform technology via dedicated interfaces and software development kits (SDK).

B.	Direct Development of External Complements		
	B.1	Control Access to Platform Technology: Within this phase, the platform owner acts as gate-keeper, actively deciding whom to grant access to platform technology.	
		B.1-1	*Determine platform access conditions:* In a first step, the platform owner determines fundamental access conditions, e.g. development language, developer competences, etc. Access will be denied to those complementors who are not willing or capable to apply to these conditions.
		B.1-2	*Agree over rights and responsibilities:* By registering to the platform, and agreeing to the platform's rights and responsibilities the complementor accepts the fundamental platform access conditions and gains the right to access the platform technology in order to develop complements within the SDK
		B.1-3	*Grant platform license to complementor:* By agreeing to the platform's rights and responsibilities the complementor further gains a platform usage license, allowing the complementor to integrate platform functionality into its application.
	B.2	Co-regulate development of complements: This sub-process co-regulates the development of complements on top of the platform by setting development rules and quality standards, sharing best practices and providing incentives to achieve strategic goals.	
		B.2-1	*Provide and maintain SDK:* In order to co-regulate the development of complements the platform owner provides and maintains a set of development tools that allow for the creation of applications on top of the respective platform.
		B.2-2	*Set development rules and quality standards:* The purpose of development rules and quality standards is to promote the high quality and reliability of the whole solution to the customer. The set of rules and expected quality standards governs third party companies in developing complements on top of the platform. Finally, these rules and quality standards determine the approval process of complements to be integrated into the platform portfolio.

		B.2-3	*Share best practices:* Best practices loosely describe experiences, success or mistakes. They are considered a key part of the success of any company as they motivate other complementors to act in a similar manner to be successful and learn from the experience of others.
		B.2-4	*Provide incentives:* Incentives are important factors to motivate or encourage complementors to follow a certain course of action. Incentives may embrace, e.g. development support, community building, funding, or access to exclusive information. Dedicated incentive programs, therefore, assist the platform owner in achieving its strategic goals.
	B.3	Ensure Goal Congruence: This sub-process acts as decision gate, determining access to the platform portfolio, and therefore, to the platform's customer base. It represents the platform owner's strongest means to ensure the complementors' congruence to its strategic goals.	
		B.3-1	Ensure quality and consistency: The quality review embraces a dedicated approval process whether the complement applies to the development rules and quality standards set by the platform owner. It ensures the platform's overall value proposition to the customer by denying those complements that fail approval.
		B.3-2	Deny platform access: Complements that fail the final quality approval are to be rejected. In order to meet the quality expectations in a second turn, the platform owner needs to provide explicit feedback to the complementor. Complementors that have successfully passed the quality review, however, do not act in a goal congruent manner face the risk of being rejected in later process phase.

Table 6: Phase B of the recommended Co-innovation Process (own illustration)

Phase C: Source External Complementary Innovations

The third phase embraces the sub-process of sourcing external complements in order to integrate them into the platform portfolio and make them available for sale to the platform's customers. Explicitly, the integration into the platform portfolio is temporal, related to the platform owner's overall portfolio management.

C.	Source External Complements		
	C.1	Grant Access to Platform Portfolio: By granting access to the platform portfolio, the platform owner actively selects a portfolio of third party products and services, complementing the platform's core value proposition and extending its market reach.	
		C.1-1	*Agree over rights and responsibilities:* In a dedicated contract, both platform owner and complementor agree about respective rights and responsibilities, guiding the relationship between both parties. These terms explicitly embrace regulations concerning platform usage, payment conditions, IP infringement and customer support.
		C.1-2	*Acquire IP license:* In order to sell the complement to customers, the complementor is required to grant an IP license to the platform owner. This authorizes the platform owner to market the complement, whilst at the same time providing planning reliability to the platform owner.
		C.1-3	*Market complement:* In order to make the complement available to the customer, the complement needs to be listed in the platform 'store'. The store represents the platform's marketplace, which mediates supply and demand on top of the platform. It comprises the variety of products and services available to complement the platform's core value proposition. To a great extent, the perceived platform value is determined by the attractiveness of the platform portfolio.

Table 7: Phase C of the recommended Co-innovation Process (own illustration)

Support Processes

The following support processes guide the platform owner in its day-to-day operations of the two-sided platform business model.

D.	Support Processes	
	D.1	*Plan complementary innovation initiatives:* This process embraces the development of dedicated complementary innovation initiatives to achieve related innovational goals set in the innovation strategy. It defines concrete activities and timelines, whilst assigning the required resources. Explicitly, complementary innovation initiatives need to be continuously aligned with internal innovational efforts in order to ensure consistency between internal and external development efforts.
	D.2	*Govern and control ecosystem evolution:* Throughout this process, the platform owner governs the platform ecosystem's evolution. It ensures that (a) the participant structure, the behavior of the platform ecosystem and the decisions made by autonomous complementors are consistent with the overall objectives and strategies set by the platform owner, and (b) that the platform owner strategically responds to important opportunities and threats emerging from the platform ecosystem, resulting in emergent platform-based innovation strategies. A key challenge, thereby, relates to the automation of monitoring and control mechanisms to coordinate external complementary development efforts, whilst reducing transactional costs (see also section 7.2).
	D.4	*Strategic Monitoring and Learning:* Finally, the platform owner is required to continuously monitor the initiatives implemented to execute innovation strategy and learn from their results. Dedicated platform intelligence efforts provide the platform owner with information relevant for strategic innovation planning and decision making throughout the entire innovation strategy process, ensuring that innovation strategy is adapted, if necessary.

Table 8: Supporting Processes of the recommended Co-innovation Process (own illustration)

6.3. Trustworthiness of Research Findings

At a concrete example, the presented case study demonstrates how the Platform-based Innovation Management Framework could enable SAP to stimulate, control and source external innovational efforts within the context of its platform leadership strategy. Through intense discussions with senior executives, corporate strategists and innovation experts, awareness could be drawn on the peculiarities and challenges of managing open innovation in the context of a two-sided platform business model. Explicitly, the process model proved to be of advantage throughout discussions as it served as concrete 'show-and-tell' object. This way, the discussions yielded detailed valuable feedback on how to improve the process model and the application of corresponding governance mechanisms. Overall, the broad consent of experts as well as executives proved the quality of research results and the relevance of the process model in industry practice.

Discussing the platform-based innovation process with dedicated focus groups at SAP further revealed a series of benefits, which its implementation could have:

- Most fundamentally, the members of the different focus groups agreed that the process model would support SAP in leveraging a vibrant platform ecosystem in order to deliver 'whole solutions' to customers, while addressing their individual requirements.
- Further, the process model would allow making explicit an end-to-end innovation process, aligning innovational efforts on core technology and applications with co-innovational efforts, while ensuring consistency in platform and ecosystem evolution.
- Additionally, the participants acknowledged that innovation management targeted at platform leadership requires both proprietary internal innovation strategies to advance the core platform and its core applications as well as external innovation strategies to stimulate, channel and steer external complementary innovations. This, however, could only base on an overall platform vision and an integrated innovation management approach to systematically plan, implement, monitor and control innovational activities for the purpose of continuously evolving the platform's overall value proposition.

In summary, throughout the discussions with dedicated focus groups the participants have recognized the strategic relevance of managing open innovation in two-sided platform businesses, i.e. within the context of a platform leadership strategy. The process model, finally, has been acknowledged to allow SAP to strategically steer complementary innovation efforts in the context of a platform leadership, while benefiting from emergence and self-organization as major sources of innovation within the business ecosystem. Thereby, the participants' interest has further focused on a dedicated

platform-based performance management system as well as on the question, which key performance indicators to implement in order to monitor and assess the platform ecosystems' performance. As these aspects have not been the focus of the present work, they represent an important avenue for future research, further detailed in section 7.2.

7. Final Conclusion

The present dissertation argues that value creation in two-sided platform businesses significantly differs from value creation throughout the traditional supply chain approach. Explicitly, the triangular set of relationships between platform owner, customers and third party companies complementing the core platform offer causes indirect network externalities to become a major source of value creation. Correspondingly, dedicated platform leadership strategies are required to exploit indirect network externalities. Therein, the platform owner's central challenge turns out to be the orchestration of a complex self-organizing web of direct and indirect relationships between autonomous interdependent actors, co-creating value, while the value of the total offering is determined and driven by the customer. As a result, two-sided platform businesses differ significantly in their economic rational and strategic behavior from non-platform businesses. This places new challenges and requirements on managing innovation in open modular platform environments; in particular, on steering external complementary innovational efforts in the systemic innovation context of a platform leadership strategy.

By analyzing the peculiarities of open innovation in two-sided platform businesses, the present work has identified four primary challenges these businesses place on the platform owner's innovation management approach. First, the strategic ambition of platform leadership requires the platform owner to lead a continuous, efficient platform evolution, while ensuring that external complementary products and services provided by the platform ecosystem evolve simultaneously and coherently with the platform. Secondly, the platform owner is required to address both the internal as well as the external dimension to manage innovations. As shown, both dimensions differ in strategic planning as well as managerial control mechanisms and need to be managed in a holistic manner, in order to ensure coherence and integrity throughout the overall platform value proposition to the customer. Explicitly, this requires the platform owner to develop a sharp understanding of core competences and platform evolution to be complemented by external partners. Therefore, the platform owner has to actively decide, which innovational efforts to pursue internally and which to source externally. Thirdly, once innovation processes are shared between larger numbers of actors, the hierarchical model of coordination and control, which is often applied within company borders, will be no longer sufficient. Instead, there is a need for extrinsic motivational efforts to stimulate profit-seeking complementors to co-innovate on top of the platform. Finally, the systemic nature of innovation in open modular platforms raises specific attention to the complementarity of innovational efforts as complementarity gives raise to indirect network externalities, determining the platform's market adoption. The platform owner, hence, is required to actively apply strategies to

exploit indirect network externalities and to stimulate and coordinate external complementary innovation efforts. In order to do so, platform owners have to adopt new modes of control in order to foster complementary innovation on top of the platform. Ensuring the partner's goal congruence, therefore, becomes of strategic importance.

As a result of the elicitation process the author claims that two-sided platform businesses require a dedicated 'platform-based innovation management' approach, targeted at addressing the peculiarities of managing open innovation within the context of a platform leadership strategy. Within this strategic context, the platform owner's innovation management function is required to:

- Lead platform and platform ecosystem evolution by holistically envisioning and orchestrating internal and external innovational efforts within the systemic innovation context of a platform leadership strategy;
- Continuously attract and tie related resources and capabilities to the platform ecosystem in order to nurture an environment for innovation;
- Strategically determine, which innovational efforts to pursue as internal core efforts and which external complementary innovation efforts to steer within the platform ecosystem;
- Facilitate the implementation of innovation goals both within the company as well as within the platform ecosystem in order to evolve partner capabilities in the platform ecosystem simultaneously and coherently with the core platform value proposition;
- Empower complementors through high degrees of freedom to co-innovate on top of the platform, while considering the platform owner in the architect and gate-keeper role;
- Exploit and share the benefits of platform innovation in order to maintain a continuous supply of complementary products and services;
- Continuously monitor behavior within the platform ecosystem in order to feedback relevant information, providing the basis of decision-making to (a) ensure innovation strategy implementation, (b) the complementors' goal congruence to the platform owner's strategic innovation goals by appropriately applying the respective means of managerial control; and (c) to adapt innovation strategy as a consequence of system changes or emerging strategies in the platform ecosystem.

Despite the importance of external complementary innovation for the platform's overall success as well as the growing interest in open innovation, the peculiarities of managing open innovation within the context of a platform leadership strategy lack academic attention. While recent innovation management literature predominantly considers

managing the innovation process within the company's boundaries, the paradigm shift to open innovation assumes that value is co-created and appropriated between partners. This implies that the total value created in a platform ecosystem is dependent on the commitment of partners to invest in complementary assets and offerings and on how well the partner's objectives are aligned to each other.

7.1. Critical Acclaim

Against this background, the present work emphasizes that the strategic peculiarities of two-sided platform business models impact the platform owner's entire innovation management; in particular, innovation strategy formulation, goal setting, strategy implementation, and the execution of innovation processes as well as strategic learning. Explicitly, the present work calls for a dedicated 'platform-based innovation management' approach, targeted at addressing the peculiarities of managing open innovation within the context of a platform leadership strategy. By proposing the 'Platform-based Innovation Management Framework' the present dissertation advances state-of-the art research by explaining how to holistically manage open innovation in two-sided platform businesses, i.e. in the context of a platform leadership strategy.

Given the recent shortcomings in innovation management literature (see section 3.5), a first contribution of the present work lies in the identification of a new research avenue that has not been addressed in academia so far: In a dedicated requirements elicitation process, the requirements two-sided platform businesses place on innovation management have been detected. Further, the author was able to create awareness by publicizing the research topic at international conferences and discussing it in-depth with the related research community, senior executives, corporate strategists and innovation experts. These discussions have confirmed the topic's relevance and importance to both academia as well as industry, revealing the necessity of a platform-based innovation management approach.

The second contribution refers to the present work's main contribution: the Platform-based Innovation Management Framework. It embraces the three core elements; (1) the 'Platform-based Innovation Management Cycle', (2) the 'Guiding Principles of Innovation Planning and Decision Making', and (3) the 'Platform-based Management Control Model'. These elements provide the basis for the platform-based innovation process model, guiding the platform owner in directing external complementary innovation in the context of a platform leadership strategy. This process addresses the platform owner's central challenge of orchestrating a complex self-organizing web of direct and indirect relationships of autonomous, but interdependent actors, co-creating and delivering value that is determined by the customer.

The third contribution of the present work lies in introducing managerial control mechanisms to Open Innovation. Applying those mechanisms consciously along the external platform-based complementary innovation process and its key decision gates allows closing the gap between the potential of open innovational efforts and the actual value generated within platform ecosystems.

The forth contribution of the present work lies in transferring the results gained into SAP's solution management, confirming its relevance and applicability in a concrete platform context.

Despite these achievements, the present work also faces limitations. In particular, the question, whether the Platform-based Innovation Management Framework contributes to or increases a company's success remains open. The validation of causal coherences between the present work's findings and company success would have required a longer time scale and the development of a dedicated performance measurement system with related key performance indicators, revealing those implications that lead to the platform ecosystem's success or failure.

7.2. Avenues for Further Research

As the development of a dedicated platform-based performance measurement system has not been the focus of the present work, it represents one avenue for further research that has been identified throughout the interview phase as well as throughout the definition phase of potential transfer efforts into SAP's solution management. Marco Iansiti, the David Sarnoff Professor of Business Administration at Harvard Business School, has addressed this issue by proposing 'productivity', 'robustness', and 'innovation' as ecosystem metrics (Iansiti & Levien, 2004). In addition, Zhu & Iansiti (2007) have identified factors that drive platform success, long-run market structure, and market efficiency. Based thereon, they have developed a dynamic model to examine the evolution of platform-based markets. These insights provide a first step into the development of a dedicated performance measurement system that actively supports the platform leader in measuring and controlling the performance of individual third party companies, participating in the platform ecosystem. Nevertheless, to the author's best knowledge, there are currently no performance measurement approaches available in academic literatures that address this research issue.

A second research issue that has been identified within the context of the present work relates to the formalization, widening and automation of monitoring and control mechanisms to actively coordinate the innovational efforts of complementary partners within the platform ecosystem (Scholten et al., 2011). As shown throughout this work, a

platform's long-term success depends on continuous innovation and renewal of the platform ecosystem, embracing continuous portfolio optimization and provision of superior customer value. With respect to a robust evolution of the ecosystem, this embraces the handling of two primary risk factors: First, information asymmetry, as complementors lack a comprehensive market view, (Shapiro & Varian, 1999; Williamson, 1981) and secondly, goal incongruence with the platform owner's objectives. In order to address these issues, two courses of action need to be followed: On the one hand, co-regulative control needs to exceed a basic regulation of legal and transactional issues. In sequence with restrictive and sanctional control loops, co-regulative control mechanisms need to expand to a verification of the actual functional quality. This requires a more sophisticated monitoring approach as well as dedicated analyses of actual demand, offering and consumption. Currently, research on the conceptual and technical aspects as well as on its respective implementation has been primarily addressed by Fischer et al. (2009; 2010). In addition to these rather reactive patterns of control, platform owners further need to (a) improve their pro-active influence towards satisfaction of undersupplied customer demand and (b) ensure the partners' goal on a macroscopic perspective. Motivational means of control, as exemplified by Facebook and Netsuite (see section 4.3) is one step to address this void. More scalable, however, would be information-driven methods. According to Scholten et al. (2010) as well as Fischer et al. (2009; 2010) automatically generated information, specifically customized per complementor could stimulate targeted self-regulatory processes and emergence within the ecosystem, while reducing transactional costs.

In conclusion, the awareness on the strategic importance of two-sided platform businesses is continuously increasing both in academic research as well as in industry practices. Correspondingly, the variety of research issues arising from this entirely new class of business designs is continuously harboring further research requirements, exceeding those exemplified above.

8. Abstract

Today's global economy migrates from vertically integrated enterprises towards specialized enterprises. In consequence, companies have to closely interoperate with partners and competitors to flexibly satisfy the customers' demand for individual product and service solutions, speed and high levels of product and service quality. In order to cope with these challenges, while keeping the focus on core competencies and cost efficiencies, many companies implement open modular platform concepts, enabling them to create platform ecosystems around their offerings. As a result, an increasing number of companies strives for 'platform leadership', which represents a company's strategic intention to provide the platform for other companies to build and deploy products and services. This process cannot be reduced to simple outsourcing decisions, but is part of renewed strategies of Open Innovation in an increasingly dynamic economic climate.

Opening up dedicated interfaces to external complementary development resources, however, changes the company's business model from formerly being 'single-sided' to then being 'two-sided'. Two-sided platform businesses, therefore, differ significantly in their economic rational and strategic behavior from non-platform businesses, as indirect network externalities become crucial to their success. Indirect network externalities imply that the more buyers are attracted to a platform, the more valuable the platform becomes to sellers. In reciprocity, the more sellers are attracted to it. In turn, the more sellers are offering innovative complementary products and services of suitable quality on top of the platform, the higher is the variety and the likelihood to match individual customer requirements. As a result, the broader the customer choice of complementary offerings on top of the platform is, the greater is the utility customers are able to derive from the platform and the greater the platform's profitability for the platform owner and its complementors. This requires platform owners to manage and sustain a continuous supply of external innovative complementary products and services to secure the profitability of their investments into an open modular platform concept. These insights indicate that the management of innovational efforts in open modular platform contexts is no longer confined to the legal boundaries of an organization.

Given the differences between platform and non-platform businesses, the present work argues that the peculiarities of two-sided platform business models require significant modifications to the platform owner's innovation management and innovation process in order to achieve competitive advantage in dynamic platform markets. Correspondingly, the present work seeks to (a) explore the peculiarities of innovation management in two-sided platform businesses and (b) to develop a platform-based innovation management

framework that guides the platform owner in holistically managing open innovation efforts within the context of its platform leadership strategy. Related research questions embrace:

- How shall a platform owner holistically manage internal and external innovational efforts within the context of its platform leadership strategy?
- How shall a platform owner decide, which innovational efforts to pursue internally and which to steer within the platform ecosystem?
- How shall a platform owner stimulate and control the supply of external complementary innovational efforts in a platform ecosystem of autonomous, however, mutually interdependent partners, striving for own profitability?
- How shall a platform owner model the open innovation process in order to coherently evolve the core platform and platform ecosystem to provide the customer with an adequate variety of high-quality complements?

Despite the importance of external complementary innovation for the platform's market success as well as the growing interest in open innovation, the state-of-the-art analysis reveals that little light has yet been shed on the open innovation processes and on the respective management control techniques to gain competitive advantage, ensure focus and value capture of open innovation efforts. Explicitly, academic literature lacks:

- A fundamental understanding of (a) the implications two-sided platform business models place on innovation management as well as (b) the resulting tasks of innovation management within this strategic context;
- A related platform-based innovation management cycle, supporting the platform owner in formulating, implementing and adapting innovation strategy;
- Guiding principles for innovation planning and decision making concerning internal and external innovational efforts to be pursued in the context of the platform leadership strategy;
- A related management control model, supporting the platform owner in implementing its innovation strategy within the platform ecosystem;
- A concrete innovation process model, guiding the platform owner in managing open innovational efforts within the context of a platform leadership strategy.

The successive requirements elicitation process reveals four primary challenges to innovation management in two-sided platform businesses. They embrace: First, the strategic ambition of platform leadership, requiring the platform owner to lead a continuous, efficient platform evolution, while ensuring that external complementary products and services provided by the platform ecosystem evolve simultaneously and

coherently with the platform. Secondly, the necessity of a comprehensive innovation planning and decision making concerning core innovation activities to be pursued in-house as well as complementary innovation efforts to be initiated and coordinated within the platform ecosystem. Both dimensions differ in strategic planning as well as managerial control mechanisms and need to be managed in a holistic manner in order to ensure coherence and integrity throughout the overall platform value proposition to the customer. Thirdly, the organization and management of open distributed innovation processes being located to a great extent outside the platform owner's company boundaries and forth, the coordination of complementary innovational efforts to exploit indirect network externalities. As a result of the requirements elicitation process the author claims that two-sided platform businesses require a dedicated 'platform-based innovation management' approach. Within this strategic context, the platform owner's innovation management function is required to:

- Lead platform and platform ecosystem evolution by holistically envisioning and orchestrating internal and external innovational efforts within the systemic innovation context of a platform leadership strategy;
- Continuously attract and tie related resources and capabilities to the platform ecosystem in order to nurture an environment for innovation;
- Strategically determine, which innovational efforts to pursue as internal core efforts and which external complementary innovation efforts to steer within the platform ecosystem;
- Facilitate the implementation of innovation goals both within the company as well as within the platform ecosystem in order to evolve partner capabilities in the platform ecosystem simultaneously and coherently with the core platform value proposition;
- Empower complementors through high degrees of freedom to co-innovate on top of the platform, while considering the platform owner in the architect and gate-keeper role;
- Exploit and share the benefits of platform innovation in order to maintain a continuous supply of complementary products and services;
- Continuously monitor behavior within the platform ecosystem in order to feedback relevant information, providing the basis of decision-making to (a) ensure innovation strategy implementation, (b) the complementors' goal congruence to the platform owner's strategic innovation goals by appropriately applying the respective means of managerial control; and (c) to adapt innovation strategy as a consequence of system changes or emerging strategies in the platform ecosystem.

Based on the identified challenges and requirements two-sided platform businesses place on innovation management, the 'Platform-based Innovation Management Framework' is developed. Within this context, platform-based innovation management is defined as an ongoing process that (a) systematically identifies, evaluates, and defines the strategic goals of proprietary and external complementary innovation; (b) implements innovation strategy both within the company as well as within the platform ecosystem; and (c) monitors, controls and aligns strategy implementation. Primary platform-based innovation management tasks, thereby, embrace:

- Envisioning and leading the overall platform and platform ecosystem evolution;
- Empowering and stimulating economic value creation activities of autonomous third party companies to enhance the platform's overall value proposition;
- Encouraging goal congruence of autonomous partners;
- Evaluating information about the overall system evolution as well as about emerging opportunities and threats within the platform ecosystem;
- Ensuring strategic coherence and appropriability of returns by maintaining control over platform and ecosystem evolution.

Based on the fundamental understanding of 'Platform-based Innovation Management', three core elements further detail the Platform-based Innovation Management Framework. They embrace the 'Platform-based Innovation Management Cycle'; the 'Guiding Principles of Innovation Planning and Decision Making' and, finally, the 'Platform-based Control Model'. The 'Platform-based Innovation Management Cycle' represents a closed loop management system that has been adapted to the peculiar innovation excellence needs of a platform owner. From a holistic platform leadership perspective, it guides the platform owner in developing a platform-based innovation strategy, translating it into operational actions and, finally, in monitoring and improving the effectiveness of both. In addition, the 'Guiding Principles of Innovation Planning and Decision Making' lead the platform owner in efficiently scaling its innovation efforts within the platform ecosystem; i.e. by actively determining the company scope, and deciding, which innovational efforts to pursue internally or which to stimulate within the platform ecosystem. Finally, the 'Platform-based Control Model' supports the platform owner in implementing strategy and orchestrating a platform ecosystem of autonomous, yet interdependent participants, while ensuring their goal congruence with the strategic platform goals. Interlinking these core platform-based innovation management elements allows modeling a platform-based innovation process that is targeted at the peculiarities of managing open innovation in the context of a platform leadership strategy. Explicitly, by allocating management control mechanisms variably to the different process phases and decision gates, the platform owner is

supported in implementing an innovation strategy in the context of an open distributed innovation environment.

Finally, the application of the Platform-based Innovation Management Framework to a concrete platform setting demonstrates that the results are suitable to support a platform owner in the ICT industry to stimulate, control and source external innovational efforts within the context of its platform leadership strategy.

9. Zusammenfassung

Globaler Wettbewerb, verkürzte Produktlebenszyklen sowie beschleunigte technologische Veränderungen erhöhen den Innovationsdruck auf Unternehmen und zwingen diese, durch kontinuierliche Innovationen ihre Wettbewerbsposition zu sichern. Die Innovationsfähigkeit des Unternehmens wird dabei zum entscheidenden Wettbewerbsfaktor und zur Grundlage für den nachhaltigen Unternehmenserfolg. Vor diesem Hintergrund öffnen Unternehmen zunehmend ihre Innovationsprozesse und integrieren externe Akteure in die unternehmerischen Innovations- und Wachstumsstrategien. Dieser Paradigmenwechsel von ehemals ausschließlich intern betriebener 'geschlossener Innovation' zu einer 'offenen Innovation' ermöglicht es Unternehmen, interne Innovationsaktivitäten durch externe Innovationspotenziale zu ergänzen.

Offene Plattformkonzepte, wie sie derzeit in der Softwareindustrie zu beobachten sind, stellen dabei ein erfolgreiches Beispiel für eine 'offene Innovation' dar. So gelingt es insbesondere den führenden Plattformanbietern wie Apple Inc., eBay Inc. oder Salesforce Inc. vom Innovationspotential tausender externer Akteure in ihrem Wertschöpfungsnetz zu profitieren, indem sie ihr Produkt- oder Dienstleistungsangebot im Rahmen ihrer 'Platform Leadership Strategy' als Plattform für die Entwicklung und Vermarktung externer Entwicklungsleistungen konzipieren. Als Voraussetzung hierfür sind modulare Produkt- oder Dienstleistungsarchitektur zu sehen, die mittels ausgewählter Schnittstellen und virtueller Entwicklungscenter gezielt für die Integration externer Leistungen geöffnet werden. Aus unternehmerischer Sicht bedingt diese Strategie jedoch nicht nur eine Öffnung zahlreicher Unternehmensprozesse, sondern auch eine Veränderung des Geschäftsmodells hin zu einem zweiseitigen plattform-basierten Geschäftsmodell. Dabei unterscheiden sich sogenannte 'zweiseitige Plattform-Organisationen' in ihrem strategischen und operativen Verhalten erheblich von traditionellen Unternehmen: Durch die Plattformnutzung der beiden Nutzergruppen 'Kunde' und 'Entwickler' werden indirekte Netzwerkeffekte zu einem entscheidenden Erfolgsfaktor für das Unternehmens. Diese implizieren, dass durch das Hinzukommen komplementärer Produkte oder Dienstleistungen das Nutzenversprechen der Gesamtplattform steigt und ein Anwachsen der Kundengruppe bewirkt. Somit steigt die Attraktivität der Plattform für den Kunden proportional zu der Vielzahl an qualitativ hochwertigen Komplementärleistungen, die von externen Entwicklungspartnern auf der Plattform angeboten werden. Gleichzeitig erhöht sich die Attraktivität der Plattform für die Entwicklergruppe, wenn die Plattform von möglichst vielen Kunden und damit potentiellen Käufern der Komplementärleistungen genutzt wird. Um die Investitionen in ein Plattformkonzept zu sichern, ist ein

Plattformbetreiber somit stetig bestrebt, möglichst viele Plattformnutzer auf beiden Seiten der Plattform zu binden und eine kontinuierliche Innovation der Gesamtplattform gemeinsam mit externen Komplementärpartnern voranzutreiben. Folglich ist das Innovationsmanagement in zweiseitigen Plattform-Organisationen nicht mehr ausschließlich auf die systematische Planung, Steuerung und Kontrolle von Innovationsprojekten innerhalb der Organisation beschränkt, sondern maßgeblich geprägt von einem interorganisatorischen Plattformkontext. In diesem Kontext muss der Plattformbetreiber die eigenen strategischen Ziele mit den Profitbestrebungen externer Partner abwägen, um erfolgreich Komplementärpartner an sich zu binden.

Diesbezüglich zeigt die Analyse der bestehenden akademischen Literatur, dass es trotz wachsendem Interesse am Thema 'Offene Innovation' sowie der strategischen Bedeutung von externen Komplementärinnovationen für den Markterfolg einer Plattform an einem holistischen Innovationsmanagementansatz sowie geeigneter Innovationsprozesse und Steuerungsmechanismen mangelt, die die strategischen Besonderheiten von zweiseitigen Plattform-Organisationen berücksichtigen.

Das Ziel der vorliegenden Dissertation ist, diese Forschungslücke zu schließen und einen geeigneten Innovationsmanagementansatz zu erarbeiten, welcher nachstehende Forschungsfragen zu beantworten vermag:

- Wie kann ein Plattformbetreiber seine internen und externen Innovationsbestrebungen im Rahmen seiner 'Platform Leadership Strategy' ganzheitlich planen, steuern und kontrollieren?
- Wie kann ein Plattformbetreiber entscheiden, welche Innovationsbestrebungen er intern verwirklichen sollte und welche er innerhalb des Wertschöpfungsnetzes orchestrieren kann?
- Wie kann ein Plattformbetreiber seine externen Innovationsziele in einem durch 'Selbstorganisation' geprägten Wertschöpfungsnetz von unabhängigen Komplementärpartnern verwirklichen?
- Wie sollte ein Plattformbetreiber den offenen Innovationsprozess gestalten, so dass er interne und externe Innovationstätigkeiten kohärent koordinieren kann, um dem Kunden letztendlich eine qualitativ hochwertige Vielfalt an externen Komplementärleistungen zu gewährleisten?

Unter Anwendung der qualitativen Forschungsmethode untersucht die vorliegende Arbeit die Besonderheiten der Wertschöpfung in zweiseitigen Plattform-Organisationen sowie die hieraus resultierenden Anforderungen an das unternehmerische Innovationsmanagement. Durch kritische Auseinandersetzung mit dem Stand der Technik in Theorie und Praxis

werden im Rahmen der Anforderungsanalyse die folgenden Anforderungen an das Innovationsmanagement identifiziert: Grundlegend erfordert eine nachhaltig erfolgreiche Verwirklichung einer 'Platform Leadership Strategy' eine kontinuierliche Weiterenwicklung des Nutzenversprechens der Gesamtplattform. Diesbezüglich müssen sowohl die Plattform als auch die komplementären Leistungen der Plattform simultan und kohärent zueinander entwickeln werden. Hierzu bedarf es einer langfristigen, übergreifenden Innovationsplanung sowie nachfolgenden strategischen Entscheidungen, welche Innovationsbestrebungen intern oder extern verfolgt werden. Beide Dimensionen unterscheiden sich sowohl in der strategischen Planung als auch in den Mechanismen zur Implementierung der Innovationsstrategie. Eine weitere Herausforderung liegt im Management des offenen Innovationsprozesses, der zu einem großen Teil außerhalb des Unternehmens stattfindet und neuer Mechanismen der Unternehmenskontrolle bedarf, um erfolgreich von indirekten Netzwerkeffekten profitieren zu können. Basierend auf diesen Erkenntnissen empfiehlt die Autorin der vorliegenden Arbeit einen dedizierten plattform-basierten Innovationsmanagementansatz, welcher es dem Plattformbetreiber ermöglicht:

- Die Entwicklung der Gesamtplattform und ihres Nutzenversprechens aus langfristiger strategischer Perspektive voranzutreiben, indem interne und externe Innovationsbestrebungen holistisch im Rahmen der 'Platform Leadership Strategy' geplant, gesteuert und kontrolliert werden;
- Aus strategischer Sicht zu entscheiden, welche geplanten Innovationsbestrebungen vorzugsweise intern zu verfolgen sind und welche im Wertschöpfungsnetz orchestriert werden können;
- Die gesetzten internen und externen Innovationsziele im Rahmen eines strukturierten Innovationsprozesses zu implementieren, um die komplementären Kompetenzen des Wertschöpfungsnetzes simultan zur Plattformentwicklung voranzutreiben;
- Komplementärpartnern kreativen Spielraum für neue Geschäftspotentiale zu geben, während der Plattformbetreiber die strategischen Entscheidungen bezüglich der Entwicklung der Gesamtplattform sowie der Ausrichtung der Komplementärleistungen auf der Plattform trifft;
- Ein attraktives, innovationsförderliches Wertschöpfungsnetz auszubilden, welches basierend auf intrinsischer und extrinsischer Motivation kontinuierlich relevante Partnerkompetenzen fördert, so dass die Grundlage für Innovationen gegeben ist;
- Das Verhalten der Kunden und Komplementärpartner sowie deren Interaktionen im Wertschöpfungsnetz kontinuierlich zu beobachten, um (a) relevante Informationen dem Plattformbetreiber als Basis für die strategische Entscheidungsfindung zur Verfügung

zu stellen, (b) die Umsetzung der Innovationsziele zu kontrollieren und mittels Anwendung geeigneter Steuerungsmechanismen sicherzustellen, sowie (c) externe Trends, Innovationen oder Innovationsbestrebungen zu identifizieren und bei Bedarf die Innovationsstrategie entsprechend anzupassen.

Basierend auf dem identifizierten Anforderungsprofil wurde ein 'plattform-basierter Innovationsmanagementansatz' entwickelt. 'Plattform-basiertes Innovationsmanagement' wird dabei als ein kontinuierlicher Prozess definiert, der im Rahmen der unternehmerischen Innovationsstrategie die internen und externen Innovationsziele identifiziert, evaluiert und bestimmt und diese sowohl innerhalb der Organisation als auch im Wertschöpfungsnetz implementiert. Der plattform-basierte Innovationsmanagement-ansatz selbst besteht aus drei Kernelementen: Dem 'plattform-basierten Innovationsmanagement-Turnus', den 'Leitprinzipien zur Innovationsplanung und Entscheidungsfindung' sowie dem 'plattform-basierten Steuerungsmodell'. Während der 'plattform-basierte Innovationsmanagement-Turnus' den Plattformbetreiber bei der Formulierung der Innovation Strategie sowie deren Umsetzung in operative Handlungsanweisungen unterstützt, bieten die 'Leitprinzipien zur Innovationsplanung und Entscheidungsfindung' dem Plattformbetreiber strategische Planungs-und Entscheidungshilfen bezüglich der Frage, welche Innovationsziele intern oder extern verfolgt werden sollten. In Ergänzung unterstützt das 'plattform-basierte Steuerungsmodell' den Plattformbetreiber, das Verhalten der Komplementärpartner im Wertschöpfungsnetz kontinuierlich zu beobachten und zu steuern, um somit seine strategischen Ziele der Plattformentwicklung zu realisieren. Basierend auf diesen Kernelementen wurde ein strukturierter offener Innovationsprozess entwickelt, der es dem Plattformbetreiber ermöglicht, mittels Zuweisung dedizierter Steuerungsmechanismen interne und externe Innovationsprojekte im Rahmen seiner 'Platform Leadership Strategy' systematisch zu planen und durchzuführen.

Die Ergebnisse der vorliegenden Dissertationsarbeit wurden im intensiven Diskurs mit Vertretern des gehobenen Managements, Konzernstrategen sowie Innovationsexperten der SAP evaluiert und bezüglich ihrer Neutralität, Konsistenz und Umsetzbarkeit sowie hinsichtlich ihrer Glaubwürdigkeit bestätigt. Am Beispiel der 'Platform Leadership Strategy' der SAP konnte verdeutlicht werden, dass der entwickelte plattform-basierte Innovationsmanagementansatz für die systematischen Planung, Steuerung und Kontrolle von offener Innovation in einem interorganisatorischen Plattformkontext geeignet ist und die mittel- und langfristigen Innovations- und Wachstumsziele des Unternehmens zu unterstützen vermag.

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