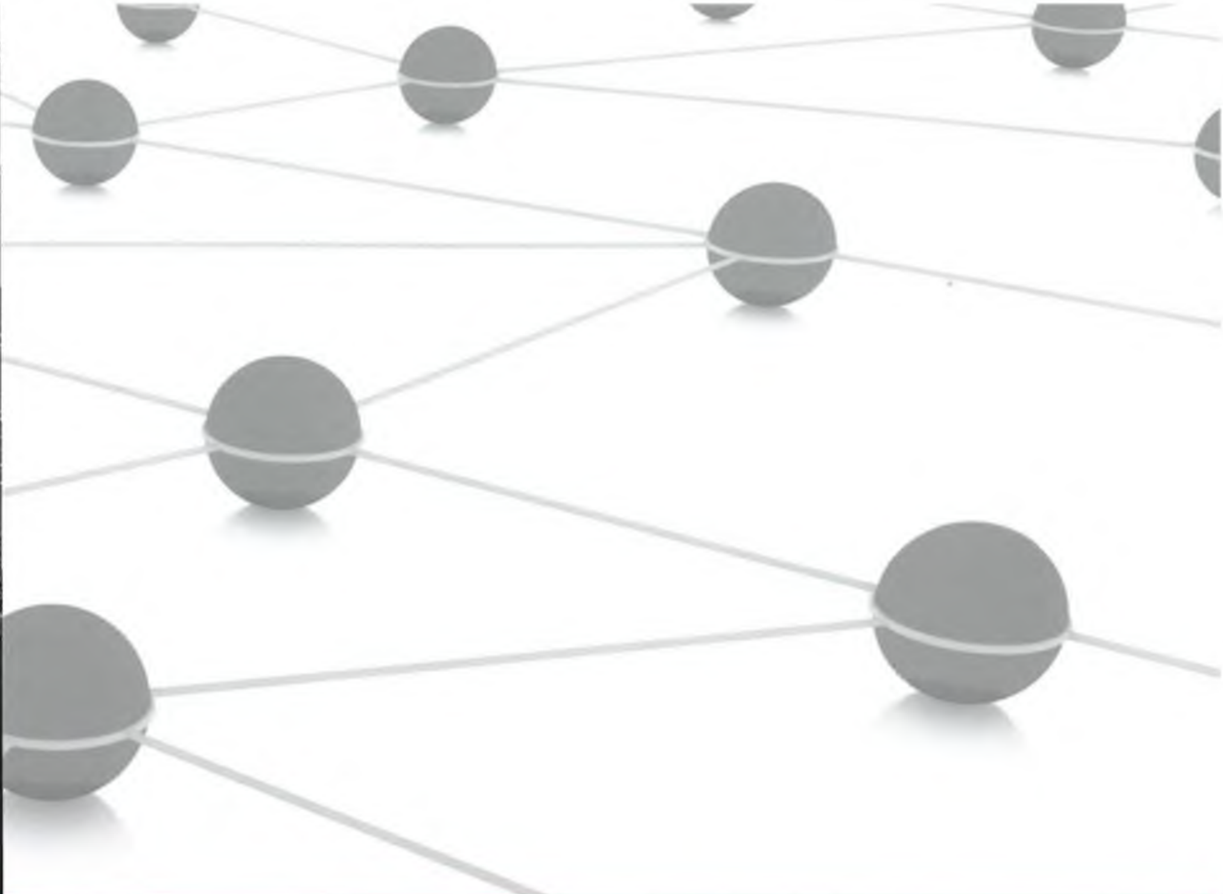

A BEHAVIORAL PERSPECTIVE ON MULTI-ORGANIZATIONAL INNOVATION ECOLOGIES

KRISTINA MANSER

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Kristina Manser (née Janzen)
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Promotor:

Prof. dr. J.M.M. Bloemer

Copromotoren:

Dr. B. Hillebrand

Dr. P.H. Driessen

Dr. ir. G.W. Ziggers

Manuscriptcommissie:

Prof. dr. K. Lauche

Prof. dr. J. Prabhu, (Universiteit van Cambridge, UK)

Prof. dr. ir. H. van Trijp, (Universiteit van Wageningen)

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Call it a clan, call it a network, call it a tribe, call it a family.
Whatever you call it, whoever you are, you need one.
(Elizabeth Jane Howard)

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Kristina Manser, July 2013

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CHAPTER 1

Introduction

In this chapter, we introduce the central topic of this dissertation and its research setting. We describe the perspective used, present an overview of the chapters and discuss the aims of the individual studies. Subsequently, we discuss the methodological approaches used and the theoretical and managerial relevance of the studies. Finally, we present an outline of the dissertation.

1.1 Introduction

A lot of organizations are involved in innovation projects that are undertaken by multiple parties. We refer to these kinds of innovation projects as multi-organizational ecologies, which are defined as a collection of heterogeneous actors (e.g., governments, suppliers, customers, and NGOs) involved in an innovation project that together create, develop and introduce an innovation (Dougherty and Dunne, 2011).

Even though co-developing innovation presents managers many advantages, they also face several difficulties during the creation and management of these kinds of innovation projects. Especially coordinating innovation undertaken by multiple parties remains a constant challenge for managers (Ethiraj and Levinthal, 2004; Granstrand and Sjölander, 1990).

Consider the following example. The development and introduction of a closed greenhouse requires the input of several parties, such as architects, manufacturers, farmers, research institutes, and governmental institutions. These actors of the multi-organizational ecology need to fulfill different activities. For example, the architect develops a construction plan for the greenhouse, the farmers support the development process by engaging in the designing process, and research institutes make the closed greenhouse a case for research and closely monitor the innovation process. Finally, governmental institutions come up with financial incentives for the farmers to encourage them to invest in a closed greenhouse. The involved actors differ among each other with regard to the resources they possess and the activities they fulfill.

Such situations where several heterogeneous actors together create and develop an innovation raise several issues with regard to innovation. It is likely that an actor is more equipped to fulfill a particular role than another one due to the resources it possesses. That means that resource possessions of the actors lead to the fulfillment of a specific role which explains how a diverse set of actors contributes to innovation performance (Chapter 2).

Furthermore, the set of diverse actors needs to be governed in a way that actors fulfill the activities that are needed to ensure innovation performance (Chapter 3). Finally, out of the activities that need to be fulfilled, some activities might be more important for innovation performance than others (Chapter 4).

The overall aim of this dissertation is to enhance our understanding of innovations undertaken in multi-organizational ecologies. Traditionally, innovation has been studied inside firm boundaries or in the scope of joint ventures or alliances. Nowadays, this scope is expanded to innovation created by multi-organizational ecologies; the phenomenon of innovation undertaken in multi-organizational ecologies will become even more prominent in this century (Adner and Kapoor, 2010; Dougherty and Dunne, 2011). Therefore, a better understanding of this phenomenon is needed.

Prior literature has called for more research on ecologies because this would help to create an understanding of this phenomenon in theory and practice (Dougherty and Dunne, 2011). Some have called for research that focuses on the 'everyday processes of complex innovation' (Dougherty and Dunne, 2011) or the 'behavior of actors' (Van Riel et al., 2013). There is 'a need to better understand the behavioral foundations of innovation ecosystems, e.g., by making an inventory of innovation roles in ecosystems and defining them' (Van Riel et al., 2013). This dissertation can be regarded as an answer to these calls.

With this dissertation we contribute by 1) showing how multiple actors can combine their resources via roles to contribute to innovation performance, 2) demonstrating how multi-organizational ecologies can be governed, and 3) presenting an overview of activities undertaken in multi-organizational ecologies.

1.2 Research setting and empirical context

1.2.1 Multi-organizational ecologies

In this dissertation we focus on complex innovations in a sustainability context undertaken in multi-organizational ecologies. We define multi-organizational ecologies as a collection of heterogeneous actors (e.g., governments, suppliers, customers, and NGOs) involved in an innovation project that together create, develop and introduce an innovation (Dougherty and Dunne, 2011).

In the marketing literature, value creation is regarded as the core objective of economic exchange (Woodruff, 1997). As innovation does not happen in isolation, the success of an innovating company also depends on the other actors in the ecology. That is, value is created jointly by the organizations participating in the ecology. If we would like to understand value creation, we need to understand multi-organizational ecologies.

The importance of multi-organizational ecologies is increasing; many industries have witnessed an emergence, often in a sustainability context (Dougherty and Dunne, 2011; Katz, 2006). But also in other contexts, value is created jointly. For example, in the health care sector where a combination of health care services from different providers is offered to the patients to treat them in the best way (Van Riel et al., 2013). Furthermore, consider the e-book Kindle from Amazon. Wireless network providers, authors, publishers, and Amazon itself together form the multi-organizational ecology. Practitioners and public policy officers also acknowledge the importance of multi-organizational ecologies. For example, governmental institutions subsidize innovation projects in the sustainable sector that are undertaken by several actors. A focus on multi-organizational ecologies therefore is in line with the current situation, in which more and more innovations are developed jointly by a group of different actors.

Multi-organizational ecologies have specific features that set them aside from the two endpoints of the scale: they stand in-between inter-company networks and large open networks.

In general, inter-company networks can be regarded as alliances, joint ventures, cooperation agreements or buyer-supplier relationships. Prior literature acknowledged (Gulati, 1998; Wathne and Heide, 2004) that the predominant focus in much of the existing literature on alliances and inter-company networks is on individual dyadic relationships, for example a relationship between a manufacturer and a customer (e.g., Faems et al., 2005; Heide and John, 1988; Heide and John, 1990; Larson, 1992). In line with prior research, a dyadic relationship between two parties can be viewed as an exemplar of an inter-company network. Literature has acknowledged also broader inter-company networks, such as a triadic relationship between a supplier, a manufacturer and a customer (Wathne and Heide, 2004).

In contrast to the inter-company networks described in prior research, multi-organizational ecologies have more than two or three participants. Literature suggests that adding an additional party to a dyadic relationship (this principle holds as well for a fourth actor entering a relationship between three parties), affects a dyadic relationship (Choi and Wu, 2009). For example, a third actor who enters the network might introduce disconnected actors or facilitate coordination between already connected actors (Obstfeld, 2005). This joining of actors is captured in the idea of a *tertius iungens* orientation which is central to (complex) innovation (Obstfeld, 2005). The adding of one or more actors to a dyadic relationship leads to more heterogeneity in the network. Multi-organizational ecologies can be distinguished from inter-company networks: they are more heterogeneous in terms of the actors that are participating, such as governments, suppliers, manufacturers, and research institutes.

Large open networks are also different than multi-organizational ecologies. Large open networks can be viewed as an accumulation of industrial and resource organizations pooling their diverse and complementary resources to stimulate innovation (Vanhaverbeke, 2006). In general, large open networks consist of customers, rival companies, suppliers, research units and other institutions (Chesbrough and Schwartz, 2007). They seem similar to multi-organizational ecologies. However, multi-organizational ecologies can be distinguished from large open networks: Multi-organizational ecologies engage in shared value creation (Adner, 2006; Adner and Kapoor, 2010). Value is proposed and created jointly by the actors in the multi-organizational ecology.

We chose to research multi-organizational ecologies in this dissertation because this specific type of network has features that make it interesting as a research setting. First, multi-organizational ecologies require the input of several heterogeneous parties. In multi-organizational ecologies, knowledge and other resources are dispersed across many different actors. Innovations are generated not by a single organization, but by the entire ecology (Dougherty and Dunne, 2011). The active participation of the actors is required (Bloom and Dees, 2008; Gann and Salter, 2000; Dougherty and Dunne, 2011), often combining public and private actors (Dougherty and Dunne, 2011), that can complement each other (Samila and Sorenson, 2010). New products, knowledge and business models can only be created and developed if the actors in the multi-organizational ecology interact with and react to the actions of others (Dougherty and Dunne, 2011). As the actors are interdependent and can only together achieve their goals, multi-organizational ecologies are a relevant unit of analysis to study the behavior of multiple actors in a social context.

Second, the actors participating in multi-organizational ecologies have different backgrounds and are very diverse regarding their resources, activities, and intentions. As this requires an active management, multi-organizational ecologies are also an appropriate setting for studying the phenomenon network governance (Chapter 3).

Third, understanding multi-organizational ecologies, i.e. individual innovation projects, is important for understanding innovation systems. Individual innovation projects are the building block of innovation systems, and only if innovation projects are successful, an innovation system is likely to flourish (Chapter 4).

1.2.2 Empirical context

More specifically, we have chosen for complex innovations because they offer an excellent opportunity to study multi-organizational ecologies. Complex innovations consist of multiple parts with unknown, unpredictable interactions (Anderson, 1999). The development and introduction of complex innovations requires the input of multiple parties (Seebode et al., 2012); the combination of resources of several heterogeneous actors is needed (Luke, Begun and Pointer, 1989; Teece, 1992; Dyer and Singh, 1998; Gann and Salter, 2000).

The importance of complex innovations undertaken in multi-organizational ecologies is increasing; many industries have witnessed the emergence of complex innovations, especially in a sustainability context (Dougherty and Dunne, 2011; Katz, 2006). Sustainability initiatives often transcend organizational boundaries and require the support of multiple organizations to be effective (Pagell and Wu, 2009). Electric vehicles, production systems for renewable energy, or closed-loop greenhouses are innovations that are characterized by high complexity and that are therefore undertaken by multiple actors. That is, the sustainable sector offers a natural biotope to study complex innovations undertaken in multi-organizational ecologies.

1.3 Introducing a behavioral perspective

This dissertation consists of three studies sharing the same perspective: they all apply a behavioral perspective in order to study innovations in multi-organizational ecologies.

Traditionally, psychology literature has regarded behavior as being automated and as undertaken in response to a stimulus (e.g., Bargh and Ferguson, 2000). In contrast to the tradition described above, I follow another stream of literature with regard to the term 'behavior'. In line with psychological literature on attitudes, intentions or habits, behavior can also be undertaken in order to accomplish a goal (goal-directed behavior) (Ajzen and Madden, 1986; Aarts and Dijksterhuis, 2000).

We define a behavioral perspective as a focus on the activities that are fulfilled in multi-organizational ecologies. We focus on the behavior of an organization participating in the multi-organizational ecology. This is in line with prior literature which has used a behavioral perspective in order to refer to the activities of organizations (Aulakh et al., 1996; Choi and Wu, 2009; Greve, 2003) or ecosystems (Iansiti and Levien, 2004). For example, Aulakh et al. (1996) took a behavioral approach to understand maintenance of cross-border marketing partnerships between two firms and Greve (2003) used a behavioral perspective to describe how different organizations react to performance feedback. Furthermore, one of the most influential management books 'A behavioral theory of the firm' by Cyert and March (1963) regards behavior as the 'actual behavior of identifiable firms'.

We take a behavioral perspective in this dissertation for the following main reasons. Former studies on multi-organizational ecologies have usually focused on the relationships between actors (Adner and Kapoor, 2010; Newell et al., 2008; Wilkinson and Young, 2002), which reveal much about the context of multi-organizational ecologies, but are less helpful in understanding how actors influence innovation in multi-organizational ecologies.

Therefore, some have called for research that focuses on the 'everyday processes of complex innovation' (Dougherty and Dunne, 2011) or the 'behavior of actors' (Van Riel et al., 2013). The behavioral foundations of ecologies need to be better understood, that is the *activities* that are undertaken in multi-organizational ecologies need to be investigated (Dougherty and Dunne, 2011; Van Riel et al., 2013).

This dissertation should be considered as an answer to this call for further research. In line with the above, we argue that in order to gain an understanding of how actors influence innovation in multi-organizational ecologies we need to look at it from the perspective of behavior that is displayed. Accordingly, we adopt a behavioral approach, i.e. we focus on the actors' activities that are fulfilled in a multi-organizational ecology.

A behavioral approach is relevant to apply in our setting because ultimately it is the behavior of actors that is likely to have the biggest impact on innovation performance. It is the actors' activities that are most directly related to innovation outcomes. A behavioral perspective is thus useful for understanding innovation and innovation performance.

All three studies presented in this dissertation apply a behavioral perspective. In the first study (Chapter 2), we argue, from a behavioral perspective, that resources are deployed in roles that are fulfilled by the actors in a multi-organizational ecology. Roles are defined as "those behaviors characteristic of one or more actors in a context" (Biddle, 1979, p. 58). By fulfilling a role in a social context, actors can influence the performance of an innovation.

In the second study (Chapter 3), a conceptualization of network governance is made based on behavioral governance mechanisms that are used to manage the innovation network. The advantage of focusing on behavior is that it aligns with research that depicts management as a set of activities (e.g., planning, organizing, leading, controlling) undertaken to shape relationships, understandings and processes and thus bring about task completion (Järvensivu and Möller, 2009; Ritter et al., 2004; Tsoukas, 1994; Watson, 2006).

The third study (Chapter 4) uses a behavioral approach by focusing on activities that are undertaken in multi-organizational ecologies. The underlying rationale for a behavioral approach is that the behaviors of actors make things happen and result in higher innovation performance.

1.4 Overview and relevance of the studies

The dissertation consists of three studies which all contribute to the dissertation's aim of understanding innovation in multi-organizational ecologies. More specifically, three papers on a behavioral perspective are presented that cover distinct topics. These papers do not build on each other; nevertheless they are related in that they share the same topic and the same perspective. They all focus on behavior that is fulfilled in multi-organizational ecologies; i.e. they study behavior on the ecology level, nevertheless they focus on different aspects of innovation undertaken in multi-organizational ecologies. The first study focuses on roles and explains how multiple actors contribute to innovation performance. The second study focuses on one activity in the network, namely network governance, and the third study analyzes several activity sets and their influence on innovation performance. Table 1.1 details the studies and provides an overview of the chapters with respect to their objectives, research designs and levels of analysis.

Even though the three papers do not build on each other, they are slightly related. The first study introduces roles as a link between resources and innovation performance. We focus on roles because the social context surrounding the actors and the innovation is taken into consideration. In this study the organizational and the ecology level are linked.

Then, in Chapter 3 and 4, we zoom in on the activities undertaken in multi-organizational ecologies and research them empirically. In these chapters, we focus on activities instead of roles because roles are too complex to incorporate in the two empirical studies. Furthermore, we zoom in on the ecology level.

More specifically, in Chapter 3, an explorative study is presented which analyzes one specific activity undertaken in innovation networks, namely network governance. The reason for analyzing network governance in more detail is that in situations where several heterogeneous actors together create and develop an innovation, special attention needs to be devoted to governing the innovation project.

In Chapter 4, several activities are investigated and their effect on innovation performance is studied. This is due to the thought that out of the activities that need to be fulfilled, some activities might be more important for innovation performance than others. In this study we have not included the construct network governance (as it was researched in the second study) because it was too complex to include in a quantitative telephone survey. The activity set project management is included though among which some of the network governance activities are measured.

In order to address the phenomenon of innovation in multi-organizational ecologies from multiple perspectives, different methodological approaches are combined: conceptual, qualitative and quantitative. The conceptual approach is used to theoretically develop a framework explaining how a diverse set of actors contributes to innovation performance. More specifically, it explains how multiple actors combine their resources to contribute to innovation performance. This approach is useful in this context and at this stage in order to translate the ideas and insights gained from literature review into a broader framework that can be tested empirically.

By applying a qualitative approach in the second study, detailed insights on network governance are gained and an attempt to theory development is made. The advantage of this explorative approach is an in-depth understanding about what network governance in the context of multi-organizational ecologies entails.

With the quantitative survey undertaken in the third study, the research approach is more large scale and hypotheses are tested. This approach is warranted in this case because based on prior research an inventarisation of activities can be made, which is then to be tested in the context of multi-organizational ecologies. By combining these three approaches, the phenomenon is studied from different angles resulting in an enhancement of our understanding of innovations that are undertaken in multi-organizational ecologies.

Table 1.1: Overview of the chapters

Chapter	*Study*	*Objective*	*Research design*	*Level*
1	Introduction			
2	Explaining innovation performance in the context of multi-organizational ecologies: A conceptual framework to link the micro and macro level	To build a conceptual framework explaining how a diverse set of actors contributes to innovation performance	Conceptual	Orga level
3	An explorative study of network governance: Towards a behavioral taxonomy	To analyze what network governance in innovation networks entails	Qualitative, 6 innovation projects, 22 interviews	Ecol
4	Activities in multi-organizational ecologies: A project-level perspective on sustainable energy innovations	To construct a typology of activities that need to be fulfilled in multi-organizational ecologies	Quantitative, 120 innovation projects, 120 surveys	Ecol
5	Conclusions			

1.4.1 Study 1: Explaining innovation performance in the context of multi-organizational ecologies: A conceptual framework to link the micro and macro level

The first study's aim is to provide a conceptual framework explaining how a diverse set of actors in a multi-organizational ecology contributes to innovation performance. We argue that complex innovations require a specific combination of resources that are brought together by different actors. Furthermore, we state that resources only contribute to innovation performance if they are deployed in roles that are fulfilled by actors. That means that possessing resources is insufficient for value creation, the resources need to be deployed. Roles serve as the linking mechanism between the resources located at the organizational level, i.e. in possession of the various organizations, and innovation performance which is located at the ecology level.

With this study we make the following theoretical contributions. Literature on multi-organizational ecologies has not yet explained how multiple actors combine their resources to contribute to innovation performance. The study aims to fill this gap by presenting a framework based on the RBV and role theory. The presented framework links the organizational level to the ecology level, and thereby addresses the recurrent call for more multilevel research (Kozlowski and Klein, 2000a; Brass, 2000).

We also provide managerial insights. Even though only conceptually, managers gain an understanding of how multiple actors can influence innovation performance. They are made aware that there are role configurations that impact innovation performance more than other ones; they could try to influence the role configuration by attracting the right organizations for the right roles.

1.4.2 Study 2: An explorative study of network governance: Towards a behavioral taxonomy

The second study's aim is to analyze what network governance in innovation networks entails. Primary and secondary data pertaining to six innovation projects in the Netherlands reveal that network governance constitutes combinations of behavioral mechanisms, applied to manage an innovation network[1]. More specifically, it identifies a specific behavioral taxonomy of three distinct modes of network governance: basically coordinated, control-

[1] In the second study we talk about innovation networks instead of multi-organizational ecologies because this term is related more to the well established term network governance which is the main focus of this paper. The two terms describe the same phenomenon, namely innovation projects undertaken in a multi-organizational setting.

oriented and reward-oriented. The study focuses on the ecology level and uses a qualitative approach and in-depth interviews.

From a theoretical perspective, we contribute to research on network governance. Despite general agreement that network governance is an important construct in the study of networks, a lack of clarity regarding its exact meaning hampers further study. The second study therefore contributes to extant literature by focusing on combinations of behavioral mechanisms that have been largely ignored. This approach leads to a clearer view of network governance. The resulting behavioral taxonomy of network governance provides guidelines for further research in the field of network governance.

The study also provides managerial insights. The presented taxonomy of network governance offers a repertoire of possible solutions that network actors may use to deal with the complex challenge of managing networks.

1.4.3 Study 3: Activities in multi-organizational ecologies: A project-level perspective on sustainable energy innovations

The third study's objective is to develop a typology of activities that need to be fulfilled in a multi-organizational ecology. By doing this, an overview of the activities undertaken is gained and the differential effect of the sets of activities on innovation performance is made observable. We show that strategic predevelopment and commercialization activities have significant and positive effects on innovation performance, whereas engineering and project management do not. This study focuses on the ecology level and applies a quantitative approach and uses survey data from 120 innovation projects.

This study contributes to extant literature. In the context of multi-organizational ecologies, we still seem to lack an understanding of how various actors jointly innovate. The presented typology results in an overview of the activities that take place in multi-organizational ecologies. It complements an innovation system perspective with a project-level perspective.

This study also has managerial implications. The classification of activities offers insights to both managers and public policy officers. Managers can more easily recognize project activities that are likely to boost the success of an innovation. Public policy officers also can benefit from project-level insights when they attempt to evaluate innovation projects and decide which projects to fund. Furthermore, the detailed insight into the activities can also enable them to help actors to set up their innovation projects.

1.5 Outline of the dissertation

The next chapters of this dissertation are organized as follows.

First, Chapter 2 provides a conceptual framework which explains how multiple actors contribute to innovation performance. Next, in Chapter 3, a behavioral taxonomy of governance mechanisms is presented. Subsequently, in Chapter 4 activities that need to be fulfilled in multi-organizational ecologies are classified. Finally, in Chapter 5, a synopsis is presented, followed by theoretical and managerial implications, reflections, limitations and several directions for further research.

CHAPTER 2

Explaining innovation performance in the context of multi-organizational ecologies: A conceptual framework to link the micro and macro level

In this conceptual paper we elaborate on how a diverse set of actors in a multi-organizational ecology contribute to performance of complex innovations by introducing roles as a link between resources and innovation performance. We argue that complex innovations require a specific combination of resources that are brought together by different actors. Furthermore, we argue that resources only contribute to innovation performance if they are deployed in roles that are fulfilled by the actors. Based on role theory and the resource-based view we develop a framework that links the organizational level to the ecology level. We introduce two principles that underlie the framework: *resource-role matching* to explain the relationship between resources and roles at the organizational level and *role optimization* to explain the relationship between role configuration and innovation performance at the ecology level. *Resource-role matching* occurs when an actor fulfills a role congruent with the resources that the actor possesses. The principle *role optimization* stipulates that there is an optimal role configuration that can be achieved when individual roles are combined. We contribute to literature on multi-organizational ecologies by presenting a framework explaining how a diverse set of actors influences innovation performance and linking the organizational level to the ecology level.

Parts of this chapter have been presented as: Manser, K., Hillebrand, B., Driessen, P.H., Ziggers, G.-W., and Bloemer, J. (2009). Explaining innovation success in the context of multiple stakeholders. 38th EMAC Conference, Nantes, May, 26-29.

2.1 Introduction

Developing and introducing innovations consisting of multiple parts with unknown and unpredictable interactions, so-called complex innovations (Anderson, 1999; Dougherty and Dunne, 2011), frequently requires the combination of resources which are mostly not found within a single organization (Luke, Begun and Pointer, 1989; Teece, 1992; Dyer and Singh, 1998; Gann and Salter, 2000). As a result, the input of multiple actors is needed for the success of complex innovations (Gann and Salter, 2000; Bloom and Dees, 2008; Adner and Kapoor, 2010; Dougherty and Dunne, 2011). For example, the development and introduction of a sustainable greenhouse requires the input of architects, manufacturers, farmers, R&D consortia, and governmental institutions to integrate the different resources (e.g. solar panels, eco-friendly materials, money) into a working system. We refer to such a set of heterogeneous actors undertaking an innovation project as a multi-organizational ecology (Bloom and Dees, 2008; Dougherty and Dunne, 2011).

The goal of this conceptual paper is to provide a conceptual framework explaining how a diverse set of actors in a multi-organizational ecology contributes to innovation performance, defined as the extent to which the innovation is considered a success in financial, market and technical terms (Griffin and Page, 1993; Hart, 1993). In doing so, we adopt a resource-based view (RBV) perspective. While RBV has been mainly used to explain performance of single organizations, it may also be used in multi-organizational ecology settings (Dyer and Singh, 1998). Following Barney (1991), resources are viewed broadly and consist of assets, capabilities, organizational processes, firm attributes, information, knowledge and skills. RBV argues that organizations that have rare, valuable, inimitable and non-substitutable resources experience high performance outcomes (Barney and Hansen, 1994). Recent contributions to the RBV literature suggest that possessing resources is a necessary but insufficient condition for value creation (Lippman and Rumelt, 2003; Hansen et al., 2004); only the resources that are bundled and deployed contribute to performance (Sirmon and Hitt, 2003; Sirmon et al., 2007). However, it still remains unclear how resources are bundled or deployed to increase performance (Priem and Butler, 2001; Kraaijenbrink et al., 2010; Sirmon et al., 2007; Sirmon et al., 2011). This is especially the case of complex innovation in multi-organizational ecologies where various resources are brought together by a diverse set of actors. In situations like these it is even more unclear how a large number of diverse resources are deployed.

This paper takes the perspective that resources are deployed in roles that are fulfilled by the actors in a multi-organizational ecology. In fulfilling a role, an actor deploys resources. Roles are defined as "those behaviors characteristic of one or more actors in a context" (Biddle, 1979, p. 58). Roles "represent patterns of individual behavior resulting from interaction with other entities" (Stewart et al., 2005, p.344). Literature in the area of multi-organizational ecologies has suggested that further research on the roles that the actors fulfill is needed to provide a better understanding of how ecologies organize for complex innovations (Dougherty and Dunne, 2011). By integrating role theory and RBV in the context of multi-organizational ecologies, this paper answers this call for further investigation.

Introducing roles as a link between resources and performance is a useful approach for three reasons. First, roles may provide a linking mechanism between the resources at the organizational level and the performance of the innovation at the ecology level in much the same way as roles serve as a linking mechanism between team member characteristics and team performance (Stewart et al., 2005). Prior research has confirmed that roles can be seen as the "major means for linking the individual [in this study the organizational] and organizational [in this study the ecology] level of research and theory" (Katz and Kahn, 1978, p. 219). Second, roles represent behavior that is undertaken in a social context, i.e. in a relation with other actors (Biddle, 1979; Stewart et al., 2005). This makes the concept of roles well-suited for studying multi-organizational ecologies in which several actors work together on an innovation and where the roles and expectations of actors influence the roles and the expectations of other actors. Third, since roles are regarded as specific behavior that is undertaken, roles are likely to explain more variation in performance of an innovation than resources: performance is related more to something that is done than to something that is possessed (Sirmon et al., 2007).

We contribute to the existing literature in two ways. First, this paper adds to literature on multi-organizational ecologies by presenting a framework explaining how a diverse set of actors influence innovation performance. Literature on multi-organizational ecologies has discussed the benefits and costs of ecologies (Adner, 2006), the stages through which such an ecology moves (Moore, 1993), and its performance outcomes (Faems et al., 2005). Furthermore, studies have addressed the structure of multi-organizational ecologies and the management of complex innovations (Grabher, 2002; Newell et al., 2008; Adner and Kapoor, 2010; Dougherty and Dunne, 2011). However, literature on multi-organizational ecologies has not yet explained how multiple actors combine their resources to contribute to innovation performance. This paper aims to fill this gap by presenting a framework based on the RBV and role theory. Furthermore, we introduce two underlying principles: *resource-role matching* to explain the relationship between resources and roles; and *role optimization* to explain the relationship between the role configuration and innovation performance. We argue that resources can have an influence on performance through the deployment of resources in roles that are fulfilled by actors. In doing so we address the call for research on how resources can be combined and integrated in a multi-organizational context (Gomes-Casseres, 1994; Smith et al., 1995; Sirmon et al., 2011). Furthermore, we introduce contextual factors (dependence, transactive memory system, macroculture) which 1) explain when the relationship between resource possessions and role fulfillment appears and 2) influence the relationship between the role configuration and innovation performance.

Second, we contribute by linking the organizational level to the ecology level. Thereby, we address the recurrent call for more multilevel research (Kozlowski and Klein, 2000a; Brass, 2000). Prior research has acknowledged that it is unclear how individual inputs aggregate to influence collective outcomes and that little work has been done to understand the relationship between the influence of individual organizations and outcomes on the network level (in this study the ecology level) (Kozlowski and Klein, 2000b; Stewart et al., 2005). Multilevel research helps to integrate concepts and methods for studying processes in organizations and networks, thus helping us to bridge the gap between micro (e.g. individual organizations) and macro (e.g. networks of organization) phenomena (Kozlowski and Klein, 2000b). A multilevel perspective acknowledges that micro phenomena are embedded in macro contexts and that macro phenomena can emerge through the interaction of lower-level elements (Kozlowski and Klein, 2000b). In the context of the present study this means that resources are combined at the organizational level which leads to the deployment of specific resources, i.e. roles, and ultimately the role configuration at the ecology level. Thus, the advantage of using a multilevel approach is a more detailed picture of how innovation in ecologies happens and hence a better understanding of this process (Brass, 2000).

The paper is structured as follows. First, we shortly discuss the RBV and role theory. Next, we introduce a framework for innovation in multi-organizational ecologies, consisting of two levels: on the organizational level we describe the relationship between resources and roles, and on the ecology level we discuss the relationship between the role configuration and innovation performance. Furthermore, we discuss three contextual factors: dependencies (innovation dependence and inter-actor dependence), transactive memory system, and macroculture. We conclude this paper with a discussion of the implications and limitations of our conceptual framework.

2.2 Theoretical background

2.2.1 Resource-based view

Resource-based view (RBV) aims to explain a firm's competitive advantage based on the resources that a firm possesses. RBV argues that if a firm is to achieve competitive advantage or high performance, it has to acquire and control valuable, rare, inimitable and non-substitutable resources (Barney, 1991). RBV thus focuses on resources as the single source of a firm's competitive advantage and states that an organization can be regarded as a bundle of those resources (Kraaijenbrink et al., 2010). The synergistic combination of resources is more important for performance than the individual resources (Kraaijenbrink et al., 2010).

While traditionally RBV literature suggests that the resources hold by a firm influence performance of that firm (Crook et al., 2008), recent research has shown that only the resources that are put into action influence performance (Sirmon and Hitt, 2003; Sirmon et al., 2007). More specifically, resources can be put into action through three processes (Sirmon et al., 2007; Sirmon et al., 2011): structuring, bundling and deploying. Structuring a resource portfolio involves processes to obtain the resources that a firm will use for bundling and leveraging purposes. Bundling refers to processes aimed at integrating resources. Deploying involves processes used to exploit resources to take advantage of market opportunities.

These recent studies focus on the management of resources in relatively simple contexts and study a manager who coordinates resources. In the context of multi-organizational ecologies focusing on a single manager would yield a limited understanding because all actors together determine how resources are deployed. Thus, RBV should be complemented by a theory that helps to understand the behaviors of actors in a social context, such as role theory (Sirmon et al., 2011).

2.2.2 Role theory

Dating back as far as the 1930s, role theory originates from sociology and social psychology and is primarily concerned with behavioral patterns and focuses on depicting and understanding behavior in social settings (Zurcher, 1983; Biddle, 1986). Role theory is based on the idea that roles are socially constructed behaviors of actors in specific situations (Allen and van de Vliert, 1984; Montgomery, 1998). It suggests that actors perform roles because they have social positions. As a result of these social positions, people (both the person in question and others in his or her social context) have specific expectations about their behavior (Biddle, 1986). For example, a mother is expected (both by herself and by others) to behave in a certain way (e.g. to protect her children from harm) because of the relationships she has with others, in this case most prominently the relationship with her children. Thus, people fulfill the role that comes with the position they hold: a role is what a person does in a relationship with other actors.

Role theory has shown to provide an excellent perspective on explaining social behavior in organizational settings. For example, Mintzberg (1980) focuses on the behavior of managers and categorized managerial work in ten individual roles, which are divided in three role types: interpersonal roles, informational roles, and decisional roles. Role theory has also been applied in the team literature. For example, Belbin (1993) takes stock of nine team roles, such as coordinator and resource investigator. Team literature frequently distinguishes between two types of roles: task and social roles (Bales, 1950; Stewart et al., 2005; Senior, 1997). Task roles are related to knowledge and skills; they are associated with work completion and problem solving and are mostly goal-oriented. Social roles refer to solidarity and cooperation and are often associated with patterns of communication (Bales, 1970; Forsyth, 1990; Stewart et al., 2005).

Role theory may also be applied to inter-organizational settings, i.e. situations where organizations are the actors performing roles in relationships with other organizations (Katz and Kahn, 1966). Studies using role theory in an inter-organizational setting have resulted in several typologies of roles: Table 4.1 provides an exemplary overview. For example, Snow et al. (1992) distinguish three roles: architect, lead operator, and caretaker. In an innovation network context, Heikkinen et al. (2007) distinguish 12 roles distributed over three distinct role types which are similar to task and social roles: net level roles, task level roles and network level roles. Similarly, Story et al. (2011) distinguish task-oriented roles (e.g. producing, developing) and network-oriented roles (e.g. connecting, integrating). Different labels exist for very similar roles. For example, the 'webber' in Heikkinen et al. (2007) is similar to the 'connecting' role in Story et al. (2011), and to the 'liaisons' in Tushman (1977). Table 2.1 details how different roles in inter-organizational settings are similar to each other.

Table 2.1 : Exemplary overview of roles in inter-organizational settings

Study	*Role*	*Description*	*Similar to role*
1) Tushman, 1977	a) Gatekeeper	Conveys information from external domains into internal domains.	5g, 3e
	b) Organizational liaison	Links the innovating subsystem with the larger organization.	1c, 2b, 4c, 5e, 6f
	c) Laboratory liaison	Connects the laboratory to other areas of the organization.	1b, 2b, 4c, 5e, 6f
2) Snow et al., 1992	a) Architect	Facilitates the emergence of specific operating networks.	3f
	b) Lead operator	Formally connects specific firms together into an operating network.	1b, 1c, 4c, 5e, 6f
	c) Caretaker	Focuses on enhancement activity in order to let the network operate smoothly and effectively.	5b
3) Knight and Harland, 2005	a) Innovation facilitator	Promotes and facilitates product and process innovation.	4a, 5b
	b) Coordinator	Administrates organizational activities and facilitate intra-network relations, communications and working practices.	5j
	c) Supply policy maker and implementer	Determines and implements policy for supply structure.	
	d) Advisor	Provides formal and informal	5f
	e) Information broker	Collates, analyzes and disseminates information to various parties.	1a,5g
	f) Network structuring agent	Monitors and influences the structure of exchange relationships.	2a
4) Gemünden et al., 2007	a) Power promoter	Has the necessary power to drive the project, to provide resources, and overcome obstacles.	3a, 5b
	b) Expert promoter	Has technical knowledge for the innovation process.	6c, 6d, 6g
	c) Process promoter	Makes the connection between the power and the expert promoter and have diplomatic skills to bring together people needed for the innovation process.	1b, 1c, 2b, 5e, 6f
	d) Relationship promoter	Has strong personal ties not only inside but especially outside the organization, e.g. to customers, suppliers or research partners.	5c

5) Heikkinen et al., 2007	a) Producer	Works concretely for the realization of the innovation.	6e
	b) Planner	Gives input to the development process, aiming at influencing the outcome of the process; Connects the existing resources of the network actors, attempting to obtain an overall picture of the process and the outcome.	2c, 3a
	c) Entrant	Becomes involved with the development net through its existing resource base and its connections with the larger network surrounding the focal net.	4d
	d) Auxiliary	Incrementally involved in the development process.	
	e) Webber	Creates new connections between distinct actors by matching them and by facilitating the organizational activities.	1b, 1c, 2b, 4c, 6f
	f) Instigator	Influences the other actors' decision making processes, e.g. by encouraging actors to take new	3d
	g) Gatekeeper	Possesses resources that are important for the activities in the net and has the power to decide of who/what is included or not in the actions.	1a, 3e
	h) Advocate	Distributes positive information about the innovation to actors outside the net and stays in the background of the operational tasks.	4d, 6h
	i) Facilitator	Stays outside the network and the actual development processes but offers resources for the use of the network.	
	j) Compromiser	Balances the actions and relationships of the net.	3b
	k) Aspirant	Is an outsider as it cannot directly influence the process, but aims to be part of the network.	
	l) Accessory provider	Does not directly influence the network or final offering, but notices significant opportunities for promoting their own products, services or expertise.	

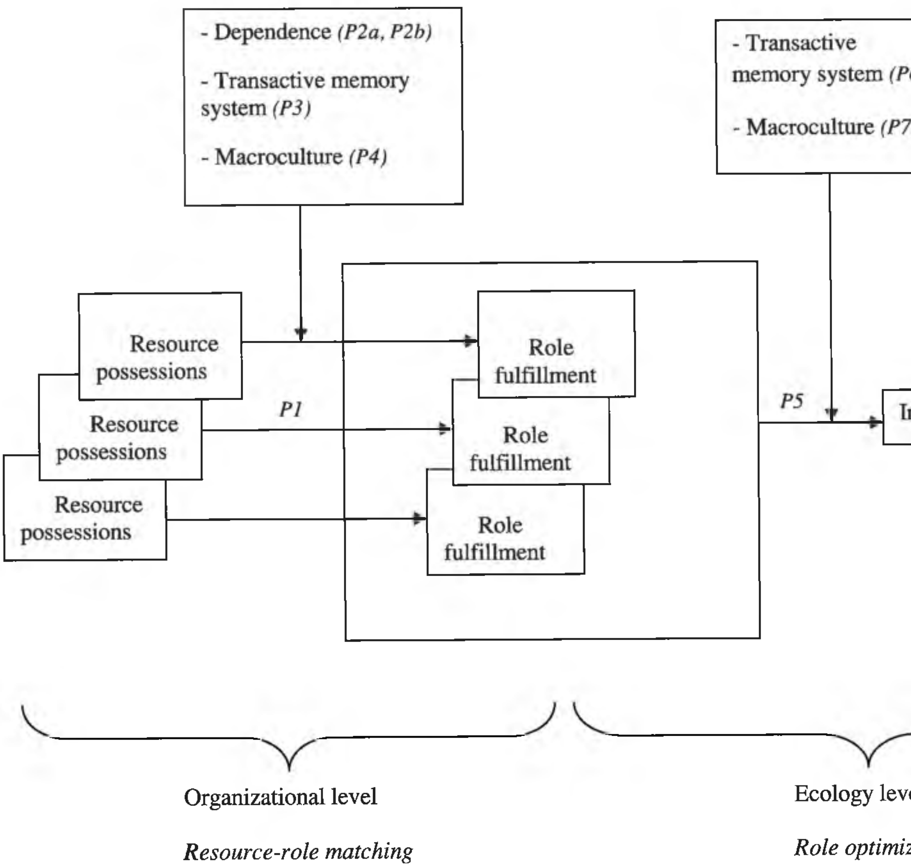
6) Story et al., 2011	a) Articulating	Process of developing an initial idea into a comprehensive description of the full concept.	
	b) Funding	Essential for turning the concept into a working prototype and ultimately on the market.	
	c) Developing	Draws on technical expertise and knowledge resources to actually turn the concept into a real product and validating the process necessary to make it.	4b
	d) Prototyping	Involves the production of early samples or models built to test whether the attributes specified have been physically delivered as intended.	4b
	e) Producing	Involves the actual processes necessary to produce the final product.	5a
	f) Connecting	Connecting (with) other actors.	1b, 1c, 2b, 4c, 5e
	g) Integrating	Technically involved in designating and coordinating tasks and responsibilities, setting targets, and overseeing progress.	4b
	h) Endorsing	Supporting relationships between participants, solely focused on the marketplace and primary intention is to encourage new product trials.	4d, 5h

Based on the above, it can be concluded that roles are very relevant in the context of inter-organizational settings, and therefore role theory provides a suitable lens to investigate how actors in a multi-organizational ecology contribute to innovation performance. By applying role theory, we focus on the behavior of actors and the social context in which it occurs, and suggest that roles are the linking mechanisms between the individual level of resources and the ecology level of the role configuration.

2.3 A framework for innovation in multi-organizational ecologies

The following sections describe the two levels that are distinguished in the framework (see figure 2.1): the organizational level, which describes the relationship between resources and roles, and the ecology level describing the influence of the role configuration on innovation performance.

Figure 2.1: Conceptual framework



2.3.1 The organizational level: Resource-role matching

We introduce the principle of *resource-role matching* to explain the relationship between resources and roles. The principle of *resource-role matching* stipulates that an actor fulfills a role congruent with the resources that it holds.

Role theory and team literature state that individual attributes, such as skills or personality, lead to the fulfillment of a specific role (Barrick et al., 1998; Stempfle et al., 2001; Biddle, 1979). Translated to an organizational context, this would mean that organizational attributes, such as resources an organization possesses, explain role fulfillment. Actors have perceptions of resource possessions of themselves and other actors and it is these perceived resource possessions that determine the perceived competence of an actor to fulfill a role well.[2]

Role fulfillment is defined as the effort an actor devotes to the fulfillment of a role that corresponds with the available resources. We argue that an organization is more likely to put effort in fulfilling a role when it possesses the resources required for that particular role. In other words, *resource-role matching* means that an actor fulfills a role that is congruent with its resources.

Our line of reasoning is based on insights from role theory. Role theory argues that each role contains information about expected and socially constructed behaviors (Heikkinen et al., 2007): actors share expectations about the role that an actor should undertake. That is, actors have expectations about their own behavior and know which behavior other actors in the ecology expect from them (Biddle, 1979). To a large extent, these expectations are based on the perceived competence of the actor, i.e. the resources the actor possesses. In line with literature on path dependency, actors are more inclined to display behavior that has been successful in the past (Penrose, 1960; Tripsas and Gavetti, 2000). Also other actors in the ecology expect them to display that behavior. For example, when developing and launching a sustainable greenhouse, an actor who owns a solar panel production plant is more likely to engage in producing solar panels because this actor is (implicitly or explicitly) encouraged to do so by other actors in the ecology. Similarly, an architectural firm which has construction skills is likely to engage in developing a construction plan for a sustainable greenhouse

[2] For convenience, we will refer to resources and not to perceived resources in the following text.

because the architectural firm holds the resources and because other actors in the ecology expect it to have the required resources and thus to be a good candidate to fulfill this role.

In other words, resources are deployed by fulfilling a role which depends on the resources possessed by an actor. This leads to the first proposition:

Proposition 1 *Actors are more likely to put effort into fulfilling a role for which they possess the needed resources than into fulfilling a role for which they do not possess the needed resources.*

2.3.2 Contextual factors: Dependencies, transactive memory system, and macroculture

Contextual factors influence the relationship between resource possessions and role fulfillment and explain when the relationship is likely to occur. We discuss the following contextual factors: dependencies, and transactive memory system, and macroculture.

Dependencies: Innovation dependence and inter-actor dependence

Actors do not only use their resources to fulfill a role because they possess the needed resources, but also because they are motivated to do so: a lack of motivation is likely to result in little effort in undertaking a role, even if the relevant resources are present. Patterns of dependence help to explain why *resource-role matching* is more likely in some contexts. We distinguish two forms of dependence: innovation dependence and inter-actor dependence.

Innovation dependence is defined as an actor's dependence on the innovation. In cases of high innovation dependence, actors are motivated to fulfill a role because they consider the innovation strategically important and having a lot of potential. The actor may even consider the organizational survival to depend on the success of the innovation (Kamath and Liker, 1990). Thus an actor who is highly dependent on the innovation would be more likely to put effort into fulfilling a role than an actor who is not that dependent on the innovation. In other words, in situations of innovation dependence, *resource-role matching* is stronger than in situations where actors do not depend on the innovation. This leads us to the following proposition:

Proposition 2a *The matching between resource possessions and fulfillment of corresponding roles is better when actors depend on the innovation than when they are less dependent on the innovation.*

Inter-actor dependence is defined as a state in which actors have to rely on other actors in order to achieve particular outcomes (Emerson, 1962; Pfeffer and Salancik, 1978). Actors may be motivated to put effort in their role fulfillment because they depend on other actors in the ecology. This applies in situations where actors are not necessarily motivated because of the strategic importance of the innovation per se, but because they depend on other actors for reasons outside the innovation project. For example, an architectural firm involved in the development of a new type of greenhouses may contribute because it expects important assignments in the future from one of the other actors. Such situations of complex exchange (Emerson, 1976; Granovetter, 1985) show that the motivation to contribute to a project does not necessarily have to be totally compensated by the outcome of the innovation project itself as long as the expected indirect value does (i.e. the expected value received from other actors). Thus, inter-actor dependencies influence the relationship between resources and roles because actors are more likely to deploy their resources if they are dependent on other actors (Frooman, 1999; Kumar et al., 1995). In other words, in situations of inter-actor dependence, *resource-role matching* is stronger than in situations where the actors do not depend on other actors in the ecology. Therefore, we propose:

Proposition 2b *The matching between resource possessions and fulfillment of corresponding roles is better when actors depend on other actors in an ecology than when they are less dependent on other actors.*

Transactive memory system

A transactive memory system refers to a set of individual memory systems that are combined to form the knowledge possessed by the actors of an ecology resulting in a shared awareness of 'who knows what' (Wegner, 1986). Initially, literature on transactive memory systems has mainly focused on dyadic relationships (Hollingshead, 1998; Hollingshead, 2001; Wegner, Erber and Raymond, 1991), but was later extended to collective contexts (Liang, Moreland, and Argote, 1995). Transactive memory system theory maintains that the cognitive division of the roles that need to be undertaken is based on two components. First, internal memory, i.e. what the actor knows personally, and second external memory, i.e. what actors collectively know about the knowledge of other actors in the ecology (Peltokorpi, 2008).

According to transactive memory system theory, it is assumed that actors divide the cognitive labor of their tasks as they specialize in different domains (Brandon and

Hollingshead, 2004). We argue that when the transactive memory is well-developed, actors know that other actors hold the resources to fulfill specific roles and they rely on them to undertake these roles. This knowledge is partly based on experience of having worked together before.

In a multi-organizational ecology actors have expectations about which role they and others should undertake. This is based on the knowledge that actors have of each other who can fulfill which role well. We argue that when the transactive memory system is well-developed, actors know better who in the ecology holds what expertise, i.e. possesses which resources to fulfill a role particularly well. That means that under the presence of a well-developed transactive memory system, actors are more sure who in the ecology holds what knowledge, so that they can encourage other actors more to undertake the role that suits them. Thus, in situations of a well-developed transactive memory system, *resource-role matching* is stronger than in situations of a poor-developed transactive memory system. Based on the above we argue that the relationship between resources and roles is stronger when a well-developed transactive memory system is present.

Proposition 3 *The matching between resource possessions and fulfillment of corresponding roles is better when the transactive memory system is well-developed than when it is not well-developed.*

Macroculture

Macroculture is defined as widely shared assumptions, norms, and values, guiding actions and creating appropriate behavior among actors (Abrahamson and Fombrun, 1992, 1994; Gordon, 1991; Phillips, 1994). Macroculture can be viewed as the social fabric that holds together the multi-organizational ecology and can be observed in strategies, processes, and operations among actors operating in the ecology. Multi-organizational ecologies differ in the strength of their macroculture (Jones et al., 1997): some multi-organizational ecologies are more interconnected and have thus developed a stronger macroculture than more loosely connected multi-organizational ecologies with weaker macrocultures (Abrahamson and Fombrun, 1992).

We argue that the relationship between resources and roles is stronger if the macroculture present in the ecology is strong. A strong macroculture encourages actors to take the expectations of others more into account. Expectations to comply to the social norms are higher and more strictly enforced than in situations where the macroculture is weak and socialization processes have not taken place (Abrahamson and Fombrun, 1992; Reddy and Rao, 1990). Thus, a strong macroculture is more likely to encourage actors to use their resources to undertake the roles that are expected from them (Schwartz and Bilksi, 1987; Rokeach, 1973). In other words, in situations of strong macroculture, *resource-role matching* is stronger than in situations of weak macroculture. This leads to the following proposition

Proposition 4 *The matching between resource possessions and fulfillment of corresponding roles is better when the macroculture in the multi-organizational ecology is strong than when it is weak.*

2.3.3 The ecology level: Role optimization

We introduce the principle *role optimization* to explain the relationship between the role configuration and innovation performance. The principle *role optimization* stipulates that an optimal role configuration exists.

Individual roles are combined in a role configuration, and different combinations of roles, i.e. different role configurations, yield different performance outcomes. Some role configurations are superior for achieving high performance because not every role is as important for the innovation to become successful, and because some roles can be better combined than others. The former implies that an optimal role configuration exists that is sought after by the multi-organizational ecology.

The collective effect of individual roles can be understood by examining the combination of roles at the ecology level (Schneider et al., 2000). Especially the literature about teams suggests that several roles need to appear in the right combination in the role configuration to ensure high performance (Senior, 1997; Stewart and Barrick, 2000). While there may be a variety of relevant roles, some of them might be more important for innovation performance than others, which means that a specific role configuration is more optimal for achieving high innovation performance than another one. This is confirmed for example in the innovation literature (Cooper, 1988; Song and Montoya-Weiss, 1998) and the innovation systems literature (Hekkert et al., 2007).

Role theory gives some suggestions about the optimal role configuration. We restrict our discussion here to the major categorization in role theory, namely the division into task and social roles, which serves as an example in order to illustrate how the principle of *role optimization* works. The distinction between task roles and social roles is well established in role theory and team literature (Bales, 1950; Bales and Slater, 1955; Stewart et al., 2005; Senior, 1997) and is also relevant in the context of multi-organizational ecologies (Heikkinen et al., 2007; Story et al., 2011).

The importance of task roles is acknowledged in the innovation literature (Cooper and Kleinschmidt, 1987; Song and Montoya-Weiss, 1998). In general, it is argued that task roles, such as producing or developing the innovation, are key activities for high innovation performance. The importance of social roles is emphasized less in the innovation literature, but the literature on teams argues that social roles may be regarded as the glue that binds the task roles (Senior, 1997). For example a social role, such as communicating, is necessary to coordinate and to make and implement decisions (Senior, 1997; Stewart et al., 2005). Social roles are especially important in a multi-organizational ecology setting where several heterogeneous parties work together and where tasks are highly interrelated resulting in a situation in which tasks have to be coordinated and managed to a great extent (Galli and Teubal, 1997; Ethiraj and Levinthal, 2004; Heikkinen et al., 2007). Moreover, social communication (next to functional communication) has been found to be important to create an atmosphere of solidarity, which may help overcoming tensions and conflicts that are unavoidable in a multi-organizational ecology (Belbin, 1993).

The above suggests that multi-organizational ecologies need to combine both task roles and social roles to ensure high innovation performance, and that a role configuration in which only task roles or only social roles are present is not likely to be successful. More formally, we propose:

Proposition 5 *A role configuration in which task as well as social roles are fulfilled results in higher innovation performance than a role configuration where only task roles or only social roles are fulfilled.*

2.3.4 Contextual factors: Transactive memory system and macroculture

To complete our model we argue that contextual factors may influence the relationship between the role configuration and innovation performance. More specifically, we suggest that the relationship between the role configuration and innovation performance is influenced by the presence of a transactive memory system and macroculture. Both are discussed next.

Transactive memory system

As discussed before, a transactive memory system refers to a set of individual memory systems that are combined to form the knowledge possessed by the actors of an ecology resulting in a shared awareness of the expertise that is available (Wegner, 1986). When the transactive memory system is well-developed, actors have a good knowledge of 'who knows what' (Wegner, 1986).

We argue that the optimal role configuration depends on the level of development of the transactive memory system. Stated differently, when a multi-organizational ecology has a well-developed transactive memory system the optimal role configuration is likely to be different than when a multi-organizational ecology has a less-developed transactive memory system. A well-developed transactive memory system may make specific roles, especially social roles like coordination and communication, redundant. Prior research has shown that the transactive memory system rather than communication accounts for the positive effect of group training (Hollingshead and Brandon, 2003; Moreland and Myaskovsky, 2000). This suggests that some aspects of communication can be covered by the transactive memory system. In other words, the need for specific social roles is diminishing when the transactive memory system is well-developed, resulting in a different optimal role configuration.

That means that the optimal role configuration will show less social roles, such as coordination and communication, when the transactive memory system is well-developed, compared to the situation where the ecology has a less-developed transactive memory system. Hence, we present the following proposition:

Proposition 6 The optimal role configuration depends on the development level of the transactive memory system.

Macroculture

As stated before, macroculture is regarded as the social fabric that holds the multi-organizational ecology together, and is based on shared assumptions, norms, and values (Abrahamson and Fombrun, 1992, 1994; Gordon, 1991; Phillips, 1994). We suggest that macroculture influences the relationship between the role configuration and innovation performance. While conceptually distinct, the moderating effect of macroculture on the ecology level is based on the same underlying reasoning as the moderating effect of transactive memory system. When the macroculture in the ecology is strong, actors have a shared awareness of the norms and values in the ecology. In such a situation, it is likely that fewer social roles need to be fulfilled in the ecology because some aspects of coordination and communication can be replaced by the macroculture. Prior research shows that when the macroculture is weak, assumptions, norms and values are only shared within the ecology to a limited degree (Harvey and Griffith, 2002). To make up for the resulting lack in mutual understanding, actors within the ecology need to put more effort in undertaking social roles like communication and coordination. When the macroculture is weak, the communication needs to be planned and monitored more carefully than when macroculture is strong (Harvey and Griffith, 2002). Based on the previous, we can argue that when the macroculture is strong, an ecology can do with a role configuration with less social roles, because the macroculture ensures that the ecology shares the same underlying norms and values providing a strong basis for acting as one person and replacing the need for putting a lot of effort in social roles. Hence, we present our final proposition:

Proposition 7 The optimal role configuration depends on the strength of the macroculture.

2.4 Discussion

With this paper, we contribute to the existing literature in two ways. First, we add to the literature on multi-organizational ecologies by making explicit how multiple actors contribute to innovation performance. In order to do that, we combine RBV and role theory and present a framework that shows how a diverse set of actors combine their resources to influence innovation performance. We base our ideas on two principles: *resource-role matching* to explain the relationship between resources and roles and *role optimization* to explain the relationship between the role configuration and innovation performance. Furthermore, we contribute by 1) explaining when the relationship between resource possessions and role fulfillment is likely to appear based on contextual factors and 2) explaining how contextual factors influence the relationship between role configuration and innovation performance.

Second, we contribute to literature by introducing a multilevel framework and linking the ecology level with the organizational level. By introducing multilevel frameworks that have well-developed conceptual foundations the micro-macro gap can be bridged (Kozlowski and Klein, 2000b). Our multilevel framework may help future researchers gaining a more detailed picture of how a diverse set of actors contributes to innovation performance and hence a better and more complete understanding of this process (Brass, 2000).

Our multilevel framework linking resources to performance through roles provides a new perspective on innovation in multi-organizational ecologies, resulting into several interesting avenues for further research.

First of all, we especially encourage further research that tests our framework empirically. In order to study the configurational aspect of the model, i.e. the influence of the role configuration on innovation performance, a configurational approach is recommended. Configurational approaches, such as set-theoretic methods, are especially helpful to study how different elements work together (Fiss, 2007; Whittington et al., 1999). Set-theoretic methods (like qualitative comparative analysis) "conceptualize cases as combinations of attributes and emphasize that it is these very combinations that give cases their unique nature" (Ragin, 1987, 2000). That means that cases are not disaggregated into independent, analytically separate aspects, but instead configurations are treated as different types of cases (Fiss, 2007). As a result, set-theoretic methods are interesting methods to study which different role configurations lead to high innovation performance as they allow researchers to study how the optimal role configuration changes based on the presence of contextual factors. Further research might want to look more deeply at this issue.

Second, we stated that the role configuration can be operationalized in terms of task and social roles, which is a categorization of roles used in prior research (Bales, 1950; Bales and Slater, 1955; Stewart et al., 2005; Senior, 1997). Even though this distinction is a theoretically based starting point and frequently used in prior studies, other aspects of configurations are interesting as well. For example, another possible aspect of a configuration is whether a specific role is undertaken by one actor or by several actors. That means that there can be role specialization, i.e. a role is fulfilled by one particular actor, or role dispersion, i.e. a role is fulfilled by multiple actors. Further research should uncover other relevant aspects of configurations. This calls for exploratory studies to uncover major differences between role configurations. Social network analysis may be the starting point for such an endeavor.

Third, future research should focus on how to measure the role construct. Prior research has often tended to ignore the social aspect of roles and treated roles as acting behavior (e.g. Knight and Harland, 2005; Heikkinen et al., 2007; Gemünden et al., 2007), but some studies give an indication how the social aspect might be taken into account. For example, Story et al. (2011) and Sim et al. (2007) tried to include actors' expectations of other actors as well, even though not explicitly stated as such. We recommend that future research investigates how the social context can be incorporated in role measurement in a consistent way.

Fourth, we included three contextual factors in our model, dependencies and macroculture, and transactive memory system. Although all three factors are likely to have a considerable impact, as they capture how multiple actors relate to each other, our set of contextual factors is not exhaustive. Future research may want to think of other contextual factors in order to extend our model. For example, one could think of environmental uncertainty, which would capture the broader environment, or type of innovation, which would capture the tasks being executed in a multi-organizational ecology.

Fifth, the framework that we presented is relatively static: it focuses on innovation in ecologies at one point in time, and does not take into account changes in the role configuration over time. As innovation processes in general are characterized by high dynamism and roles that actors undertake might vary over time, future studies may want to use a longitudinal approach for studying innovation in multi-organizational ecologies. This is especially relevant in multi-organizational ecology contexts given the fact that many multi-organizational ecologies remain in existence for a long period of time.

Sixth, in our framework we adopted a perspective that focuses on individual innovation projects rather than on innovation systems or industries. Innovation systems are characterized by several innovation projects that are part of the same system; individual projects are likely to be interdependent. The interdependence between the individual projects could influence the effort that actors are willing to put into fulfilling a role, or lead to a higher fluctuation of actors or roles in the individual projects. Therefore, it would be interesting to research if the model could be translated to an innovation system context and if the same principles would hold there as well. By adding a third level to the model, innovation management research can transcend the organizational level and even the ecology level, and acknowledge complex linkages in today's world of innovation.

CHAPTER 3

An explorative study of network governance: Towards a behavioral taxonomy

Despite general agreement that network governance is an important construct in the study of networks, a lack of clarity regarding its exact meaning hampers further study. This article offers an exploratory analysis of what network governance in innovation networks entails. Primary and secondary data pertaining to six innovation projects in the Netherlands reveal that network governance constitutes combinations of behavioral mechanisms, applied to manage a network. This study therefore contributes to extant literature by focusing on combinations of behavioral mechanisms that have been largely ignored and recommending a clearer view of network governance. Furthermore, it identifies a specific behavioral taxonomy of three distinct modes of network governance: basically coordinated, control-oriented and reward-oriented.

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3.1 Introduction

Cooperating in networks, which implies loosely coupled systems of autonomous organizations jointly involved in a project, such as the development of a new product or service (Dhanaraj and Parkhe, 2006), allows organizations to pool their resources (Powell, 1990), which can be especially critical in an innovation context. Few firms are capable of developing new products or services alone (Luke, Begun, and Pointer, 1989; Teece, 1992). Yet despite their potential benefits, up to 70% of inter-organizational relationships fail (Day, 1995) which is often attributed to the difficulty of managing them (Ireland, Hitt, and Vaidyanath, 2002). Thus researchers have introduced the concept of network governance (Borgatti and Foster, 2003; Oliver and Ebers, 1998) to refer to the management of relationships among network actors and their resource exchanges. Such governance appears as a precondition for value creation and network success (Möller and Svahn, 2003; Provan and Milward, 1995; Provan, Fish, and Sydow, 2007; Ritter, Wilkinson, and Johnston, 2004).

Yet we remain far from a clear conceptualization of network governance (Möller and Svahn, 2003). A literature review by Provan et al. (2007) indicates that very few articles explain how networks are governed; generally they neglect or just implicitly address governance. As Provan et al. (2007, p. 503) noted 'a gap appears to exist in the literature in understanding how interorganizational networks govern themselves. (...) Only few empirical examinations exist exploring how activities and relationships occurring within a network are managed and coordinated'. This lack of clarity may have arisen because network governance is a complex, multi-faceted concept that appears in various forms, such that it is difficult to measure and study. However, failing to respond to this challenge leaves little guidance available to managers or researchers. To address this gap in prior literature, we explore network governance empirically and present a conceptualization grounded in the behavior of network actors.

The remainder of this article is organized as follows: We first review governance literature in an inter-organizational context and inventory the mechanisms to obtain a starting point for our empirical investigation. We argue for a conceptualization of network governance that takes a behavioral approach and describe our method. Next, we outline the mechanisms we identify through case studies and their combinations, which produces the behavioral taxonomy of network governance. We conclude with a discussion of the results and our contributions to academic literature, as well as limitations and recommendations for further research.

3.2 Theoretical background

Prior literature distinguishes networks as a form of governance and the governance of networks. The former approach views the network as a type of coordination and an alternative to markets or hierarchies (Provan and Kenis, 2007). It reflects a transaction costs economics approach (TCE; Williamson, 1994), such that exchanges take place in markets, hierarchies or networks, depending on the transaction costs associated with each. In TCE, networks are an intermediate form of governance, between markets and hierarchies (Powell, 1990).

This model can explain why networks may be a superior governance mode, but it cannot reveal how networks themselves are governed. Studies of the governance of inter-organizational relationships mostly focus not on networks but rather on dyadic relationships (e.g., Uzzi, 1997; Wathne and Heide, 2004; Wuyts and Geyskens, 2005). They often attempt to understand network governance by investigating three network characteristics: the use of trust (versus contracts), legal form and structure.

First, relationships between organizations might be governed either through trust (Gulati, 1995) or through contracts (Kogut, 1995). The former style relies on social exchange theory (Blau, 1964) and focuses on informal arrangements based on social norms, trust and mutual adjustment. The latter centres on contracts and reflects TCE theory (Faems, Janssens, Madhok, and van Looy, 2008; Kumar, Heide, and Wathne, 2011). Recent empirical research offers ambiguous findings regarding the relationship between contracts and trust though; contracts might facilitate trust building (Luo, 2002; Poppo and Zenger 2002), or trust might serve as a precondition for contracts (Larson 1992; Ring and van de Ven 1994), or contracts could have a negative influence on the trust between partners (Dyer and Singh, 1998; Lyons and Mehta, 1997; Malhotra and Murnigham, 2002).

Second, some studies focus on the legal form of the relationships, such as joint ventures, franchising, commercial agreements or licensing. Grandori and Soda (1995) describe a wide range of legal forms that vary in their levels of formalisation, centralisation and mix of coordination mechanisms. Similarly, Grandori (1997) describes legal forms that are based on specific mixes of coordination mechanisms, as well as their capacity for dealing with interdependencies among network actors. The selection of a legal form depends on a firm's prior ties (Gulati, 1995) and the technological intensity of the alliance's product area, in combination with the size of the parent firm (Osborn and Baughn, 1990).

Third, some studies have tried to explain network governance by investigating the structure of the network, especially the position of its leader (e.g., Dhanaraj and Parkhe, 2006; Park, 1996; Provan and Kenis, 2007; Thorgren, Wincent, and Örtqvist, 2009). The structural elements thus distinguish specific governance forms; for example, Provan and Kenis (2007) delineate three forms of network governance: participant-governed (network managed by the network actors), lead organization-governed (network managed by one organization) or network-administrative-organization-governed (network managed by an administrative board that is not part of the network). Similarly, Park (1996) distinguishes bilateral and trilateral governed networks. The effectiveness of these network forms depends on various contingencies, such as trust, goal alignment or network size.

Although investigations of network characteristics reveal much about the context of network governance, we still seem to lack an understanding of how networks can be governed and thus what network governance entails. For example, prior research explains that different leadership positions are possible but offers little insight into what a project leader actually does to manage relationships and resources exchanges among network actors. We need a conceptualization of network governance that focuses on activities rather than network characteristics. A behavioral conceptualization of network governance also aligns with research that depicts management as a set of activities (e.g., planning, organizing, leading, controlling) undertaken to shape relationships, understandings and processes and thus bring about task completion (Järvensivu and Möller, 2009; Ritter et al., 2004; Tsoukas, 1994; Watson, 2006).

Furthermore, focusing on activities has managerial importance. Prior research acknowledges that a focus on behavior is needed because 'there is a stream of research investigating multiorganizational structures, but it does not accurately depict a network manager's behavior' (McGuire, 2002, p. 600). Therefore, the role of management, i.e. the set of activities to be undertaken, demands more investigation to understand 'what exactly should be done and how' (Provan and Kenis, 2007, p. 248). If scholarship's ultimate goal is to inform action and provide managerial guidance, new models of network governance are needed (McGuire, 2002).

Accordingly, we adopt a behavioral approach and define behavioral mechanisms as activities used to manage relationships and resource exchanges among network actors. Prior studies have acknowledged the relevance of behavioral mechanisms. A review of the literature on networks, inter-organizational relationships, and alliances provides a set of behavioral mechanisms that might help govern a network, which we use as a starting point for our research. The behavioral mechanisms identified in the literature can be found in Table 3.1.

Communicating is defined as informing, talking and negotiating with each other. It ensures that network actors know all the relevant issues regarding the network and has been found an important mechanism (Grandori and Soda, 1995; Ritter et al., 2004). Another behavioral mechanism is *planning* which is defined as setting performance standards and objectives and which ensures effective management of the network (Das and Teng, 2001; Dekker, 2004; Grandori and Soda, 1995, Järvensivu and Möller, 2009). *Monitoring* has also been noted as a behavioral mechanism in the literature (Das and Teng, 2001; Kenis and Provan, 2006). It refers to the close observation of the process, outcome and behaviors of network actors to evaluate the results according to predefined performance standards and network objectives. It stimulates network actors to conform to the rules and produce the desired output (Das and Teng, 2001; Kenis and Provan, 2006). Furthermore, prior research acknowledges the use of the mechanism *restricting access*, referring to network actors selecting other participants based on certain criteria, such as reputation or knowledge. *Restricting access* may lead to a network in which only the most valuable actors are present which helps governing the network (Grandori and Soda, 1995; Jones, Hesterly, and Borgatti, 1997). Literature on interorganizational cooperation agreements has paid attention to *sanctioning* as a behavioral mechanism. Sanctioning is defined as the punishment of network actors which can reduce opportunistic behavior in the network (Avadikyan, 2001; Tenbrunsel and Messick, 1999). The use of *social control* is acknowledged by Jones et al. (1997) or Ouchi (1979, 1980) and is helpful for reinforcing parameters of acceptable behavior. The last behavioral mechanism that is noted by prior research is rewarding which may stimulate network actors to do their best (Grandori and Soda, 1995; Gulati and Singh, 1998).

While previous studies thus have identified several behavioral mechanisms, most studies consider only a limited number of mechanisms. For example, some authors focus on social behavioral mechanisms, such as the use of social control (Jones et al., 1997), whereas others consider formal behavioral mechanisms, for example planning (e.g., Das and Teng, 2001; Dekker, 2004; Grandori and Soda, 1995) and monitoring (Jaworski, 1988; Kenis and Provan, 2006). In addition to addressing a limited number of behavioral mechanisms, prior literature does not show how they combine. Behavioral mechanisms likely function in relation with one another, such that in specific combinations, they complement, substitute for or exclude the others (Jaworksi, 1988; Jaworksi, Stathakopoulos, and Krishnan, 1993; Klein Woolthuis, Hillebrand, and Nooteboom, 2005; Vlaar, van den Bosch, and Volberda, 2006). Not every combination of behavioral mechanisms appears; rather, a limited number of network governance modes should each be characterised by the presence or absence of a specific combination of behavioral mechanisms. However, desperately needed insight into how behavioral mechanisms combine and jointly form specific modes of network governance remains lacking in the literature and is needed for a good understanding of network governance. By focusing on combinations of behavioral mechanisms, this study addresses potential synergy between the mechanisms and provides a more complete overview of network governance and thus an in-depth understanding of how networks are governed. The resulting behavioral taxonomy of network governance can provide guidelines for further research in the field of network governance, as well as a repertoire of possible solutions that network actors may use to deal with the complex challenge of managing networks (Grandori, 1997).

Table 3.1: Overview of behavioral mechanisms in prior literature

Behavioral mechanism	*Definition*	*Function*
Communicating	Extent to which network actors inform, talk and negotiate with one another other	Ensures that network actors are always up to date regarding issues relevant for the network
Planning	Setting performance standards and objectives	Ensures effective management of network and allows for evaluation the output
Monitoring	Close observation of the process, outcome and behaviors of network actors to evaluate the results according to predefined performance standards and network objectives	Ensures that network actors confo to the rules and produce the desire output
Restricting access	Selecting network actors based on criteria such as reputation and knowledge	Ensures the creation of a network which the needed and most valuab partners are present
Sanctioning	An authorised party's (e.g., project leader's) efforts to punish network actors	Reduces opportunistic behavior; network actors see that sanctions be implemented if they do not act according to rules
Using social control	Reprimanding of network actors who violate network norms, values or goals, by other network actors	Defines and reinforces the parame of acceptable behavior by demonstrating what can happen if norms or values are violated
Rewarding	Using an incentive scheme to stimulate network actors to meet defined objectives	Reduces opportunistic behavior an produces an incentive for network actors to do their best

3.3 Method

3.3.1 Research design

Considering how little we know about what network governance entails, an exploratory study seems warranted. Case studies are particularly useful for exploring new areas and gaining new information (Yin, 1994). We therefore employ a multiple case study design with six cases, generally considered an appropriate number for exploratory research (Eisenhardt, 1989).

The unit of analysis (case) refers to a project for which a network of organizations has developed a (product or process) innovation. We selected cases that focused on sustainable innovations, because these projects tend to be very complex and require input from various parties. This makes it likely that network governance is a relevant issue. All selected cases were either recently completed or close to completion. This ensured that we could gain an overview of the whole innovation process and has the advantage that it was easier for respondents to recall what had happened.

To obtain variation across cases (allowing us to capture a diverse set of contexts and more possibilities to generalize our results), we aimed to select them to differ on three criteria. First, we selected cases differing in the degree of performance outcome of the project. While performance outcome is difficult to assess a priori, we were able to obtain a preliminary assessment based on secondary data. Second, we included both projects aimed at developing process innovations (e.g. the food chain case) and projects aimed at developing product innovations (e.g., the electric car case. Third, we selected innovation projects in which a governmental organization was listed as participant (e.g., the greenhouse case) and innovation projects without a participating governmental organization (e.g., the packaging case). We provide brief descriptions of the cases, including the innovations developed, in Appendix I.

3.3.2 Data collection

We rely on two types of data sources. To gain background knowledge of the cases and triangulate the findings (Jick, 1979), we first collected secondary data, such as business reports, project plans, monitoring reports, newspaper articles and website information. This collection produced more than 700 pages of text pertaining to the background of the projects, participating actors, project performance and the projects' evolution over time.

We then collected data through interviews with members of these networks, whom we identified through the secondary data. Therefore, we began by interviewing the main actor in the network, usually the organization that initiated it or the project leader. Using a snowballing technique, additional selection of respondents was based on their involvement in the network and the diversity of perspectives on the network. In total, we interviewed 22 respondents in 23 interviews (one respondent were interviewed twice), including project leaders, project monitors and network actors. Interviewing continued until we reached a saturation point at which we were gaining no new information. The number of interviews per case also depended on the size of the network. Detailed information on the collected data can be found in Table 3.2.

The semi-structured interviews were guided by a detailed topic list (see Appendix II). The topic list provided a general guideline for the interview, but respondents were free to address other topics or to discuss them in another order. While the topic list contained the main topics to be addressed during the interview, follow-up questions depended largely on the answers provided by the respondents. More specifically, whenever the respondents mentioned a behavioral mechanism, we asked follow-up questions to obtain a better understanding of its application, such as why it had been used (or not) and if it might complement or influence the use of another mechanism. Thus we gained an understanding of when behavioral mechanisms were used in combination.

The interviews started with some general background questions about the product and the network (e.g., size, project performance, project goal), the participants (e.g., roles, activities) and the general project background. To determine how the network was managed, we then used three different techniques to increase the probability of gaining a comprehensive overview of the mechanisms and governance modes.

First, we applied a critical incident technique (Andersson and Nilsson, 1964; Flanagan, 1954), such that we asked respondents to recall a particular memorable incident (positive or negative) during the project. We then asked the respondent to describe when this had happened, what had happened, who were involved, what the circumstances were of the incident, and how the network dealt with those incidents. Because many incidents related to network governance issues, the resulting narrative provided a rich account of how each network was governed without having to prompt the respondent with network governance-related concepts. To obtain an in-depth understanding of the working of the mechanisms we also asked why actors had acted they way they did.

The second technique consisted of open questions about the governance of the network. For example, we asked respondents to explain how the network actors knew what they had to do and how the network ensured that every actor fulfilled its role as best it could. To ensure we gained an in-depth understanding of these behavioral mechanisms, we encouraged respondents to give concrete examples of when, how and to what effect these mechanisms were used. However, the respondents were not directed in their answers, so this technique provided a relatively unbiased view of what the respondents believed were important mechanisms for managing the network.

The third technique specifically asked respondents to indicate if a certain behavioral mechanism had been present in the network. Thus we could check if mechanisms not yet mentioned in the interview (but identified in the literature study) were relevant for that network. For example, when the respondent had not yet mentioned rewarding, we asked to what degree incentives and rewards were used to manage the network. Follow-up questions prompted the respondent to describe what kind of rewards was used, who rewarded, when rewards were given et cetera.

Whenever the respondents mentioned a behavioral mechanism, we asked follow-up questions to obtain a better understanding of its application, such as why it had been applied (or not applied) and if it might complement or influence the application of another mechanism. Thus we gained an understanding of when behavioral mechanisms were used in combination.

Table 3.2: Description of case data

Innovation project	*Number of interviews*	*Interview time (minutes)*	*Type of documents (total pages)*
Bus	3	232	Project plan, website of the initiating company, contract (52 pages)
Food chain	4	322 *	Project plan, monitoring reports, project reports, cooperation agreements (231 pages)
Greenhouse	5	383	Project plan, monitoring reports, project reports, scientific articles (303 pages)
Packaging	3	204	Project plan, website of the initiating company, other information found on Internet, press releases; contract** (20 pages)
Electric car	2	182	Press releases, website of the initiating company, other information found on Internet (20 pages)
Hen housing	6	388	Project plan, monitoring reports, articles, project reports (98 pages)
Total	23	1711 (= 28.5 hours)	724 pages

* Including 90 minutes of observing a discussion session.

** We were allowed to inspect this source, but do not have a copy.

3.3.3 Data coding and analysis

All interviews were tape recorded and fully transcribed, and then the transcribed interviews were entered into a qualitative data analysis program (Atlas.ti) and coded manually following a hierarchical coding scheme. Table 3.3 shows an excerpt of the code book for a predefined category communication. Communication was coded according to the means of communication (telephone communication, email communication, and face to face communication) and the aim of communication (to stimulate, to inform, and to coordinate). The coding scheme combined descriptive, interpretive and pattern coding (Miles and Huberman, 1994). The initial codes were based on the mechanisms found in the literature and additional codes and refinements of the initial codes were spurred by the case data.

Table 3.3: Excerpt code book for the main category communication

Predefined main category: Communication
Category 1: Means of communication
Subcategory 1.1: Telephone
Subcategory 1.2: Email
Subcategory 1.3: Face to face
Category 2: Communication's aim
Subcategory 2.1: Stimulate
Subcategory 2.2: Inform
Subcategory 2.3: Coordinate

In addition to the coding procedure, we developed comments and memos (Miles and Huberman, 1994; Strauss and Corbin, 1990), most of which were tied to a specific code and offered a construct defmition, often together with a text segment that illustrated the code. Other memos stated norms for coding or summarised essential aspects of a case.

The coding and analysis procedure was iterative. The first author assigned codes and did the initial analyses. The initial analyses included checking whether the mechanisms should be divided into submechanisms and classifying mechanisms. Also, a qualitative assessment was made of the extent to which each mechanism had been used in each case, ranging from absent through low and medium to high. Furthermore, the initial analyses involved investigating how the mechanisms were related to each other and why network actors used them. This allowed the construction of a taxonomy that reflected the presence or absence of the mechanisms. Next, the research team came together to discuss the results and further possibilities for analysis. By making a distinction between initial analyzer and secondary analyzers (the rest of the research team) we aimed to gained the bests of two worlds: the initial analyzer was intimately familiar with the cases and the analyses, the rest of the research team could preserve more distance and act as the devil's advocate and critical examine the soundness of the analyses. Thus the discussions between the first author and the rest of the research team prompted new insights and caused the first author to rethink some interpretations and conduct additional analyses. Several iterations were needed to arrive at a classification that all researchers agreed upon, that made sense, and where the classes formed were both exhaustive and mutually exclusive (Bailey, 1994).

3.4 Results

To provide a first impression of the six cases, we first describe the networks in terms of the following characteristics: size, presence of a governmental organization, contract completeness, leadership, performance, dependence, trust, familiarity, project innovativeness, and project terms (see Table 3.4).

Table 3.4: Network description

	Bus	*Food Chain*	*Greenhouse*	*Packaging*	*Electric Car*	*Hen Housing*
Size (number of participants)	9	6	29	7	5	15
Governmental organization	No	Yes	Yes	No	No	Yes
Contract completeness	Medium	Low	Low	High	High	High
Leadership	External project leader	External project leader	External project leader	Internal project leader	Internal project leader	Internal project leader
Performance	Low-medium	Low	Medium-high	High	Medium-high	High
Dependence	Asymmetric	Asymmetric	Symmetric	Symmetric	Symmetric	Symmetric
Trust	Medium	Low	Medium	Medium	High	High
Familiarity	Low	Low	Medium	Low	High	Medium-high
Project innovativeness	High	Low	Medium	Low	High	Medium
Project duration	Defined end	Defined end*	Defined end*	Ongoing	Ongoing*	Defined end*

* Project has ended.

First, the projects investigated are relatively small in size. Size is here defined as the number of network actors that are participating in the innovation project and ranged from 5 to 29 network actors. Second, the cases also differed with regard to the presence of a governmental organization; in three cases a governmental organization played an active role in the project. Third, the cases varied in their contract completeness, i.e. the extent to which the contract includes detailed arrangements with regard to financial obligations, shares, licensing, rules, and deadlines (Poppo and Zenger, 2002). Contract completeness ranged from very general, unspecified (as in the case of Food chain) to very detailed and customized to the specific situation, covering many aspects of the cooperation and future contingencies (as in the case of Packaging). Fourth, the set of cases included two types of leadership: projects where the project leader is part of the project itself (internal project leader) and projects with project leaders that do not have an active role in the project apart from managing the project (external project leader). Fifth, the networks also differ in the performance outcomes, which is measured based on the extent to which the network has reached its goals and has been a commercial or technical success. Sixth, cases also differ in how the network actors depend on each other: some cases are characterized by symmetrically dependent network actors (actors equally dependent on each other), while other cases are characterized by asymmetrically dependent network actors (some actors depend more on other actors in the network than the other way around). Seventh, the data show that some cases are characterized by a high degree of trust, whereas other cases are characterized by low degrees of trust. Trust is the extent to which network actors rely on each other. Eighth, the set of cases included both projects where network actors know each other very well, e.g. from other projects, before the project started (high familiarity), but also projects where network actors were less (medium familiarity) or not acquainted with each other prior to the project (low familiarity). Ninth, project innovativeness (in terms of involving new technologies as perceived by the respondents) ranged from low (in 2 cases) to medium (in 2 cases) to high (in 2 cases). Finally, the cases also differed regarding the duration of the project, e.g. some projects had a defined end which was clear when the project started and others are ongoing projects.

Our study focuses on combinations of behavioral mechanisms, so we begin our discussion by outlining each mechanism and their combinations, which leads to our taxonomy of network governance. The data reveal that several behavioral mechanisms are used to manage networks. Table 3.5 contains an overview of added and refined behavioral mechanisms. One behavioral mechanism had not been identified in our literature review: encouraging a solidarity atmosphere. In some networks, explicit attempts aimed at making network actors feel like part of the project and the group. We also determined that some identified mechanisms could be refined and divided. For example, communicating may have two purposes: for coordination and for stimulation. Similarly, rewarding and sanctioning may be used both formally and informally. Formal use refers to activities based on explicit agreements defined in a contract, whereas informal use indicates those activities not supported by explicit agreements. In addition, the analyses reveal that social control might be used before or after a specific incident; the ex post social control corrects the behavior of project participants who violated project goals, norms or values, whereas the ex ante social control influences the behavior of network actors in advance.

Furthermore, these behavioral mechanisms occur in specific combinations that constitute three main categories: basic, control and reward. First, the set of basic behavioral mechanisms appear all six of our case studies: planning, monitoring and communicating for coordination, which appear necessary to govern a network at some basic level. Second, certain control mechanisms are aimed at reducing opportunism in the network, namely, using social control, sanctioning and restricting access. Third, the final set of reward mechanisms aims to motivate network actors by communicating for stimulation purposes, rewarding and encouraging a solidarity atmosphere.

Table 3.5: Additional/refined behavioral mechanisms derived from data

Mechanism	*Definition*
Communicating for coordination	Interacting with network actors to ensure activities are aligned
Communicating for stimulation	Interacting with network actors to ensure they are motivated to do their utmost to make the project succeed
Sanctioning formal	Punishing network actors, such as by reducing their resources, for not meeting written agreements
Sanctioning informal	Punishing network actors, such as by reducing their resources, for not (appropriately) conducting tasks that they were supposed to do according to mutual understanding
Using ex post social control	Reprimanding network actors for not having fulfilled their tasks, to define and reinforce the parameters of acceptable behavior
Using ex ante social control	Directing network actors' behavior by showing them in advance what they have to do to meet the project's goals and the project team's norms and values
Rewarding formal	Giving benefits when predefined outcomes are reached to stimulate network actors
Rewarding informal	Showing appreciation for the achievements of network actors by giving benefits
Encouraging a solidarity atmosphere	Creating a feeling of togetherness to make network actors feel part of the project and valued

3.4.1 Case comparisons: Towards a behavioral taxonomy of network governance

The results distinguish three modes of network governance, which we summarise in Table 3.6. *Basically coordinated networks* do not use any behavioral mechanisms beyond basic ones, whereas the other two modes go beyond these basic mechanisms but in different ways. *Control-oriented networks* combine basic mechanisms with control mechanisms, and *reward-oriented networks* use basic mechanisms together with reward mechanisms. The distribution is relatively even; we assign two cases to each governance mode.

Table 3.6: Overview of modes and mechanisms

	Basically coordinated		*Control-oriented*	
	Bus	Food Chain	Greenhouse	Packaging
Communicating for coordination	High	Medium	High	High
Planning	High	Medium	Medium	High
Monitoring	High	High	High	High
Restricting access	Absent	Absent	High	High
Sanctioning informal	Absent	Medium	High	High
Sanctioning formal	Absent	Absent	Absent	High
Using ex ante social control	Absent	Absent	High	High
Using ex post social control	Absent	Low	High	High
Communicating for stimulation	Low	Low-medium	Medium	Low
Rewarding formal	Absent	Absent	Absent	Absent
Rewarding informal	Absent	Absent	Absent	Absent
Encouraging solidarity atmosphere	Absent	Absent	Absent	Absent

Mode 1: Basically coordinated network

Both the Bus and the Food Chain cases are basically coordinated networks that rely on a combination of the basic behavioral mechanisms communicating for coordination, planning and monitoring, but no other behavioral mechanisms. The combination of mechanisms actually employed seems necessary for a minimum degree of network governance; all networks use them, and some respondents explicitly argued that planning, monitoring and communicating for coordination were essential to network management. For example, the project monitor of the Food Chain case explained:

> *Each time that we met, a plan was made. It is very important that we know what we have to do.* (Project monitor, Food Chain)

The respondents also noted that they needed to monitor (1) budgets to ensure appropriate expenditure amounts, (2) outcomes to determine what had been achieved and what needed to be done better in the future and (3) activities to ensure whether everyone was doing whatever had been agreed. The project leader of the Bus case thus considered monitoring very important and stressed the effort put into monitoring:

> *The progress of the project is constantly monitored. We also cooperate with a nearby University of Applied Sciences. The students of this school measure our outcomes. That makes the measurement very objective.* (Project leader, Bus)

Monitoring was also considered very important in the Food Chain case. This network not only monitored the progress of the project but also summarised the behavior of network actors in detailed monitoring reports.

Finally, communicating for coordination purposes was essential to keep all network actors up to date and to negotiate and arrange next steps. As a network actor from the Bus network explains:

> *Communication has two main goals: Sharing of information and the planning of concrete actions.* (Network actor, Bus)

Communicating for coordination works very well in the Bus network, which has agreed to meet six times per year. The main actors are in contact more often, several times a week, to coordinate their highly interrelated tasks. In the Food Chain case, communication is not as smooth; respondents indicated that they met approximately twice a year and were not well informed by each other. The project monitor explained:

It was very difficult to communicate in this project. Sometimes people just could not be reached. (Project monitor, Food Chain)

The data offer some explanations for why these networks rely, either voluntarily or involuntarily, on a limited set of behavioral mechanisms and why network actors undertake activities only to ensure a minimum of network governance. Some network actors argue that basic mechanisms suffice, such as respondents from the Bus case who considered rewards unnecessary to manage a network:

We do not need rewards. I would not know what we can do better by using rewards. We all work as hard as we can, a lot of people with almost no payment. A lot of people do this [project] in their free time, without any compensation at all. That means a lot of them do this for the good cause. (Project leader, Bus)

Similarly, they did not use sanctioning elements because sanctioning someone for making a mistake or not meeting a deadline would not be very productive; such setbacks seemed inherent to innovation projects and not necessarily the fault of any specific actor. However, respondents might have expressed this scenario to justify their own lack of specific activities. In both cases, the network actors had few capabilities to manage the network using other means and therefore had to rely on basic mechanisms. For example, respondents from the Food Chain case noted that they had no ability to employ sanctioning elements, partly due to the asymmetric dependence within their network. The Food Chain network comprised both a scientific and a business project; whereas the scientific project depends heavily on the business project, the reverse is not true, which makes it very difficult to use additional mechanisms.

Similarly, in the Bus network the project initiator had no alternative partners, so it was dependent on partners. The less dependent parties were unwilling to sign contracts that included sanctioning, which created few possibilities for managing the network and made it difficult to implement control mechanisms.

Another reason that these cases apply only basic behavioral mechanisms is that their networks are led by external project leaders who are part of the project but not part of the business project. These external project leaders rarely can enforce additional behavioral mechanisms. They do not sit at the core of the network; sometimes they do not know all the details of the project and cannot make all decisions. Thus they have little means to implement control or reward mechanisms. As the project leader of the Food Chain case sighed:

"This project just cannot be managed." (External project leader, Food Chain)

Similarly, external project leaders are often less affected by the project and its outcomes, so they are less eager to control or encourage network actors.

Mode 2: Control-oriented network

The Greenhouse and Packaging networks both add a combination of control mechanisms (social control, restricting access and sanctioning) to the basic mechanisms but refrain from using reward mechanisms. Its strong focus on control and the prevention of opportunistic behavior prompt us to call this type the control-oriented mode of network governance.

The data show that sanctioning plays a particularly important role by allowing network actors to keep control over the network and reduce opportunism, whether formally or informally. Project participants with something to lose often seem anxious to specify the rights of the parties and the consequences if requirements are not met in writing. For example, in the Packaging case, it was important to safeguard intellectual property:

> *We have signed a non-disclosure with all parties and all rights are going exclusively to the initiating party. This has been very important lately; we have already made use of it once in order to protect our ideas.* (Network actor, Packaging)

Another respondent confirmed that the possibility of penalising network actors served to manage the network:

> *All third parties have contracts with us and if they do not meet the agreed requirements, they can be penalised.* (Project leader, Packaging)

Inspection of the contracts (during the interview) that are used in the Packaging network confirms that they are quite extensive and that they list especially the sanctioning elements and the protection of intellectual property.

However, sanctioning can be informal and based on informal agreements rather than written in a contract. Misbehavior can be sanctioned, even if only through an implicit understanding of agreements. Both projects thus used or considered informal sanctioning; for example, the project monitor of the Greenhouse case explained:

> *It was not formal, but you could be kicked out of the network.*
>
> (Project monitor, Greenhouse)

Control-oriented networks are also characterized by a heavy reliance on social control mechanisms. Unlike sanctioning, social control does not punish but rather exerts social pressure to correct the behaviors of network actors after a violation, to make sure it will not happen again, or to direct their behaviors in advance to prevent unwanted behavior. For example, the Packaging network recorded the performance of individual network actors, to communicate the information during network meetings, with the explicit objective of publicly revealing who had done their jobs and who had not. Poor comparative performance makes an individual member feel pressured to do better next time, so as the project leader of the Packaging case explained:

> *Everybody else can see this and this pushes them [to do better].*
> (Project leader, Packaging)

Similarly, in the Greenhouse case the project leader used to call network participants before a meeting to tell them that they were expected to come. By calling and making expectations explicit, social pressure was created.

Finally, the control-oriented networks rely on restricted access that reflects various criteria. For example, the project reports of the Greenhouse network reveal that the selection criteria for admitting actors to the network had been discussed in advance, put down in writing and then employed during candidate interviews. Growers who wanted to participate had to meet two criteria: They had invested in a (semi-)closed greenhouse (or had concrete plans to do so) and were willing to share experiences with other growers. The network took the interview process very seriously:

> *Interviews have been conducted with a lot of potential growers in order to select the ones that really fit.* (Project monitor, Greenhouse)

The Packaging network also thoroughly screened potential partners:

> *Whenever potential partners told us the project would financially not be a problem for them, we did some research to see whether this was actually true. We wanted to make sure that the organization is financially healthy and therefore checked their financial situation and general background very carefully.* (Network actor, Packaging)

The cases employing a control-oriented governance mode did not use reward mechanisms. For example, when asked whether they used reward mechanisms, the project leader in the packaging case responded:

> *No, no, we are not good at rewarding, we don't celebrate things.*
> (Project leader, Packaging)

Control mechanisms are mostly initiated by project leaders. For example, in the Packaging case, the project leader was internal; it is one of the organizations which invented the product. Because of its position in the core of the project, it wanted to retain an overview of the project and its progress. Furthermore, intellectual property controls were critical. The contracts in this case reaffirmed these findings, due to their high level of completeness.

The data again offer some explanations for the use of the control-oriented mode of network governance. First, symmetric dependence in the networks (i.e., all network actors equally depend on one another) enables network members to control the other parties by implementing control mechanisms. Actors are more willing to sign contracts that include sanctioning elements if they have an interest in the project and depend on their partners. Second, these networks' reliance on control mechanisms is also due to a lower amount of trust and familiarity compared to the other investigated networks. In both the control-oriented networks, trust was not exceptionally low, but network actors considered it problematic to count on trust all the time. For example, in the Packaging case the project leader considered trust fickle and unreliable, such that:

> *Trust can end very quickly. [...] In our industry it is hard business and in the end it is important to earn money and then you need to rely on businesslike agreements.*
> (Project leader, Packaging)

Furthermore, the external project leader of the Greenhouse case pointed out that despite trust among the growers, a lot of distrust persisted in the administration group, due to their different opinions and expectations. The project administration group thus needed detailed, written information on almost any activity, and the actors were unwilling to share information.

Mode 3: Reward-oriented network

The Electric Car and Hen Housing networks apply, in addition to the basic behavioral mechanisms, a combination of behavioral reward mechanisms. Behavioral control mechanisms are absent though. This reward-oriented mode is characterised by a strong focus on rewarding network actors for doing a good job, motivating them and creating an atmosphere of solidarity.

The data show that the two reward-oriented networks in our study are characterised by exceptional amounts of solidarity. Network actors know a lot of personal things about one another and exchange personal, non-work-related information, such as through weekly lunch meetings. The project leader of the Electric Car case stressed the importance of social information:

> *I like to have them all around a table, with food, so that we can eat together. Then you also get to hear about problems in the family or about the illness of a project partner's wife [...] that is important as well. That is their life and it is mine, as well. In that way we are able to create a special team spirit.* (Project leader, Electric Car)

Another informant confirmed the atmosphere of solidarity within this network:

> *You learn a lot about each other. I know that Tim's wife is ill and that Gerry has to take his caravan to Zeeland. You know all these kinds of things; you are socially very well informed about each other.* (Network actor, Electric Car)

For the Electric Car project, the offices (which all participating organizations use freely) were designed to stimulate exchanges and give network actors the sense that everyone was part of the project. A network actor thus shared his experiences:

> *It is important that you are not working in hierarchical levels. I was sitting next to the project leader and the secretary in the office. This supports the exchange and the stimulating atmosphere. This is good for the project.* (Network actor, Electric Car)

Such an atmosphere also helps manage the network, because network actors who feel part of the project and valued are more inclined to support that project.

Reward-oriented networks also indicate high levels of communication for stimulation. Communication is frequent; the main actors in both networks are in contact almost every day. Regular meetings include the broader network and are more frequent if urgent issues arise. Communication is not used just to coordinate tasks but also constantly reminds all network actors how important they are for the project and the importance of its ultimate goal. For example, the project leader of the Hen Housing network explained:

> *I regularly show the business plan to the whole group. I think this is a good way to show them what we are doing together, to create a positive drive and stimulate them, something like 'this is what we are doing together'.* (Project leader, Hen Housing)

The data suggest that communication is stimulating when it shows that the work that actors do is valuable and recognized. A respondent from the Electric Car network elaborates on this point by stating that any human wants to be valued and that it is important to respond to that need:

If everybody is doing overtime on Sunday [...], then you have to value that, really value that. You should tell them that you appreciate it and that it is well done. This also works for me: if I work hard on Sunday and somebody tells me 'Tim, you did a great job', then I think 'thank you for noticing that I worked hard and for giving me a compliment'. We like to be appreciated and to be valued. (Project leader, Electric Car)

Finally, reward-oriented networks emphasise the use of formal and informal rewarding. Formal rewards, such as contracted bonuses if project objectives are met or exceeded, are very straightforward instruments for managing network actors. Several respondents indicated they felt motivated to meet set objectives for extra remuneration included in the contracts. For example, a network actor in the Electric Car case stated:

We will get bonuses when we have produced 300 electric cars and that is a very big bonus. Everybody finds that very interesting. (Network actor, Electric Car)

Similarly, a farmer from the Hen Housing network revealed that he would 'score better' if the project succeeded:

The better the hen housing system works, the more money I can earn.

(Farmer, Hen Housing)

Rewarding can also be more informal though; for example, network participants of the Electric Car case were spontaneously invited on a city trip with their families when they reached a milestone.

These reward mechanisms are mostly initiated by project leaders, who are internal and know all the details of the project. Therefore, at the heart of the project, they have an excellent position from which to influence the network atmosphere. The data also show that this mode of network governance is characterised by minimal control mechanisms, which suggests that reward mechanisms might substitute for control mechanisms. Respondents from the two reward-oriented cases indicated that they believed that controlling and rewarding are two completely different ways of managing a network that do not match very well; they had a clear preference for rewarding rather than controlling. For example, the project leader in the Electric Car project argued that sanctioning and controlling would not fit the style of management present in the network:

I do not see much in sanctioning, I prefer motivating people.

(Project leader, Electric Car)

The project leader of the Hen Housing network similarly observed:

Rewarding works a lot better than sanctioning. Penalty agreements haven't been used [in our project]. (Project leader, Hen Housing)

Both project leaders then suggested their preference was especially strong in an innovation context, because

[...] control and innovation are two things that do not go very well together. (Project leader, Electric Car)

The data offer some explanations for why these networks use the reward-oriented mode: Both networks are symmetrically dependent, and actors depend equally on one another. When the project leader of the Electric Car case tried to create dependencies to make it more difficult for network actors to leave the project or act opportunistically, he made network actors financially dependent on the project by allowing them invest in it. Thus, he is dependent on them, but they are also dependent on him and the success of the project. He thereby created clear incentives for network actors to do their best to make the project successful.

In addition to symmetric dependence, these networks are characterised by a high amount of trust and familiarity. The high degree of trust may be partly explained by the fact that several actors knew each other before the project started. Some respondents even deliberately looked for partners they knew already to reduce their risks and to make the project easier to manage:

You have to look for people from whom you know how they behave. If I admit somebody to the network who I do not know, then I do not know whether he is going to do a good job, I do not know his personal characteristics. Well, I prefer looking for people in personal circles. (Project leader, Electric Car)

The resulting high level of trust may explain the absence of control mechanisms. For example, with the high levels of trust in the network, there was less need to rely on written agreements:

I think that trust was in general high. I think that is the reason why there was little emphasis on formal written agreements. Yes, I think that there was quite a lot of trust. (Project monitor, Hen Housing)

Furthermore, respondents pointed out that that intrinsic motivation and empowerment (and lack of control) are the best ways to govern innovative projects, as this makes that you achieve the most. As one of the respondents phrases it:

There is trust that partners have an intrinsic motivation to achieve set goals together. [...]. We all have the same drive and that is to make this a success, and if you all want that, we can achieve a lot. Well, that's how I feel it. (Farmer, Hen Housing)

3.4.2 Network governance mode and performance

The central aim of this study is not to analyse the extent to which network governance modes influence performance, but we can derive some tentative insights from the data. The interviews featured three types of performance: goal attainment, the technical success of the innovation and the commercial success of the innovation. The latter two measures are not applicable for all cases, because some of them are not on the market yet, and others did not have inventing a new technology as an objective.

In order to measure performance, we asked respondents to indicate to what extent the network reached its goals, to what extent the innovation can be regarded as a technical success, and to what extent it can be regarded as a commercial success. For example, for the packaging case the respondent indicated that all milestones have been reached and that the project has fulfilled the expectations. Therefore, we rated goal attainment as being high. Furthermore, the respondent explained that the recipe for the packaging material is now ideal, indicating that the innovation is a technical success. Therefore, we rated technical success as being high. Table 3.7 summarizes the performance outcomes per case though.

Table 3.7: Performance per governance mode and case

Mode	*Case*	*Goal attainment*	*Technical success*	*Commercial success*
Basically coordinated	Bus	Low-medium	Medium	n.a.
	Food Chain	Low	n.a.	Low-medium
Control-oriented	Greenhouse	High	Medium	n.a.
	Packaging	High	High	n.a.
Reward-oriented	Electric Car	Medium-high	High	n.a.
	Hen Housing	High	High	High

Notes: n.a. = not applicable

Respondents from the basically coordinated networks generally believed that not all goals had been reached and that the projects had not succeeded. In contrast, respondents from the control- and reward-oriented networks were very satisfied with the success of their projects:

> *It is running as we hoped it would. Eighteen months ago we stated that we would like to have the first eggs in the supermarket by spring 2010 and we reached that goal.* (Project leader, Hen Housing)

This suggests that the basically coordinated networks performed worse, in terms of reaching their goals, than networks using the other two network governance modes. The same outcome fits, where applicable, with regard to commercial and technical success: The basically coordinated networks scored lower on these two performance measures than the control- or reward-oriented networks. For example, the Packaging network created a new recipe for a sustainable package and developed a functional machine, which ensured its technical success.

These performance differences suggest, though only generally, that basic behavioral mechanisms are insufficient to ensure good performance. Either behavioral control mechanisms to reduce opportunistic behavior or behavioral reward mechanisms to motivate network actors to act in accordance with project objectives are needed as well. This recommendation appears especially acute in the Food Chain case; respondents argued that gaps in motivation, structure and coordination resulted in the failure to meet predefined objectives. The project group met rarely, and tasks discussed in meetings often were not completed. The project monitor remarked:

> *We were in a negative flow; nobody did anything, so we thought very often 'well this task can wait'*. (Project monitor, Food Chain)

The network actors also indicated that they would have liked to have more structure and coordination, as well as incentives to give their best to the project.

3.5 Conclusions

Despite general agreement that network governance is an important construct for the study of networks, research in this field has been hampered by a lack of clarity about its exact meaning. We set out to explore what network governance entails in innovation networks; our explorative study found that network governance is best viewed as combinations of behavioral mechanisms that can be applied to manage a network.

This study therefore extends research on network governance and makes two main contributions to literature. First, we focus on behavioral mechanisms that so far have gained little attention in network governance literature. Prior research on the management of inter-organizational relationships has mostly addressed network characteristics (e.g., Gulati, 1995; Poppo and Zenger, 2002; Provan and Kenis, 2007) and thus produced many important insights, though without offering an understanding of the activities available to govern networks. By using a behavioral approach, our conceptualization of network governance details how networks are governed. Furthermore, the studies that have addressed behavioral mechanisms in a network context mainly have been conceptual or investigated a limited number of mechanisms (e.g., Grandori, 1997; Grandori and Soda, 1995). To the best of our knowledge, our study is one of the first to investigate network governance empirically and systematically to unravel the behavioral mechanisms that are used to manage networks. In so doing, our study provides guidance for future research by presenting a comprehensive set of behavioral mechanisms. In turn, we establish a body of common knowledge and address calls in prior research (Oliver and Ebers, 1998; Provan et al., 2007).

Second, our study contributes to existing literature by suggesting that network governance should be understood as specific combinations of behavioral mechanisms that can be applied to govern a network. We extend literature on network governance, which has addressed behavioral mechanisms mostly separately (e.g., Grandori, 1997; Grandori and Soda, 1995; Gulati and Singh, 1998; Jones et al., 1997; Park, 1996). We not only identify combinations of behavioral mechanisms, but also reveal which mechanisms appear in which networks and how they can combine into alternative modes of network governance. In turn we develop a taxonomy of three network governance modes: basically coordinated, control-oriented and reward-oriented. This is not to say that these three governance modes identified are exhaustive for all potential governance mechanisms for networks. Nevertheless, random combinations of mechanisms appear unlikely; rather, mechanisms from the same mode fit each other particularly well. Moreover, our results suggest that further research should focus more on combinations of behavioral mechanisms, rather than individual mechanisms, because any network is likely to apply all mechanisms contained in a specific mode. By studying the combinations of behavioral mechanisms, we also gain more complete insights into what network governance is. Our study redirects research on network governance and advances understanding of the configurative pattern of behavioral mechanisms with a taxonomy that is both fine-grained and conducive to the further study of network governance. Our taxonomy provides a tool for the systematic comparison of alternative modes of network governance and offers the basis for further elaborations.

3.6 Discussion

We based our taxonomy on behavioral mechanisms, but this approach is not intended to imply that network characteristics (structure or trust) or the personality of the project leader, are unimportant. These factors play important roles; in particular, the tentative results suggest that both network characteristics and project leader personalities can influence the behavioral mechanisms adopted and thus the specific mode of network governance chosen. Further research should consider a combined approach that acknowledges the relationships among behavioral mechanisms, network characteristics and personality.

Regarding structure, our study gives tentative insights that the position of the project leader (especially within or external to the network) relates to the likelihood of the appearance of specific network governance modes. A project with an internal project leader is more likely to use the reward- or control-oriented modes of network governance than projects with external project leaders, perhaps because the project leader knows the details of the project and is directly affected by events within that network. Furthermore, by representing the very heart of the project, an internal project leader has an excellent perspective on how to influence governance in the network.

Regarding trust, we find that it appears more important in one mode than in another. A high amount of trust in the network makes it more likely that a network will adopt a reward-oriented mode. In a trusting atmosphere, parties are more likely to share information and jointly solve problems, which reduces opportunistic behaviors. This is in line with prior research that describes trust as an important condition for creating an open atmosphere (e.g., Larson, 1992; Ring and van de Ven, 1994; Zand, 1972). In contrast, when trust is low or network actors think that they cannot rely on trust, a control-oriented mode is more likely.

Finally, our study suggests that a preference for either the reward- or control-oriented mode stems from the personalities of project leaders. For example, the project leader of the Packaging case has a very careful and controlling personality and wants to protect his organization through behavioral control mechanisms. In contrast, the project leader of the Hen Housing case is very open and believes that all network actors mean well, so he arranged to build the hen housing system before anything had been signed. Thus the personality of the project leader should help determine the choice of activities undertaken, i.e. the behavioral mechanisms that are applied, in the network. Moreover, some project leaders (or network actors in general) may be more fit to undertake some activities than others.

Furthermore, this study has implications for resolving the debate about whether networks can be managed at all (Ritter et al., 2004). Some authors have argued that networks cannot be managed because they are not legally organized entities that participants join of their own will (Podolny and Page, 1998; Powell, 1990); others posit that hub firms can control networks or that network actors can manage them (Jarillo, 1988; Provan and Kenis, 2007). Our findings suggest that some networks can only be managed in a limited way, whereas others can be managed very well. This distinction is especially apparent in the basically coordinated mode of network governance; asymmetric dependence and the type of leadership make it difficult to add other behavioral mechanisms. That is, the basically coordinated networks can be managed only in a limited way, whereas reward- and control-oriented networks can be managed more effectively.

3.7 Limitations and directions for further research

Our taxonomy provides an understanding of network governance and may serve as a guide for additional empirical research into network governance. When using an explorative approach, the focus of the research is not put on showing and testing causality, but rather on exploring and gaining new information. Considering how little is known about network governance, an exploratory study is warranted. With this study we show how six innovation networks are governed by applying combinations of behavioral mechanisms and made a first step to investigate what network governance entails. As an exploratory study though, it suffers from several limitations that offer opportunities for further research.

First, our proposed taxonomy of network governance results from an exploratory, qualitative study of six cases. We worked to maximise the possibilities of revealing all network governance modes (e.g., starting with an extensive literature study, generating an extensive set of mechanisms, using an exploratory research approach), but we cannot completely rule out the possibility that other modes exist. In addition, we do not want to raise the impression that the found modes and mechanisms are exhaustive for all innovation networks. For example, one combination that we did not find is the combination of behavioral control and reward mechanisms. However, based on our results we do not expect this governance mode to be very realistic. Our empirical findings suggest that these two types of behavioral mechanisms require completely different mindsets and atmospheres. However, further research should use quantitative, large-sample methods to test our proposed taxonomy and to see if there might be other governance modes as well. For example, researchers might use cluster analysis to determine if the results reveal the same network governance modes we found qualitatively. Such research also could investigate when a particular mode should be most expected, according to the structural aspects of the network or the personality characteristics of the project leader. Similarly, such research could include more consequences of the various modes; our limited number of cases and the nature of our study permit us only tentative suggestions about the performance implications of different network governance modes. Including consequences in a quantitative study instead could reveal the strength of the relationships among the various modes of network governance and performance outcomes.

Second, we studied relatively small, purposefully built, innovation networks. Furthermore, we only studied a limited number of cases, that means that a lot of other innovation projects that might be different (e.g., large open networks), have not been included in this research. This raises the question to what extent the findings might be generalizable. It is hard to say to what extent the findings might be generalizable to similar innovation networks or to different kinds of innovation networks. It might be argued though that similar innovation projects (e.g. in terms of size, kind of innovation, type of leadership) would offer similar results. It can be argued that contingencies, such as size, would influence the use of behavioral mechanisms in networks differently. That means that other kinds of networks, for example large open networks, might use different mechanisms or some mechanisms might be completely absent. For example, in large open networks, the mechanisms 'restricting access' would not be useful because these networks are often open for interested participants and do not apply a strict selection. Further research should focus on such network types to increase the generalizability of our results.

Third, research might take a longitudinal perspective and investigate whether different modes are more likely to emerge, depending on the project stage. For example, a newly formed network comprised of unfamiliar actors might adopt the control-oriented mode at first, then later consider implementing reward mechanisms. This idea is in line with research that suggests that the applied mode can change over time (Lowndes and Skelcher, 1998; Provan and Kenis, 2007).

Fourth, it would be interesting to study whether some network actors have resources to support one mode of network governance better than another. Research on network competence argues that some organizations are better equipped to handle and exploit inter-organizational relationships (Ritter and Gemünden, 2003).

This study enhances understanding of what network governance entails. As a first step in the right direction, we hope it serves as the basis for several ongoing, interesting streams of research.

CHAPTER 4

Activities in multi-organizational ecologies: A project-level perspective on sustainable energy innovations

Complex innovations involve multi-organizational ecologies, which reflect heterogeneous sets of actors. With a project-level perspective on innovation activities in multi-organizational ecologies, this study combines literature on new product development, innovation systems, and interorganizational relationships and networks to construct a typology of activities. This study offers a first, explorative step towards classifying the activities that are relevant in the context of multi-organizational ecologies. By doing this, an overview of the activities undertaken on the ecology level is gained; furthermore, the prevalence of the activity sets and their differential effect on innovation performance is made observable. The authors use government-funded sustainable energy projects in the Netherlands as an empirical context and consider both archival and survey data. The results support the proposed typology across four activity sets. Both strategic predevelopment and commercialization activities have significant and positive effects on innovation performance, whereas engineering and project management do not. The data show that for sustainable energy projects, commercialization activities are often insufficient, yet important to reach high innovation performance. This project-level perspective complements an innovation systems perspective to clarify the success of complex innovations, such as sustainable energy.

This chapter is based on: Manser, K., Hillebrand, B., Driessen, P.H., Ziggers, G.-W., and Bloemer, J. (2012). Activities in multi-organizational ecologies: A project-level perspective on sustainable energy innovations. Under review in Technological Forecasting and Social Change.

4.1 Introduction

Many industries have witnessed the emergence of complex innovations with multiple parts that entail unknown, unpredictable interactions (Anderson, 1999), such as production systems for renewable energy, public transit smart cards, e-health systems, aircrafts, and closed-loop greenhouses (Dougherty and Dunne, 2011; Katz, 2006). Innovation complexity increases with the number of components involved, the degree of customization, the number of design choices, the elaborateness of system architectures, the range and/or depth of knowledge and skills, and the variety of information inputs (Hobday, 1998). Developing complex innovations requires the mobilization and management of a wide set of resources, which rarely can be found within a single organization (Gann and Salter, 2000). Instead, their development requires active participation by multiple organizations (Bloom and Dees, 2008; Gann and Salter, 2000), often combining private and public actors (Dougherty and Dunne, 2011), that can complement each other (Samila and Sorenson, 2010), such as buyers, suppliers, nongovernmental organizations, knowledge institutes, and governments. For example, sustainable housing combines the inputs of architects, builders, suppliers, and local and national governments. Following Dougherty and Dunne (2011), we refer to such a heterogeneous set of actors involved in an innovation project as a multi-organizational ecology.

Complex innovations often emerge from complex innovation systems (Katz, 2006). Therefore, complex innovations are often studied from an innovation systems perspective (e.g., Bélis-Bergouignan and Levy, 2010; Geels, 2005; Hekkert et al., 2007; Liu and White, 2001; Negro et al., 2006). The innovation system perspective regards innovation at an aggregate level, at the level of the innovation category (e.g., electric vehicles in general). The project-level perspective instead focuses on innovative products or services (e.g., Tesla Roadster, Nissan Leaf, Opel Ampera, in the context of electric vehicles) and tries to understand the specific projects in which the innovation occurs. While an innovation system perspective is especially useful for understanding the success of an innovation category as a whole, observations from practice suggest that decisions regarding subsidies are often made on the project level. That means that for managers and policy makers, who are involved in complex innovations in multi-organizational ecologies (e.g., by subsidizing an innovation project), a focus on the project level is recommended in order to understand what happens in an innovation project.

Understanding individual innovation projects is important for understanding innovation systems (Hekkert et al., 2007). While innovation systems also comprise other elements (e.g., rules, regulations and unwritten norms), innovation projects are arguably the most important building blocks of successful innovation systems: innovation systems without successful projects are unlikely to flourish, while even a limited number of successful projects may spur a whole innovation system. The project-level perspective complements the innovation system literature, in particular regarding the study of activities within innovation systems (e.g., Hekkert et al., 2007; Suurs et al., 2009). Therefore, this study takes a project-level perspective of innovation activities in multi-organizational ecologies.

In this paper, we use focus on the activities that take place in multi-organizational ecologies. In doing so, we take a behavioral approach. This is in line with repeated claims in the literature that management (including the management of innovation in multi-organizational ecologies we would argue) should be seen as a set of activities aimed at shaping relationships, understandings and processes and that thus bring about task completion (Hekkert et al., 2007; Ritter et al. 2004; Tsoukas, 1994; Watson, 2006). Ultimately, it is the behavior of actors that make things happen and will result in higher innovation performance. A behavioral approach may thus be useful for understanding complex innovation.

More specifically, based on new product development (NPD) literature, innovation systems literature, and interorganizational relationship and network literature, we develop a typology of activities that have the potential to contribute to successful innovation in multi-organizational ecologies. Especially in the context of multi-organizational ecologies, we still lack an understanding of how various actors can influence innovation. Typologies are an effective means “to bring order out of chaos” and they can transform the complexity into well-ordered sets (Baily, 1994). By constructing a typology we can identify the innovation activities and structure them by means of categorizing them. The constructed typology ultimately results in an overview of these activities which is up to now lacking in the literature (Hekkert et al., 2007). It can be the case that an activity set is represented highly, but the actual effect of the activity sets might be low or insignificant. Therefore, in order to analyze if an activity set is a necessary condition or a determinant, we investigate the prevalence of the activity sets. Furthermore, we investigate the differential effect of the identified activity sets on innovation performance.

As an empirical context, this study uses 120 sustainable energy projects in the Netherlands. Such projects involve attempts to decrease dependence on traditional, fossil fuel-based energy sources. We focus on energy transition projects that have received funding from a government agency. Accordingly, our project-level perspective offers insights to both managers and public policy officers in the sustainable energy sector. Managers can recognize project activities that are likely to boost the success of an innovation. This benefit is substantial, because coordinating and developing complex innovations, undertaken by multiple parties, remains a constant challenge for managers (Ethiraj and Levinthal, 2004; Granstrand and Sjölander, 1990). Public policy officers also can benefit from project-level insights when they attempt to evaluate innovation projects and decide which projects to fund. Furthermore, the detailed insight into the activities can also enable them to help actors in a better way to set up their innovation projects.

4.2 Conceptual background

4.2.1 Activities and innovations in multi-organizational ecologies

Several streams of literature provide input for a typology of activities that might apply in a multi-organizational context. These streams are combined in this study. First, innovation systems literature describes functions that are present in innovation systems (e.g., Edquist and Johnson, 1997; Galli and Teubal, 1997; Hekkert et al., 2007). Second, innovation management literature, especially that focused on NPD, delineates necessary activities during the innovation process (e.g., Cooper, 1990; Henard and Szymanski, 2001; Song and Montoya-Weiss, 1998). Third, literature on interorganizational relationships and networks has addressed social activities that might bind functional activities together, though not always in the context of innovations (e.g., Heikkinen et al., 2007; Gemünden et al., 2007; Story et al., 2011).

Innovation systems literature describes activities as "functions", i.e. behavior that an actor in the innovation system undertakes. For example, Edquist and Johnson (1997) discuss three functions of institutions in innovation systems: institutions reduce uncertainty by providing information, manage conflicts and cooperation, and provide incentives for innovation. Galli and Teubal (1997) distinguish between hard and soft functions in their discussion of the evolution of innovation systems. Hard functions include R&D activities and the supply of scientific and technical services to third parties; soft functions involve the diffusion of information, knowledge, and technology; policy making; design and implementation of patents, laws, and standards; the diffusion of scientific culture; and professional coordination (Galli and Teubal, 1997). Furthermore, Jacobsson et al. (2004) list five functions to analyze the dynamics of a technological system: the creation of new knowledge, influence of search process directions, supply of resources, creation of positive external economies, and the formation of markets (Jacobsson et al., 2004). Finally, Hekkert et al. (2007) propose a set of functions needed to bring about technological change and ensure that innovation systems are performing well, namely, entrepreneurial activities, knowledge development, knowledge diffusion through networks, guidance of search, market formation, resource mobilization, and the creation of legitimacy/counteract resistance to change.

Innovation management literature instead studies critical activities during the NPD process (e.g., Cooper, 1990; Henard and Szymanski, 2001; Song and Montoya-Weiss, 1998). It tends to take a process approach, such that critical activities get associated with the stages an innovation undergoes over time. Thus Veryzer (1998) distinguishes strategic planning and concept generation, followed by pretechnical evaluation, technical development, and finally commercialization. Others offer similar suggestions (e.g., Schilling and Hill, 1998; Song and Montoya-Weiss, 1998), which has led innovation management literature to focus generally on functional activities, with less attention paid to management and communication-related activities, let alone the specifics of managing multi-organizational ecologies (Rochford and Rudelius, 1992; Utterback, 1971). The approach used in this study is similar to the ones used in prior NPD studies, but we focus on the ecology level; therefore, different items need to be developed.

Finally, interorganizational relationship and network literature offers an idea about which activities bind together functional activities identified in innovation management literature, though not always in the context of innovations (e.g., Heikkinen et al., 2007; Knight and Harland, 2005). This research mostly defines activities in terms of roles, such that it investigates a specific role set or individual roles (e.g., Gemünden et al., 2007; Gupta et al., 2006; Sim et al., 2007; Story et al., 2011; Tushman, 1977). For example, Sim et al. (2007) consider differences among inventors, champions, implementers, and innovators in innovation processes. Gupta et al. (2006) describe multiple champion roles in new ventures, and Gemünden et al. (2007) study the influence of champions, promoters, and gatekeepers in highly innovative ventures. Furthermore, Story et al. (2011) define two role categories, task-oriented and network-oriented, and analyze how the relevant roles (e.g., articulating, developing, connecting) support the development of different competences.

Using all three streams of literature, we explain the likely influence of four activity sets for innovation in multi-organizational ecologies on innovation performance. Our consideration of activity sets is in line with prior literature, which tends to categorize by functions (e.g., hard vs. soft) or roles (e.g., task- vs. network-oriented). Following innovation management literature, we conceptualize performance as the extent to which an innovation succeeds in financial, market, and technical terms (Cooper and Kleinschmidt, 1987; Griffin and Page, 1993; Hart, 1993).

4.2.2 Hypotheses

Strategic predevelopment activities

The first activity set, strategic predevelopment, takes place before the innovation has been developed. This strategic effort pertains mostly to seeking direction for the project. In a multi-organizational ecology, several actors work together on the innovation, each of whom brings its specific resources to the table. Therefore, this activity set has particular importance in this context. To achieve an optimal combination of resources, it is necessary to conduct a strategic analysis of what can be done with the various resources available. The result often determines the strategy to follow for the rest of the innovation process. Two activities are part of this activity set: identifying opportunities and integrating innovative technologies.

First, by *identifying opportunities*, the actors define the project by appraising the needs that the innovation might satisfy and making decisions about which markets to enter. In multi-organizational ecology settings, the market opportunities must be matched with the resources that various actors possess (Crawford and di Benedetto, 2000; Urban and Hauser, 1993).

Second, *integrating innovative technologies* means that the actors combine the different technologies that various actors posses to develop the innovation. Generally, the emergence of a new technology is a period of confusion; there are many ways to combine product subsystems (Henderson and Clark, 1990). In the context of complex innovations undertaken in multi-organizational ecologies, new knowledge might be created by combining separate technologies into new configurations (Dougherty and Dunne, 2011). Therefore, complex innovation projects often start with thinking about how the different actors can best combine their different technologies.

Strategic predevelopment activities can be a major driver of innovation performance (Cooper, 1988). They are important to undertake because projects should not move directly from idea generation to large-scale development (Cooper, 1999). Considering the nature of complex innovations, strategic predevelopment likely has an even greater impact in this context. We hypothesize:

H1 *Strategic predevelopment activities have a positive influence on performance in the context of complex innovations.*

Engineering activities

Engineering activities focus on building the actual innovation (Heikkinen et al., 2007). This activity set therefore lies at the heart of innovation and is important in any innovation project, not just complex ones. Designing and developing lead to a real innovation that can be launched and promoted. We distinguish two engineering activities, with some overlap because they go hand in hand: designing the innovation and developing the innovation.

Designing the innovation focuses on a determination of the likely functions and characteristics of a concept product (Kotler and Rath, 1984). It thus involves the evaluation and refinement of ideas for producing a product, whose attributes indicate a high potential for market success (Urban and Hauser, 1993). The design process should lead to a product or service concept that can be developed further in the next step (Urban and Hauser, 1993). Some design processes do not lead to a concept but to a blueprint. In complex innovations with elaborate systems architecture, designing the blueprint often precedes development.

The second activity, *developing the innovation*, focuses on the actual building of the innovation. If the design or blueprint is satisfactory, innovation construction begins (Song and Montoya-Weiss, 1998) and turns the concept into a functioning product or service by not only constructing the innovation but also confirming its necessary processes (Story et al., 2011). Because engineering activities are necessary to create an innovation (Belderbos et al., 2010; Ernst, 2001), we hypothesize:

H2 *Engineering activities have a positive influence on performance in the context of complex innovations.*

Commercialization activities

Commercialization activities aim to market the innovation and support its introduction. This activity set has particular importance in a multi-organizational ecology setting, where not only must potential customers adopt the new product, but it also other parties need to be convinced that the innovation is worth supporting. That is, multiple stakeholders determine the success or failure of a new product (Humphreys, 2010). For example, in the case of sustainable housing, the builder must win over not only customers, but also providers of technologies, real estate developers, and policy makers. Four activities constitute this activity set: launching, promoting, brokering, and legitimizing the innovation.

The *launching* activity reflects the implementation of the innovation on the market. The firm must determine how to enter the market, using which marketing strategy (Hekkert et al., 2007; Henard and Szymanski, 2001; Jacobsson et al., 2004; Urban and Hauser, 1993). In multi-organizational ecologies, launching entails deciding which actors will lead the introduction, which market to enter first, and who constitute pivotal stakeholders in that market. Launching overlaps with promoting the innovation, as its strategic precursor, and is thus more strategic than promoting.

Second, *promoting the innovation* refers to making people aware of the innovation and influencing their adoption behavior accordingly (Rogers, 2003; Rogers et al., 1993). This activity focuses on the marketplace and should encourage new product trials (Story et al., 2011), but in a multi-organizational ecology context, it also must spread to promoting in the entire network around the innovation. For example, actors might influence wider acceptance of an innovation by stressing its strategic importance (Gupta et al., 2006). Such actors often are champions, that is, "parties that informally emerge to actively and enthusiastically promote innovations" (Howell et al., 2005, p. 642).

The third activity, *brokering*, focuses on connecting with new parties that are important for the success of the innovation, such as opinion leaders in the market. In the context of complex innovations developed in a multi-organizational ecology, cooperation with additional partners is often necessary, and brokers can play an essential role by introducing new partners that cooperatively attain better innovation performance (Gemünden et al., 2007). This activity highlights new relationships, such as building new linkages among previously unconnected parties (Bessant and Rush, 1995; Gupta et al., 2006; Jacobsson et al., 2004; Kirkels and Duysters, 2010; Story et al., 2011). For example, so-called network champions introduce new relationships when parties at multiple levels must interact to adopt the innovation (Woodside, 1994).

Finally, *legitimizing the innovation* involves lobbying for its approval in the eyes of other parties (Garud et al., 2002; Hekkert et al., 2007; Suchman, 1995). Actors performing this activity leverage their personal and professional relationships and use their own professional judgment to signal the trustworthiness of the innovation (Story et al., 2011). Actors with the power to drive the project and help overcome obstacles that might arise thus can legitimize the project for others (Gemünden et al., 2007). Especially in emerging or very innovative industries, some parties may be hesitant to adopt innovations; the lack of legitimacy leaves them not knowing what to expect (Rao et al., 2008). To gain legitimacy, the innovation might rely on associations or cooperations with well-reputed, established entities. In our context of complex innovations, legitimizing can be particularly crucial, because of the uncertainty that actors have about accepting an innovation created by other actors. Because commercialization activities are important for innovation performance (Henard and Szymanski, 2001; Langerak et al., 2004), especially considering the nature of complex innovations, we hypothesize:

H3 *Commercialization activities have a positive influence on performance in the context of complex innovations.*

Project management activities

Project management activities are communications aimed at harmonizing exchanges among project participants. Project management activities span the other activity sets, in that they are needed to execute all other activities satisfactorily. They are very relevant in multi-organizational ecologies where several actors with diverging backgrounds and interests work together to innovate. This activity set also can simplify the exchange and facilitate cooperation in networks with many different actors (Edquist and Johnson, 1997; Heikkinen et al., 2007). Three activities fall within this activity set: task coordinating, communicating with project participants, and communicating with external participants.

Task coordinating involves the management of task-related exchanges across multiple participants. Especially in multi-organizational ecologies, this activity is important, because many participants need to be informed about the tasks to complete. Because multiple participants are part of the project and tasks may be highly interrelated, task coordination is a vital element (Belbin, 1993; Galli and Teubal, 1997; Senior, 1997).

Communicating with project participants refers to nonfunctional communication, aimed at creating an atmosphere of solidarity in the network to overcome tension or conflict (Belbin, 1993). It goes beyond communication about the tasks that need to be executed and involves frequent, high-quality contacts. Because innovation processes generally result from communication and information exchanges (Utterback, 1971; Rochford and Rudelius, 1992), communication quality is important. In multi-organizational ecologies this activity may be especially relevant to create an esprit de corps within the project team.

Finally, in *communicating with external participants,* dyadic communication takes place between a project participant and an external participant. This activity has two goals: First, the two sides should discuss which tasks to complete, such that their communication has a task-related aspect, and second, the regular contact with external participants is important for the progress and success of the innovation. In multi-organizational ecologies especially, more tasks must be coordinated externally, and external participants need to feel like a part of the innovation process.

The multitude of actors in multi-organizational ecologies also likely makes project management activities highly important for innovation performance (Dougherty and Dunne, 2011). Therefore, we hypothesize:

H4 *Project management activities have a positive influence on performance in the context of complex innovations.*

4.3 Methods

4.3.1 Empirical context

This study uses the sustainable energy sector as its empirical context, because it offers a natural biotope for studying complex innovations (Dougherty and Dunne, 2011). The ongoing transition to sustainable energy involves a broad variety of actors, with widely varying interests, that must participate to address the complexity in this field (Cuppen, 2012). We concentrate on projects funded by the Energy Transition and Innovation Programs of the Ministry of Economic Affairs, Agriculture and Innovation in the Netherlands, whose goal is to establish a sustainable energy supply in the long term through structural changes. The main focus of the program is to support projects that bring together multiple parties, bundle their resources, and thereby induce structural changes to achieve sustainable energy supply by 2050. Thus, this context can serve as an exemplar to better understand innovation activities in multi-organizational ecologies.

Examples of innovation projects within the Energy Transition and Innovation Programs include the development of a new bioplastic, the development of an energy-efficient truck for inner-city transportation (with a hydrogen fuel cell and a wheel motor), and the construction of a sustainable residential area (involving the replacement of old apartments by new apartments with closed energy loops and sustainable energy sources). Innovation projects span seven subsectors: sustainable mobility, green raw materials, chain efficiency, alternative gas, sustainable electricity, built environment, and greenhouses as energy supplier.

4.3.2 Data

We obtained data from two sources. First, we used archival data to identify and describe projects, according to the project files kept by the government agency administering the Energy Transition Program. These project files contained the grant applications, all interim reports on the project, and various supporting documents. From these files, we identified 189 projects and all the actors mentioned as participants. An expert from the government agency then assessed each project to distinguish the project leader, internal participants, and external participants. Project leaders were the grant applicants; internal participants were co-applicants of the formal grant application. External participants were not part of the formal grant application, but were mentioned as relevant actors in the project file. The difference between internal and external participants was made clear for the respondents. The same expert helped us code background information about the innovation projects, such as its subsector, as we show in Table 4.1.

Table 4.1: Sample profile by subsector

Subsector	*Frequency*	*Percentage*
Built environment	51	42.5
New gas	17	14.2
Chain efficiency	15	12.5
Sustainable mobility	11	9.2
Greenhouse as energy supplier	11	9.2
Sustainable electricity	6	5.0
Green raw materials	9	7.5
Total	120	100.0

Second, a telephone survey was employed to ask project leaders which activities have been present in the innovation projects, to what extent the project participants fulfilled a particular activity, and how they perceived the projects' performance. This survey was part of a larger research project and featured the questions that were relevant for this study.

Prior to the survey, the leaders of the 189 projects received a letter from the government agency administering the grants, requesting their participation. Of the 189 project leaders, 122 agreed to participate in the telephone survey, for a response rate of 65%. Two projects were deleted because of the high number of missing values, yielding a sample of 120 projects, which ranged in size from 2 to 39 actors, with a mean value of 7.

4.3.3 Measures

The measures in the survey included activities and innovation performance. Activity sets were operationalized using 11 items, grouped into four constructs, according to the activity sets that we identified in the theory section (see Table 4.2). Each activity was measured by a Likert-type scale that respondents used to rate the following statement: "In this project, a lot of attention has been paid to [activity]" (1 = "strongly disagree," and 5 = "strongly agree"). The input for the questionnaire was based on a combination of new product development, innovation systems, inter-organizational relationships and networks literature. Discussions and pretests among experts of the field ensured that respondents understood the description of the activities (e.g. identifying the opportunity, integrating innovative technologies) well. The items were chosen so that respondents could easily relate to them and understand them well, and were kept as succinct as possible to be suited for use in a telephone survey. The items for the activity sets appear in Table 4.2.

Since we had no access to a more objective performance measure, such as revenues gained, we measured performance based on five items derived from the literature (see Table 4.2), including technical success, market success, financial success, competitive advantage, and cost reduction (Cooper and Kleinschmidt, 1987; Griffin and Page, 1993; Hart, 1993). Because the innovations in our sample aimed to stimulate a system change toward more sustainability, we developed a sixth item to capture this performance aspect: "This project contributes to a sustainable society." In line with the aim of the projects in the dataset this is a relevant performance measure. All six items are weighted equally to compute the dependent variable innovation performance, thus representing an overall measure for innovation performance.

We included several control variables in the analyses: the sector to which the innovation belonged, investments made in the project (in Euro), project duration (in years), the size in terms of project participants, the type of grant (i.e., first trial development of an innovation or broader implementation of an existing innovation), and whether the project was being led by a small or medium-sized enterprise (SME). We gathered these data from archival project files.

4.3.4 Discriminant validity

To establish the discriminant validity of the measurements for the four activity sets, we estimated alternative measurement models using confirmatory factor analysis (CFA). CFA is a method to estimate and subsequently fit a theory-driven model for the relationships between observed measurements and latent variables or factors (Hair et al., 1998). As alternative, theoretically plausible operationalizations of activity sets, we also specified several measurement models (see Table 4.3). Model 1 includes all eleven activity measures into one dimension, such that the four activity sets would not be distinguished at all. Model 2 divides the activities into hard and soft sets (Galli and Teubal, 1997), so the eight strategic predevelopment, engineering, and commercialization activities are hard innovation activities, whereas the three project management activities are the soft ones. Model 3 distinguishes task-oriented from network-oriented activities (Story et al., 2011): The four strategic predevelopment and engineering activities are task-oriented, whereas the seven project management and commercialization activities are network-oriented. Models 4 and 5 are three-factorial variants of Model 3. In Model 4, all seven commercialization and project management activities merge into one construct (network-oriented activities), and the remaining two activity sets are as proposed in our theoretical framework. In Model 5, the four engineering and strategic predevelopment activities represent a single construct (task-oriented activities), leaving the remaining two activity sets as we proposed.

However, none of these alternative models receives support from our CFA. As we show in Table 3, the χ^2 differences between each alternative model and the hypothesized model are all significant at $p < .005$, suggesting that the hypothesized model, which operationalizes activities in four activity sets, is psychometrically superior to all alternative models. Furthermore, the hypothesized model represents the data well, with a χ^2 that does not differ significantly from 0 ($\chi^2 = 49.386$, $p = .102$), a good confirmatory fit index (CFI = .968; Bentler, 1990), and a satisfactory root mean square error of approximation (RMSEA = .050). The CFA results thus indicate that the hypothesized model with four separate activity sets best represents the data.

Another method for assessing discriminant validity is to test whether each of the correlations for all pairs of constructs is significantly different from 1 (Anderson and Gerbing, 1988). All correlation estimates across the four activity sets in the hypothesized model differ significantly from 1 ($p < .005$), again demonstrating the sufficient discriminant validity across all four activity sets.

Table 4.2: Measurement items, loadings, Cronbach's alphas, and item correlations

Construct and items	*Cronbach's alpha*	*Standardized loading CFA*	*Item-to-total correlation*
Strategic predevelopment	.666		
A lot of attention has been paid to identifying the opportunity.		.695	.863**
A lot of attention has been paid to integrating the innovative technologies.		.718	.868**
Engineering	.752		
A lot of attention has been paid to designing the innovation.		.634	.894**
A lot of attention has been paid to developing the innovation.		.951	.897**
Commercialization	.773		
A lot of attention has been paid to launching.		.652	.789**
A lot of attention has been paid to promoting the innovation.		.797	.811**
A lot of attention has been paid to brokering.		.671	.740**
Project management	.711		
A lot of attention has been paid to task coordinating.		.582	.773**
A lot of attention has been paid to communicating with project participants.		.604	.789**
A lot of attention has been paid to communicating with external participants.		.809	.829**
A lot of attention has been paid to legitimizing the project.		.604	.750**
Innovation performance	.747		
The innovation is a technical success.		.620	.643**
The innovation has a high market acceptance.		.466	.719**
This innovation yields a great competitive advantage.		.557	.765**
The project results into a profitable innovation.		.570	.744**
The project leads to cost reductions		.603	.716**
The project contributes to a sustainable society.		.604	.627**

** Significant at $p < .01$ (two-tailed).

Table 4.3: Confirmatory factor analyses activity sets

Model	χ^2	*df*	*p*	*CFI*	*RMSEA*
1. One factor (all activities)	135.573*	44	.000	.745	.132
2. Two factors (hard activities, soft activities)	118.691*	43	.000	.789	.122
3. Two factors (task-oriented activities, network-oriented activities)	101.980*	43	.000	.836	.107
4. Three factors (network-oriented activities, strategic predevelopment, engineering)	65.372*	41	.009	.932	.071
5. Three factors (task-oriented activities, project management, commercialization)	87.381*	42	.000	.874	.095
6. Hypothesized model (strategic predevelopment, engineering, project management, commercialization)	49.386	38	.102	.968	.050

* The χ^2 difference with the hypothesized model is significant at $p < .005$.

4.3.5 Reliability and convergent validity

To assess reliability, we calculated Cronbach's alphas. These values for the four activity constructs and one performance construct (see Table 2) reveal four alpha coefficients greater than .7, which indicates satisfactory reliability (Nunnally, 1978). The alpha coefficient for strategic predevelopment is close to the .7 level, which is acceptable, considering the exploratory nature of this study (Hair et al., 1998).

Furthermore, convergent validity was assessed by examining the item-to-total correlations and by performing CFAs on the activity and innovation performance measures. In Table 2 we present the item-to-total correlations between the individual items and their respective constructs. All item-to-total correlations for the activity constructs are significant ($p < .01$) and range between .740 and .897. Furthermore, the standardized factor loadings from the CFA should be .5 or higher (Hair et al., 1998), as is the case for all items in the activity sets. The convergent validity for the activity sets is thus satisfactory.

For the dependent variable, innovation performance, one performance construct emerged from the CFA ($\chi^2 = 10.242$, df 7, $p = .175$, CFI = .979, RMSEA = .062). The factor loadings are greater than .5, with the exception of the market acceptance item, which is close to .5. We thus retained it for theoretical reasons. The correlations for all items of innovation performance are significant ($p < .01$) and range between .627 and .765.

4.3.6 Common method variance

In this study the independent and the dependent variable were measured by the same rater. Therefore, we examined the potential for our results to be explained by common method variance. We have checked for common method variance with Harmans single factor test (Podsakoff and Organ, 1986; Jarvenpaa and Majchrzak, 2008). Common method variance implies that variance in observed scores can be partially attributed to a methods effect. We performed a Harmans single factor test by entering all the measures in the study into an exploratory factor analysis and restricting the analysis to the emergence of one factor only. The results show that 16.755% of the variance is explained by a single factor, indicating that common method variance is an unlikely explanation for our results.

4.4 Results

4.4.1 Prevalence of the activity sets

First, we explore the prevalence of the activity sets to study their salience, by calculating mean scores for each construct representing an activity set. Table 4.4 shows descriptive statistics alongside with correlations between the constructs in the study. The results show that all activity sets are to some degree executed in the innovation projects. The mean scores for the activity set constructs reveal that project management and commercialization activities are the least prevalent, with means of 3.86 and 3.72, respectively. In contrast, strategic predevelopment and engineering activities are executed to a greater extent (4.27 and 4.34, respectively). The differences in means between strategic predevelopment and engineering on the one hand and commercialization and project management on the other hand are significant (strategic predevelopment – commercialization: $t = 6.274$, $p = .000$; strategic predevelopment – project management: $t = 4.565$, $p = .000$; engineering – commercialization: $t = 6.470$, $p = .000$; engineering – project management: $t = 5.010$, $p = .000$).

Table 4.4: Correlations and descriptive statistics for activity sets and innovation performance

Construct	*Mean*	*Standard deviation*	*Strategic predevelopment*	*Engineering*	*Commercializ*
Strategic predevelopment	4.27[a]	.820	1		
Engineering	4.34[b]	.786	.300**	1	
Commercialization	3.72	.912	.394**	.256**	1
Project management	3.86	.854	.310**	.196*	.565**
Performance	4.02	.709	.353**	.238**	.335**

** Significant at $p < .01$ (two-tailed). *Significant at $p < .05$ (two-tailed).

[a] The mean of strategic predevelopment activities is significantly greater than the means of commercialization and project manage

[b] The mean of engineering activities is significantly greater than the means of commercialization and project management activiti

4.4.2 Estimated model

To test our hypotheses, we summed the multiple indicators for each construct, then used the resulting summated score to represent that construct in a simultaneous equation model, as has been recommended for small samples (Hu and Bentler, 1995; cf. Li and Calantone, 1998). We included activity sets as antecedents, as well as six control variables. We also tested for interaction effects between the activity sets and between the activity sets and the control variables, but we found no significant effects on the dependent variable. Therefore we do not take them into consideration in the final model. The R-square value is .261 for the whole model. Considering that it included only activity sets and several control variables, the model fits the data well, as we detail in Table 4.5.

Strategic predevelopment activities (.226, p = .024) and commercialization activities (.267, p = .019) have positive, significant influences on innovation performance, in support of H1 and H3, respectively. Engineering and project management activities do not have significant effects on innovation performance though, so we must reject both H2 and H4.

As we show in Table 4.5, the control variables have no significant effect on innovation performance, with the exceptions of the SME and project duration variables. Specifically, SME has a marginally significant (10% level) positive effect on innovation performance, suggesting that projects with small project initiators (fewer than 250 employees) might perform better than projects with large project initiators. Maybe small companies are more eager to do their best for the project, because they depend much more on its success. Project duration also has a marginally significant, positive influence on innovation performance: projects that take more time exhibit greater innovation performance. This could indicate that a certain amount of time is needed to ensure that projects succeed.

Table 4.5: Effects on innovation performance (OLS results)

	B	*Standard error*	*Std. Beta*	*T*	*p*
Activity sets					
Strategic predevelopment	.180	.078	.226	2.289	.024
Engineering	.050	.080	.060	.625	.533
Commercialization	.191	.080	.267	2.385	.019
Project management	-.008	.083	-.011	-.099	.922
Control variables					
Subsector[a]					
New gas	-.069	.189	-.037	-.366	.715
Greenhouse as energy supplier	-.005	.215	-.002	-.021	.983
Chain efficiency	-.043	.195	-.021	-.222	.825
Sustainable electricity	-.030	.260	-.011	-.115	.909
Green raw materials	.205	.238	.083	.859	.392
Sustainable mobility	.196	.212	.087	.925	.357
Project investments	.000	.000	.088	.916	.362
Project duration in years	.087	.047	.174	1.832	.070
Project size in participants	-.004	.015	-.029	-.297	.767
Grant type[b]	-.164	.147	-.122	-1.113	.268
SME[c]	.264	.135	.202	1.961	.053

$R^2 = .261$, n = 120

[a] Dummy variables, with built environment as the reference category.
[b] Dummy variable, 0 indicates trial development of the innovation, 1 is implementation of the innovation.
[c] Dummy variable, 0 indicates ≥ 250 employees, 1 indicates < 250 employees.

4.5 Discussion

Our findings show that strategic predevelopment activities (H1) have a positive influence on innovation performance. This result is in line with findings in traditional NPD literature (Cooper, 1988; Cooper and Kleinschmidt, 1986; Henard and Szymanski, 2001) that suggest that market studies and preliminary market- and technical assessments are crucial activities for the success of new products. Our results thus suggest that strategic predevelopment activities are also important in a multi-organizational ecology context. On average, the projects in our study score high on strategic predevelopment activities, which suggests that project participants are aware that such activities are important.

Our results also show that commercialization has a positive impact on innovation performance, in line with prior NPD research (Cooper, 1988; Hultink et al., 1997; Langerak et al., 2004) that suggests a strong market launch is a distinguishing characteristic of successful innovation projects. The findings also suggest that commercialization activities are generally underrepresented, as indicated by a relatively low mean. Apparently, room for improvement remains in many projects.

Engineering activities do not have a significant influence on innovation performance though, which seem to contradict prior research that states that technological activities represent the core of value creation and contribute substantially to performance (Belderbos et al., 2010; Ernst, 2001; Narin et al., 1987). Engineering activities do not explain differences in performance. We do not mean to suggest that engineering activities are unimportant; rather, the insignificant effect of engineering activities may indicate that organizations are very well aware of their importance, as implied by the high mean for engineering activities, suggesting that, on average, projects put a lot of effort into these activities. Thus engineering activities are a hygiene factor, which most projects understand and therefore ensure a sufficient level of engineering activities.

Finally, we find no significant influence of project management activities on innovation performance. This result is remarkable; especially in multi-organizational ecologies we would expect projects to be in need of strong project management activities. Previous studies have suggested that many organizations struggle with proper project management (Ethiraj and Levinthal, 2004; Granstrand and Sjölander, 1990). We offer two possible explanations for not finding any significant influence of project management activities on innovation performance. First, the projects in our sample were fairly small in terms of the number of participants, so perhaps project management was comparatively easy to undertake. Second, the projects in our study were all funded by an agency that required significant, detailed information about how the project would be managed in the grant application. The population for our sample thus may have created some bias toward projects that perform well with regard to project management. Both explanations suggest that, even if the mean project management score is not extremely high, our sample may be characterized by sufficient project management activities, explaining why project management has no significant effect in our study.

4.6 Conclusions

With this study, we offer a new perspective on the study of complex innovations in a multi-organizational ecology context by focusing on activities at the innovation project level. In doing so, our study contributes to three streams of literature.

First, it expands interorganizational network literature by focusing on activities. Previous studies have noted complex innovation with multiple actors (Adner and Kapoor, 2010; Newell et al., 2008; Wilkinson and Young, 2002), but usually with a focus on relationships between various actors, rather than the activities that these actors undertake and the impact of such activities on performance. Our study results show that focusing on activities may be a useful approach for understanding complex innovation. After all, the behaviors of actors make things happen and thus ultimately result in innovation performance. This study offers a rationale for a more behavioral approach in the study of multi-organizational ecologies.

Second, we contribute to traditional NPD literature that has investigated critical activities for successful NPD (e.g., Cooper, 1990; Henard and Szymanski, 2001; Song and Montoya-Weiss, 1998; Tzokas et al., 2004). While this stream of literature has mostly focused on NPD in single organizations, our study shows that it is possible to translate such activities to a context of complex innovations involving multiple actors. This issue is not trivial: at first sight, the activity sets we have proposed (strategic predevelopment, engineering, project management and commercialization) may seem to resemble findings from prior NPD studies, but the meaning of the activity sets actually differs for the context of complex innovations undertaken in multi-organizational ecologies. For example, commercializing complex innovations entails brokering and legitimizing, which demands more attention to a broader set of stakeholders who must be convinced about the value of the innovation. Similarly, complex innovation projects must integrate techniques from a diverse set of actors, and the actors must critically assess these technologies (and their combination) before embarking on the project. Traditional NPD literature has devoted little emphasis to project management activities, but in the context of complex innovations involving multiple actors, both inside and outside the project team, this activity set is a relevant addition. Only the engineering activities appear relatively similar to what we already know from NPD literature.

Third, this study contributes to literature on innovation systems by offering a project-level perspective of innovation in systems and proposing a typology of activities undertaken in innovation projects. While prior research has suggested typologies as well (e.g., Hekkert et al., 2007), these typologies are mostly theoretical or qualitative in nature, and do not focus on the project level. Whereas innovation system literature has contributed substantially to our understanding of how technologies evolve at the aggregate level, it has tended to ignore the activities that take place at the project level. Therefore, our study provides a first step to complement innovation system literature by offering an approach to study activities at the project level. This is important because system change (the dependent variable in many innovation system studies) requires individual projects to succeed. In other words, system change is based on grass-root initiatives. While system change certainly is more than just adding up individual projects in the relevant system, our approach provides a good basis for understanding complex innovations at the project level and thus a new cornerstone for understanding system change.

4.7 Implications for practice

Our study provides useful insights into the determinants of innovation success, which is important for both managers and policy makers. It may help managers understand how to influence innovation performance, i.e. which activities to undertake. Similarly, policy makers can use the insights of this study to better understand which projects are most likely to benefit system change, which can be especially helpful for evaluating grant applications. For example, granting institutions might want to require applicants to include detailed activity plans, because it will help them derive a better estimate of the project's chance for success.

4.8 Limitations and further research

Our study suffers from some limitations, some of which are due to the sample and others which have their roots in the questionnaire administration. Our study also offers opportunities for further research, some of which result from the status of our study as a first step toward a new perspective on complex innovations.

First of all, we note that our study involves a relatively small sample from one sector in one country. This raises the question to which extent the findings are generalizable to other settings, for example to larger innovation projects. For example, it can be imagined that larger (implying more heterogeneous) projects would require more project management activities because task coordination is more complex. It could also be the case that there is more need for strategic predevelopment activities in larger projects, because the market opportunities have to be matched with a wider set of actors.

Second, the innovation projects that we have investigated are funded by the government. This means that our sample may be biased toward relatively successful projects, in that it featured only projects that had been judged as good enough for a subsidy. As we noted before, detailed information about how the project would be managed was required in the grant application which might for example have created some bias towards projects that perform well with regard to project management. This leads to the question to what extent the findings can be generalized to non-funded projects or projects that are not that successful. For example, it might be the case that projects that are not subsidized have a higher need for project management activities in order to be successful. Further research should investigate the extent to which the findings generalize to other industries, other countries, larger innovation projects, and non-funded projects, preferably using larger sample sizes.

Third, our study has two other shortcomings which are due to the set-up and design of the study and the constraints in the administration of the questionnaire. As this study was part of a larger research project, we were dependent on external parties and not free in the design and administration of the questionnaire. That is why the dependent and the independent variable are measured by the same respondent which might lead to problems. We have checked for common method variance with Harmans single factor test and the results showed that common method variance was not an issue. Nevertheless, we suggest that further research should include different respondents for measuring the variables. Furthermore, the study relies on a subjective performance measure; therefore, it might be a good idea to include an objective performance measure, such as revenues generated.

Fourth, due to the reasons described under point three, we were not able to include a quality criterion in the questionnaire, i.e. we did ask to what extent a specific activity had been undertaken, but we did not take into account if the quality of the activity undertaken was good or bad. One might argue that it does not say much if for example strategic predevelopment activities have been undertaken to a high extent, but it is unknown if these activities were undertaken well. Nevertheless, in the scope of this exploratory research in which the aim was inventory and to make a typology of the activities that are fulfilled in a multi-organizational context, it offers insights into which activity sets are undertaken at all. An idea for further research is to include the quality of the activities undertaken, and to see if this leads to different results. For example, one might ask 'In this project, [activity] has been undertaken at a high quality level'.

Our study may be extended in several interesting ways. For example, we did not consider how the impacts of the various activity sets change over the course of an innovation project, which would require a longitudinal approach. Another interesting avenue for further research would be to focus on combinations or configurations of activity sets, rather than the effect of individual sets. Such an investigation likely would provide more insight into the relative distribution of required activity sets, though it would require a larger sample size than we used. Such a study could investigate the distribution of the activity sets over various actors, that is, who should be doing what? Prior research (Barrick et al., 1998; Biddle, 1979) indicates that an actor's activities should be congruent with its resources (e.g., skills, competences). An extension of our proposed model thus could include resources. Another extension might add moderators (e.g., innovation radicalness) to determine whether the impact of activity sets differs by type of innovation. Thus, we present a preliminary approach to a project-based perspective on complex innovations; we hope it sparks further research in this area.

CHAPTER 5

Conclusions

In this chapter, we conclude this dissertation by presenting a synopsis. Subsequently, we discuss the main findings and theoretical and managerial contributions of the three studies. Furthermore, we describe the broader implications of this dissertation. We end with a reflection, limitations and some interesting avenues for further research.

5.1 Synopsis

The overall aim of this dissertation was to enhance our understanding of innovations undertaken in multi-organizational ecologies. In this dissertation three distinct topics on multi-organizational innovation ecologies were presented. The presented papers elaborated on the following issues.

First of all, in order to explain how a diverse set of actors contributes to innovation performance, the resources of the actors need to be taken into account together with the roles they fulfill. The first study provided an overall framework, helping to understand how multiple actors contribute to innovation performance by introducing roles as a link between resources and innovation performance. The essence of this study is that specific roles need to be fulfilled in the right combination in order to guarantee innovation performance.

Then, in Chapter 3, an explorative study is presented which analyzes one specific activity undertaken in innovation networks, namely network governance. The reason for analyzing network governance in more detail is that in situations where several heterogeneous actors together create and develop an innovation, special attention needs to be devoted to governing the innovation project. This study identifies a specific behavioral taxonomy of three distinct modes of network governance: basically coordinated, control-oriented and reward-oriented.

Finally, in Chapter 4 we investigate several activities and analyze their prevalence and their effect on innovation performance. This study presents a typology of activities that are fulfilled in multi-organizational ecologies.

5.1.1 Behavioral perspective

In this dissertation three essays were presented that share the same perspective. They apply a behavioral approach to the study of innovation in multi-organizational ecologies. Incorporating a behavioral approach adds a new perspective to the study of innovations in multi-organizational ecologies because prior research has mostly focused on the relationships between the various actors (Adner and Kapoor, 2010; Newell et al., 2008; Wilkinson and Young, 2002).

A behavioral approach is relevant to apply in our setting, because in compliance with the dissertation's goal of finding out how actors can influence innovation in a multi-organizational ecology, we need to focus on something that has an impact on an outcome, such as behavior. Behavior is likely to explain more variation in innovation performance than for example the relationships between the actors or the structure of the multi-organizational ecology. That means that by applying a behavioral perspective, the actual influence on innovation undertaken in multi-organizational ecologies can be predicted. Ultimately it is the behavior of actors that makes things happen, i.e. the behavior that is fulfilled in the multi-organizational ecology has an impact on the innovation. A behavioral perspective is thus useful for understanding innovation and innovation performance.

5.1.2 Findings

The first study provides an overall framework, helping to understand how multiple actors contribute to innovation performance by introducing roles as a link between resources and innovation performance. Based on role theory and the resource-based view the framework introduces two principles: *resource-role matching* to explain the relationship between resources and roles at the organizational level and *role optimization* to explain the relationship between the role configuration and innovation performance at the ecology level. *Resource-role matching* occurs when an actor fulfills a role congruent with the resources that the actor possesses. The principle *role optimization* stipulates that there is an optimal role configuration that can be achieved when individual roles are combined.

The second study analyzes what network governance in innovation networks entails. Three distinct modes of network governance are identified: basically coordinated, control-oriented, and reward-oriented. Basically coordinated networks rely on a combination of basic mechanisms, but no other behavioral mechanisms. Control-oriented networks focus on control and the prevention of opportunistic behaviour. They add a combination of control mechanisms to the basic mechanisms, but refrain from using reward mechanisms. Reward-oriented networks focus on motivation and an atmosphere of solidarity by using a combination of behavioral reward mechanisms, while control mechanisms are absent.

The third study presents a typology of activities that are fulfilled in multi-organizational ecologies and analyzes the differential effect of these activity sets on performance. We take a new perspective on the study of complex innovations in a multi-organizational ecology context by focusing on activities at the innovation project level. The results show that both strategic predevelopment and commercialization activities have significant and positive effects on innovation performance, whereas engineering and project management do not. These results are in line with findings in traditional NPD literature (Cooper, 1988; Henard and Szymanski, 2001; Hultink et al., 1997; Langerak et al., 2004) that suggest that market studies, preliminary market- and technical assessments and a strong market launch are crucial activities for the success of new products. Our results thus suggest that strategic predevelopment and commercialization activities are also important in a multi-organizational ecology context.

Together, these three studies enhance our understanding of innovations undertaken in multi-organizational ecologies. We gained an understanding of how innovation performance can be realized, how the diverse set of actors can be managed, and which activities are important to fulfill.

5.2 Implications

5.2.1 Theoretical implications

This dissertation contributes to the literature in several ways. The first study makes two main contributions. First, we add to literature on multi-organizational ecologies by presenting a framework explaining how actors influence innovation performance through combining their resources. Literature on multi-organizational ecologies has not yet explained how multiple actors combine their resources to contribute to innovation performance. This paper aims to fill this gap by presenting a framework based on the RBV and role theory. Furthermore, we add by presenting two underlying principles that have not been identified in the literature before: *resource-role matching* to explain the relationship between resources and roles; and *role optimization* to explain the relationship between the role configuration and innovation performance.

Second, by introducing a multilevel framework, we link the ecology level and the organizational level. In the context of the present study this means that resources are combined at the organizational level which leads to the deployment of specific resources, i.e. roles, and ultimately the role configuration at the ecology level. In so doing, the gap between the micro level and the macro level can be bridged leading to a better and more complete understanding of how a diverse set of actors contributes to innovation performance.

The second study contributes to literature in two ways. First, it contributes to the network governance literature by presenting a taxonomy grounded in the behavior of actors. By using a behavioral approach, our conceptualization of network governance details how networks are governed. This closes the gap in prior research which has mostly addressed network characteristics (e.g., Gulati, 1995; Poppo and Zenger, 2002; Provan and Kenis, 2007). To the best of our knowledge, our study is one of the first to investigate network governance empirically and systematically to unravel the behavioral mechanisms that are used to manage networks. In so doing, our study provides guidance for future research by presenting a set of behavioral mechanisms. Second, this study contributes to existing literature by suggesting that network governance is viewed as combinations of behavioral mechanisms that can be applied to manage a network. We extend literature on network governance, which has addressed behavioral mechanisms mostly separately (e.g., Grandori, 1997; Grandori and Soda, 1995; Gulati and Singh, 1998; Jones et al., 1997; Park, 1996). Our study redirects research on network governance and advances understanding of the configurative pattern of behavioral mechanisms. The taxonomy provides a tool for a systematic comparison of alternative modes of network governance and offers a basis for further elaborations.

The third study contributes to several streams of literature. First, it expands interorganizational network literature by focusing on activities. Previous studies have mostly focused on relationships between various actors, rather than on the activities that these actors undertake and the impact of such activities on performance (Adner and Kapoor, 2010; Newell et al., 2008; Wilkinson and Young, 2002). This study offers a rationale for a more behavioral approach in the study of multi-organizational ecologies as our results show that focusing on activities may be a useful approach for understanding complex innovation.

Second, we contribute to traditional NPD literature that has investigated critical activities for successful NPD (e.g., Cooper, 1990; Henard and Szymanski, 2001; Song and Montoya-Weiss, 1998; Tzokas et al., 2004). We show that it is possible to translate such activities to a multi-organizational ecology context. Furthermore, we add project management activities which is relevant in the context of complex innovation involving multiple actors.

Third, this study contributes to literature on innovation systems by offering a project-level perspective on innovation in systems and proposing a typology of activities undertaken in innovation projects. Whereas innovation system literature has contributed to our understanding of how innovations evolve at the aggregate level, it has tended to ignore the activities that take place at the project level. Therefore, our study provides a first step to complement innovation system literature by offering an approach to study activities at the project level. This is important because success on the innovation system level is based on the performance of individual innovation projects.

5.2.2 Managerial implications

This dissertation has implications for managers and policy makers alike who can apply the insights that we offer.

First, even though the first study applies a conceptual approach, managers gain an understanding of how multiple actors can influence innovation performance and how they together create and develop an innovation. They are made aware that there are role configurations that impact innovation performance more than other ones. Furthermore, our framework explains how the roles that are undertaken need to match the resources of the organization participating in the multi-organizational ecology. Managers can profit from these insights by trying to influence the role configuration in the multi-organizational ecology by attracting the right organizations for the right roles.

Second, our results show what network actors can do to manage relationships and resource exchanges in innovation networks. The presented taxonomy of network governance offers a repertoire of governance mechanisms that actors may apply to deal with the complex challenge of managing networks. More specifically, our results show that innovation networks can be governed by three different modes of network governance. This knowledge can help managers who participate in innovation networks to apply a governance mode that suits the network the best. Furthermore, policy makers may profit from our results when they have to take a decision regarding subsidizing an innovation network, and would like to take the type of governance into account in their decision.

Third, our results provide useful insights into the determinants of innovation success, which is important for both managers and policy makers. Our findings may help managers to more easily recognize project activities that are likely to boost the success of an innovation. Public policy officers may also benefit from project-level insights when evaluating innovation projects and deciding which projects to fund. For example, granting institutions might want to require applicants to include detailed activity plans, because it will help them derive a better estimate of the project's chance for success. Furthermore, a better insight into the activities may also enable them to help actors to set up their innovation projects.

5.2.3 Broader implications of the dissertation

The idea of multi-organizational ecologies is acknowledged in the literature. Prior research noted the emergence of ecologies for many sectors like health care, financial services, or renewable energy (Dougherty and Dunne, 2011). In a multi-organizational ecology business firms, nonprofit foundations, public institutions, and other actors innovate together. The notion of 'ecosystems' is similar to ecologies, both terms refer to a system of actors involved in an innovation and the relationships between them (Adner, 2006; Adner and Kapoor, 2010).

The phenomenon multi-organizational ecologies is transferrable to different contexts. The perspective of multi-organizational ecologies is not only useful for understanding sustainable innovation as done in this dissertation, also in other situations multi-organizational ecologies are prominent. For example, in the mobile service sector, Apple and the surrounding organizations can be regarded as a multi-organizational ecology. Apple itself manufactures the portable devices (e.g., iPhone, iPod, MacBook), offers the operating system (e.g., iOS) and software distribution platforms (e.g., iTunes, AppStore), but other organizations such as music and movie companies and software developers also play an important role in the multi-organizational ecology. Together they offer the services and provide value to the customer. Furthermore, consider an example of the healthcare sector. It is now common practice that hospitals, independent doctors, research centers, physiotherapists, language therapists, and sport centers collaborate to provide the best value to the customers, in this case to treat the patients in the best way. This agglomeration of actors can be regarded as a multi-organizational ecology.

These examples suggest that there is a shift from innovation (or products/services in general) developed by a single organization to innovation (or products/services in general) that are created and developed by multiple actors. Today, value is created in multi-organizational ecologies; that means value is created jointly by multiple actors. The concept of multi-organizational ecologies will even become more prominent in the coming years (Adner, 2006; Dougherty and Dunne, 2011).

Prior literature has called for more research on ecologies because this would help to create an understanding of this phenomenon in theory and practice (Dougherty and Dunne, 2011). Furthermore, it is noted that 'there is a need to better understand the behavioral foundations of innovation ecosystems, e.g., by making an inventory of innovation roles in ecosystems and defining them' (Van Riel et al., 2013).

This dissertation can be regarded as an answer to this call. This dissertation offers a lens through which innovation as it happens today can be looked at. The adoption of the multi-organizational ecology approach has two main implications for the organization of the innovation process. First, value creation should be viewed as the outcome of the interplay of the actors in the ecology. That means that value is created jointly by multiple actors in the ecology and optimal value propositions require the cooperation between these actors. Based on this dissertation, we can better understand how value is created. We mapped the multi-organizational ecology by combining role theory and the resource-based view. Furthermore, we argued that we need to focus on the behavior of actors and classified mechanisms and activities.

Second, as multiple actors innovate together, managing this set of heterogeneous actors becomes an important issue. Based on this dissertation we are able to explain a new type of management problem: managing on the ecology level. We provide guidelines and a possible repertoire of strategies that can be used in order to manage the multi-organizational ecology.

Innovation in multi-organizational ecologies and especially the management and organizing of these ecologies can be regarded as a new frontier for research. This dissertation offers a research agenda along two lines on which further studies can build to ultimately help managers to gain an understanding of innovation in multi-organizational ecologies.

First, the adoption of a multi-organizational ecology lens has implications for the innovation process itself. A potential avenue for further research is the study of the organization of the innovation process. Conditions surrounding the innovation process might be studied that are likely to have an influence. For example, as innovation in multi-organizational ecologies requires knowledge sharing, an appropriate infrastructure needs to be created.

Second, more research is needed on the management of multi-organizational ecologies. The complex interrelationships between the various actors demand special attention, as in such complex situations it is difficult to predict how actors will react to changes in the multi-organizational ecology. In order to understand the interrelationships in multi-organizational ecologies, agent-based modeling could be used.

We encourage further research on multi-organizational ecologies to elaborate on our ideas and to provide a theory of innovation in multi-organizational ecologies. Ultimately, managers need to profit from the insights gained in this dissertation and in future research. They need profound guidelines of how to manage a multi-organizational ecology and an understanding of how good value propositions are made. Further research need to use our framework and ideas and build on these in order to come up with concrete guidelines for managers.

5.3 Reflection

5.3.1 Methodology

In order to research the phenomenon under investigation, we have relied on three different methods. We used a combination of conceptual, qualitative and quantitative approaches in order to address the phenomenon of innovation in multi-organizational ecologies from multiple perspectives. By combining these three approached, the phenomenon is studied from different angles resulting in an enhancement of our understanding of innovations undertaken in multi-organizational ecologies.

By using a conceptual approach in the first study, a framework can be developed theoretically. At this stage of knowledge, this approach is useful in order to translate the ideas and insights gained from our literature review into a broader framework. The framework can be hold general, different levels can be acknowledged and moderators included without having to worry of an empirical research design. The framework offers an overview of the aspects that are already known and potential linkages between them. Furthermore, it creates a common language and provides a logical overview guiding further research.

Potential shortcomings of the conceptual approach are that the built framework is too broad and complex. It incorporates different levels, a range of resource possessions and various roles, which ultimately result into a role configuration. For example, resource A might lead to the fulfillment of role A, but also partly to the fulfillment of role B. Moreover, for investigating the role configuration, an approach such as a set-theoretic method needs to be applied in order to study how the optimal role configuration changes based on the inclusion/exclusion of individual roles. The conceptual framework offers interesting insights into how multiple actors jointly contribute to innovation performance, but it remains a challenge to test this framework empirically.

The second study applies a qualitative method. The advantages of this explorative approach are in-depth insights on network governance and an attempt to theory development. Especially in cases where little is known about an issue, such an approach is an interesting and effective means to gain an understanding. The result is a detailed and deep understanding about what network governance in the context of multi-organizational ecologies entails and a knowledge base for possible large scale future research.

There are also some disadvantages of this approach. We can base our conclusions on only six cases, the generalizability is low. Based on qualitative research alone it is difficult to produce general conclusions. We have gained an understanding of what network governance in the six innovation projects we studied entails.

With this study, we showed that these innovation projects can be governed by applying three distinct modes of governance. It is difficult to generalize the findings to other projects, we cannot state that these three modes are exhaustive for all kinds of networks and can be translated to any other network. In order to draw this kind of conclusions and test the proposed ideas, a quantitative, large sample approach is needed.

The third study uses a quantitative method. This approach is warranted when the study can build on prior knowledge and when statistical support for a model needs to be found. An advantage of quantitative research is that traditional statistical methods can be used and the research can be replicated more easily than by using a qualitative approach.

A potential disadvantage is that a larger amount of data is needed in order to gain strong results. Also quantitative research ignores the context, such as the natural setting.

With this study, we were able to show that some activity sets are more relevant for high innovation performance, and that other activity sets do not contribute to innovation performance. Regarding the generalizability of the results to different contexts, it can be imagined that for example large open networks might require different activity sets for guaranteeing innovation performance. Therefore, this study should be regarded as a first step towards new theory building, but with room for testing more large scale and in different settings.

5.3.2 Limitations and avenues for further research

We conclude this dissertation with several limitations and suggestions for further research. Limitations of each of the studies have been discussed in detail at the end of each chapter.

Therefore, we focus on more general directions for future research on the study of innovation in multi-organizational ecologies.

First, we used a limited number of cases and respondents. Further research should be conducted that extends the studies by focusing on a higher number of cases and respondents. This would allow us to draw stronger conclusions and increase the validity of the research.

Second, to further investigate the generalizability of our findings, future research might focus on contexts other than sustainable innovation. Sustainability as such is a very important theme in today's society. Organizations, individuals, and governments increasingly worry about the natural and social environment. Several motives underlie sustainability, such as a desire to change the world and to show appropriate behavior based on norms and values. The sustainable context of our empirical studies might have caused some bias towards projects in which actors are highly intrinsically motivated to do their best to change the world. This in turn might have influenced the mode of governance or the relevance of activities. Further research should look at this issue more deeply. It can be imagined that a high intrinsic motivation, as it might be the case especially in sustainable innovation projects, influence the actor's willingness to fulfill a role, i.e., the effort he is willing to put into undertaking a role is stronger in situations of high intrinsic motivation. This issue has to be kept in mind when testing the conceptual framework, developed in Chapter 2, empirically.

Another issue regarding generalizability is that in Chapter 4 we have relied on government-funded cases. Therefore, it might be possible that this has created some bias. The sample may be biased toward relatively successful projects, in that it featured only projects that had been judged as good enough for a subsidy. Furthermore, government-funded projects often have to monitor the project very closely and report back to the subsidizing entity. That means that the projects need to show a certain amount of performance and meet the agreed deadlines and working packages in order to receive the funding. These circumstances might have created some bias, and might impact the generalizability of the results. Further research should investigate the extent to which the findings generalize to other sectors and non-funded projects, preferably using larger sample sizes.

Third, we studied relatively small, purposefully built, multi-organizational ecologies. We did not address large, more open networks that emerged naturally. Perhaps these contingencies would influence the results. It can be imagined that governance in larger open networks is different than in smaller networks and that other activities are more relevant for innovation performance. Further research should focus on such network types to increase the generalizability of our results.

Fourth, further research might take a longitudinal perspective. It would be interesting to investigate whether and how the emergence of governance modes or the impact of the role configuration varies over the course of an innovation project. This is especially relevant in multi-organizational ecology contexts given the fact that many multi-organizational ecologies remain in existence for a long period of time.

Fifth, as a large part of this dissertation is exploratory or conceptual in nature, we encourage further research that tests our findings empirically. We recommend a quantitative and more large-scale approach in order to validate our findings.

Finally, this dissertation has focused on innovation performance as the dependent variable. A means to specify innovation performance is to focus on an important point in the product lifecycle, the take-off point. Diffusion literature suggests that once a threshold is crossed, growth becomes an autonomous process until the market is saturated (Bass, 1969; Golder and Tellis, 1997; Stremersch, Tellis, Franses, and Binken, 2007). Take-off thus represents an important, and more specific, measure for innovation performance. An idea for further research is to investigate if the take-off of an innovation is due to the roles that multiple stakeholders have fulfilled prior to take-off and if so how. A holistic model of stakeholder influence on the take-off of innovations is still missing in the literature.

5.4 Taking a broader perspective

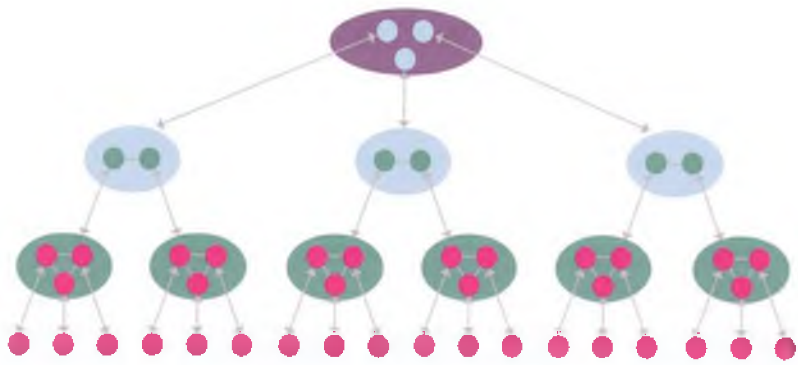
5.4.1 Investigating multiple levels

In this dissertation we have focused on the ecology level which is in line with its goal of understanding innovation in multi-organizational ecologies. More specifically, in Chapter 2, the organizational level and the ecology level are linked by introducing roles as a mechanism, whereas in Chapter 3 and 4 we only focus on the ecology level. This dissertation thus adopted a perspective that focuses on individual innovation projects rather than on innovation systems or industries. Innovation systems are characterized by several innovation projects that are part of the same system. Furthermore, we have not addressed individuals that are part of organizations.

Figure 5.1 shows the levels that we have studied and the levels that have not been addressed in this research in relation to each other. The figure details four levels: the individual level, the organizational level, the ecology level and the system level. The individual level is the level of individual people working in organizations. On the organizational level organizations are located and on the ecology level innovation projects are located. The system level consists of several innovation projects that together form the innovation system, e.g. an industry. The innovation projects on the system level are related to each other and are likely to be interdependent.

The following paragraphs present how a broader perspective, i.e. also focusing on the individual and the system level, can be applied and some directions for further research for which the framework developed in Chapter 2 (see Figure 2.1) can be useful.

Figure 5.1: Relation between the different levels



5.4.2 Integrating the individual level: The ideal innovation team

When translating the framework to a single organization or team setting, we need to study personal characteristics, such as capabilities of individual team members, instead of studying resources of different organizations.

An interesting avenue for further research is to identify the ideal role configuration in an innovative team setting by analyzing the relationship between team member characteristics, team member roles and team-level role configurations in relation to project performance. Based on insights from this dissertation (especially Chapter 2), we state that project performance depends on the role configuration and that the roles that these actors undertake should fit the characteristics of the actors. Prior research has acknowledged that persons who fulfill roles congruent with their capabilities do this more successfully than persons who fulfill a role that do not match their capabilities (Barry and Stewart, 1997; Senior, 1997). That means that teams work most effectively when all of the team members pick up the role that matches their capability set to the greatest extent. Team member roles serve as the linking mechanism between personality traits and team outcomes (Stewart, Fulmer, and Barrick, 2005).

Research along these lines may contribute to the team literature by focusing on innovation teams and innovation-related roles. Assuming that different team members in different settings would have to fulfill different roles, we argue that it is important to take the nature of the team (e.g., innovation team or manufacturing team) into account. For example, it could be imagined that members of an innovation team need to fulfill more brokering roles than other teams. Especially in innovation contexts, connecting with new parties (i.e., brokering) that are important for the success of the innovation, such as opinion leaders in the market, is important.

Future research can also contribute to the team literature by extending the model with variables, such as the context. For example, innovation teams most of the times face more complexity and insecurity than other teams within an organization. Further research could investigate how the optimal role configuration of the innovation team changes based on the context (e.g., complexity, insecurity).

Furthermore, by translating our framework to a setting where the individual level is included, new insights might be gained, such as the knowledge of other variables (e.g., friendship, former experiences) that need to be taken into account. As we are studying individual persons, their characteristics might not directly lead to the fulfillment of a specific role. For example, it could be imagined that variables, such as friendship between team members or former negative personal experiences might influence role fulfillment. On the one hand, team members who are friends may be eager to fulfill their role satisfactorily because they are motivated to participate in the team and to together create and develop an innovation. On the other hand, team members who have made negative personal experiences with each other may not be too eager to fulfill their role satisfactorily because they are not motivated to participate in the team due to the negative atmosphere.

5.4.3 Integrating the system level: Explaining innovation system success

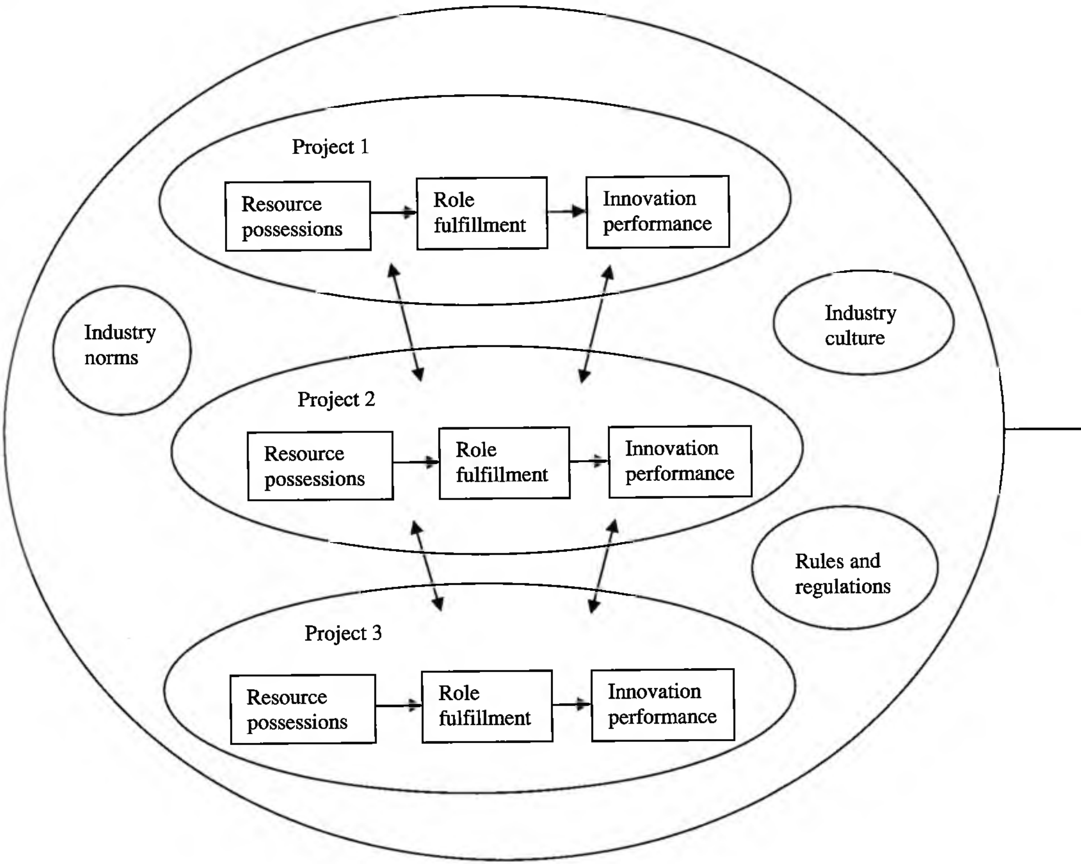
In Chapter 2, we argued that understanding individual innovation projects is important for understanding innovation systems and ultimately system change. We stated that individual innovation projects are the building blocks of innovation systems, and that only if innovation projects are successful, an innovation system can be successful. Adding an innovation system level to our framework would provide a broader perspective on the study of innovation. By applying a broader perspective, the success of an innovation on the system level, such as an industry, can be understood. This perspective might be helpful for understanding how for example energy saving light bulbs became a success. Prior research noted that innovation systems are an important determinant of technological change and that technological change and its resulting innovations are best understood as outcomes of innovation systems (Hekkert et al., 2007).

Understanding the success of an innovation on the system level requires us to study several individual innovation projects of the same industry, i.e. the same innovation system. In line with Hekkert et al. (2007) who state that in order to analyze change, the activities that take place in an innovation system need to be mapped, we could translate our framework developed in Chapter 4 to an innovation system setting. Since an innovation system does not only consist of several individual innovation projects, but also of rules and regulations, industry norms and the industry culture, these aspects need to be included as well.

The following simplified figure shows the adapted framework which depicts an innovation system consisting of three innovation projects and takes the influence of rules and regulations, industry norms and industry culture into account.

In line with Chapter 4, we argue that in order to explain the performance of an innovation system, we need to analyze the whole innovation system in which several innovation projects are related to each other. We argue that we can only understand the innovation process and ultimately the success of an innovation system when we include all aspects of the innovation system. That means that we need to take the interaction and interdependence between the different innovation projects into account. Innovation does not happen in isolation: individual innovation projects influence each other.

Figure 5.2: Framework of an innovation system



An interesting avenue for further research is to translate the framework developed in Chapter 2 to an innovation system context and see if the same principles would hold there as well. By adding a third level to the model, innovation management research can transcend the organizational level and even the ecology level, and acknowledge complex linkages in today's world of innovation. The following issues are particularly interesting for future studies because they differentiate between studying innovation on the ecology level and system level.

First, it might be interesting to look at how the individual projects are influencing each other. An approach to do that is to analyze how the performance of an innovation project has an effect on other innovation projects. For example, if project 1 is very successful, would this have a positive effect on project 2 as well? It seems very likely that there are some loop effects or network effects that would influence innovation performance, and that innovation projects can profit from successful other innovation projects.

Second, further research might want to analyze how the roles that are undertaken in the different innovation projects are related to each other. The interdependence between the individual projects could influence the effort that actors are willing to put into fulfilling a role, or lead to a higher fluctuation of actors or roles in the individual projects. For example, are there separate role configurations of each innovation project or can roles that are fulfilled in different projects be substituted or enriched? Would this lead to an optimal role configuration of the innovation system? For example, if the actors in innovation project 1 are undertaking the role of developing a prototype for an electric car, would this trigger the actors in innovation project 2 to start developing a prototype as well, or would they rather wait and profit from the experiences?

Third, in line with Chapter 2, it is also likely that contextual factors, such as rules and regulations or industry norms/industry culture have an influence on role fulfillment and the role configuration in the whole innovation system. For example, there might be situations in which rules and regulations are established that guide the whole innovation system, such as tax reductions for electric cars (e.g., when the whole industry has reached a certain sales volume). Thus the role fulfillment in innovation project 1 is likely to influence the role fulfillment in innovation project 2. An idea for further research is to analyze how these contextual factors are influencing the innovation system and the roles undertaken in the innovation system.

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APPENDIX I: Descriptions of the cases used in Chapter 3

Bus case

The Bus case project was initiated in 2008; the first part is completed. Its innovation deals with the development of an energy-efficient bus that eliminates power transfers between the motor and the contact patch with the road. In a conventional traction arrangement, 50% of the energy used by a city bus gets wasted by these friction-producing power transfers. The innovative bus can cover four times as much distance with the same amount of fuel compared with a conventional diesel bus. The project aims to develop five city buses and test them by operating them throughout the city. Three main actors are responsible for the day-to-day project activities: the bus inventor, the concession holder and a foundation that is the official project leader. Other parties play roles, including the city in which the buses operate and the Ministry of Infrastructure and Environment. The purposeful network features a contract that details the terms of the cooperation, including the project goal and how many meetings per year should take place. The network is performing at an average level, and not all project goals have been reached.

Food Chain case

This project started in 2007 and lasted until 2010. It developed a supply chain to deliver fresh, seasonal and sustainably produced vegetables and fruits from rural areas into cities. The supply chain is very short and transparent; the consumer thus can build a direct relationship with the farmers who grow the products. Consumers know where the products come from and also get to know the farmer. The products are sold under a brand name in a small, sustainable, independent supermarket in Amsterdam. This project was initiated by two foundations (which are no longer part of the network) that wanted to bring cities back in touch with rural areas. The main remaining actors are a governmental organization, the food chain organization and two universities. The network, built for this purpose, uses an incomplete contract that is something like a cooperation agreement. The project has not met all its goals and after being in financial difficulties in 2010, the food chain organization has been sold.

Greenhouse case

This innovation project lasted from 2005 to 2008. It dealt with the innovation of (semi) closed greenhouses and their adoption in the Netherlands. To achieve its goals, the project organized platform meetings with growers who already used (semi-)closed greenhouses or had plans to do so in the future. In these meetings, growers shared their experiences with the new system, in consultation with researchers who provided information on subsidies and developments in related industries. The project thus included growers, suppliers of greenhouses, several researchers from universities and several governmental and non-governmental institutions. The purposefully built network worked with a loose contract that described, for example, how often the network was to meet. The growers were expected to meet every six weeks; the project administration group met approximately three times a year. Network actors perceived the project as successful in terms of stimulating the development and adoption of (semi-)closed greenhouses, though the innovation itself, the (semi)closed greenhouse, did not meet high initial expectations.

Packaging case

Initiated in 2008, for this project an engineering firm focused on product- and machine development in accordance with cradle-to-cradle principles. The network is still functioning. The innovation involves packaging material that is 100% bio-degradable and compostable, as an environmentally friendly alternative to polystyrene and molded paper packaging materials. It was inspired by nature, made of natural fibres and uses natural binders. The material can be used as shock absorbing and filling material to package household appliances, furniture or food. Three main actors in the network deal with one another every day. The network has a clear purpose and the goal to invent a real product and establish it on the market. The contracts are very complete and detailed, including intellectual property protection and sanctioning clauses. The network thus far has reached its predefined goals and is on schedule.

Electric Car case

This project started in 2007 and lasted until 2010. It was built around the development of an electrically powered, lightweight, plastic car under a brand name. The first model was designed for companies that operated in the city distribution sector. In 2008, the first five prototypes were manufactured and introduced at the Paris Motor Show. The project was initiated by one organization and undertaken together with several commercial and technical partners. In line with its purposes, the network features contracts that quite complete, though minimal focus centered on them. Financial difficulties led to the sale of the innovation to a Chinese investor.

Hen Housing case

This innovation project, lasting from 2007 to 2010, focused on a round hen housing system that integrates animal welfare standards comparable to free range or organic (open air) laying hen husbandry (e.g., natural shelter) with the advantages of closed hen housing systems that produce cage or barn eggs (e.g., protection against aviary airborne diseases). The main players in this network were the organization responsible for building the housing system, a governmental organization, a university, the farmer on whose grounds the system has been built and the city in which the project took place. The network's goal was shared by all network actors. The contracts stated, for example, incentives for predefined outcomes, though no significant focus was put on these formal written agreements. This project has been a great success, exceeding expectations.

APPENDIX II: Topic list Chapter 3

Topic list

1. Background questions about the product, the network, the actor, and the performance

- Could you describe the product? (in terms of newness, advantages for customers and society, complexity, technology etc.)
- Could you explain something about the history of the network?
- Why are you participating in the project?
- How many actors are part of the project and which activities do they undertake?
- Which activities are you fulfilling in the network?
- Do you know the other actors personally?
- How often are you in contact with the other actors?
- To what extent did the network reach its goals?

2. Critical incident technique

- Could you describe a positive moment?
- Do you remember a moment when the cooperation in the network was going very well?
- Could you describe a negative moment?
- Do you remember a situation when an actor did something that was extremely bad?

Follow-up questions

- Could you describe the event?
- When did it happen?
- Which factors influenced the situation?
- What did the actors do or not do?
- What was the result?

3. Unaided questions

- How do the actors know what they have to do?
- How are the activities synchronized in order to achieve the best result?
- How are decisions made?
- How does it happen that every actor is undertaking the wished and needed behavior?
- How are the goals of the project determined?
- Did this change in the course of time?

4. Questions on the mechanisms

4.1 Restricting access

- To what extent was the project open?
- To what extent are the participating actors selected based on their reputation?
- To what extent are the participating actors selected based on their knowledge?
- Could you name an example?
- Does this happen informally or is this based on a written agreement?

4.2 Relying on macroculture

- To what extent is the project relying on norms and values?
- To what extent is every actor undertaking the activity that he has to because the same norms and values are applicable?
- Could you give an example?
- Did this change in the course of the project?

4.3 Using social control

- To what extent do actors fulfill their tasks because they are frightened that others talk badly about them or that they will be excluded socially?
- Could you give an example?
- Did this change in the course of the project?

4.4 Communicating

- To what extent do the actors communicate with each other?
- To what extent do you coordinate based on communication?
- Did this change in the course of the project?
- Is this formally defined?

4.5 Planning

- To what extent are goals defined?
- How concrete is the planning?
- Could you name an example?
- Which actor determines the planning?
- Is this based on a written agreement? (Ask if possible to see and/or copy)
- Did this change in the course of the project?

4.6 Monitoring

- To what extent is the project monitored?
- To what extent is the behavior of actors observed and registered?
- Does monitoring go hand in hand with evaluation?
- Could you name an example?

- Who is monitoring whom?
- Which actor determines who is monitored?
- Is this based on a written agreement? (Ask if possible to see and/or copy)
- Did this change in the course of the project?

4.7 Sanctioning

- To what extent are sanctions applicable?
- Could you name an example?
- Who does penalize who?
- Which actor determines that sanctions are applied?
- Is this based on a written agreement? (Ask if possible to see and/or copy)
- Did this change in the course of the project?

4.8 Rewarding

- To what extent are rewards or incentives used in order to manage the innovation project?
- Could you name an example?
- Which actor determines that rewards are applied?
- Is this based on a written agreement? (Ask if possible to see and/or copy)
- Did this change in the course of the project?

4.9 General

- To what extent have the actors in the project defined specific procedures or rules in written agreements?
- Could you give an example? (e.g. contracts, protocols, deadlines, plannings)
- What is there defined exactly? (Ask if possible to see and/or copy)
- Did this change in the course of the project?

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5. Other questions

- In general, who is managing the project most of the times?
- Was this determined before or chosen? (Mandated vs. voluntary)
- Is the actor governing the network, part of the network itself or externally located?
- To what extent does trust play a role in the network?
- To what extent are the actors dependent on each other?
- To what extent do actors have different goals?

NEDERLANDSE SAMENVATTING

Een gedragsperspectief op multi-organisationele innovatie ecologieën

Het doel van dit proefschrift is het vergroten van onze kennis van multi-organisationele innovatie ecologieën. Bij steeds meer innovatie projecten zijn meerdere partijen betrokken, verzameld in zogenaamde multi-organisationele innovatie ecologieën. Hoewel het samen ontwikkelen van innovaties vele voordelen heeft voor managers, is het managen van innovatie projecten in multi-organisationele ecologieën ook erg moeilijk.

Omdat innovation nu vaker in multi-organisationele innovatie ecologieën gecreerd wordt, is het succes ook afhankelijk van de andere actoren in de multi-organisationele innovatie ecologie. De actoren creeren samen waarde. Als we waarde creatie willen begrijpen, moeten we een beter inzicht hebben in innovatie in multi-organisationele ecologieën.

Onderzoek duidde het gedrag van multi-organisationele innovatie ecologieën aan als een terrein waarover meer inzicht nodig was, en wilde een focus op 'the behavior of actors' (Van Riel et al., 2013) of op 'the everyday processes of complex innovation (Dougherty and Dunne, 2011). Daarom is in dit proefschrift voor een gedragsperspectief is gekozen.

Dit proefschrift laat zien 1) hoe meerdere actoren hun resources kunnen combineren en bijdragen aan innovatie performance via rollen (Hoofdstuk 2), 2) hoe multi-organisationele innovatie ecologieën gemanaged kunnen worden (Hoofdstuk 3), en 3) een overzicht van activiteiten die in multi-organisationele innovatie ecologieën gedaan worden (Hoofdstuk 4).

Bevindingen per hoofdstuk

In hoofdstuk 2 wordt een conceptueel raamwerk gepresenteerd dat verklaart hoe heterogene actoren in een multi-organisationele ecologie bijdragen aan innovatie performance. Complexe innovaties hebben een bepaalde combinatie van resources nodig - deze worden samengevoegd van de verschillende actoren. Bovendien kunnen alleen de resources die gebruikt worden en leiden tot het vervullen van een rol, bijdragen aan innovatie performance. Rollen zijn een mechanisme dat resources op het organisatieniveau koppelt aan innovatie performance op het ecologieniveau.

In hoofdstuk 3 wordt geanalyseerd wat network governance in innovatie netwerken inhoudt. Primaire en secondaire data van zes innovatieprojecten in Nederland laten zien dat network governance uit combinaties van gedragsmechanismen bestaat die gebruikt worden om een netwerk te managen. We identificeren een taxonomy van drie verschillende typen van network governance: *basically coordinated, control-oriented* en *reward-oriented.*

In hoofdstuk 4 presenteren we een overzicht van innovatie-activiteiten in multi-organisationele ecologieën en laten we zien dat het mogelijk is om een typologie te maken bestaande uit vier soorten innovatie-aciviteiten. De data wijst uit dat *strategic predevelopment* en *commercialization activiteiten* een significant positief effect hebben op innovatie succes en dat *engineering* en *project management activiteiten* geen effect hebben op innovatie performance hebben.

Theoretische bijdragen

We dragen bij aan onderzoek naar innovaties in multi-organisationele ecologieën.

Ten eerste, literatuur heeft nog niet verklaard hoe multiple actoren hun resources combineren om innovatie performance te beïnvloeden. Met de eerste studie proberen we dit gat in de literatuur te vullen en presenteren we een raamwerk gebaseerd op de resource-based view en role theorie. In dit raamwerk wordt het organisationele niveau en het ecologie niveau gelinkt (Hoofdstuk 2).

Ten tweede, hoewel onderzoek heeft laten zien dat network governance een belangrijk construct is voor de studie van netwerken is, weten we nog steeds niet exact wat het nu precies inhoudt. De tweede studie poogt dit gat in de literatuur op te vullen door te focussen op combinaties van gedrags-mechanismen die tot nu toe nog niet bestudeerd zijn. Dit resulteert in een gedetailleerd beeld van network governance en richtlijnen voor vervolgonderzoek (Hoofdstuk 3).

Ten derde, we weten nog niet hoe diverse actoren in multi-organisationele ecologieën succes van innovaties beïnvloeden. Met het creeren van een typologie is een overzicht gemaakt van de activiteiten die vervuld moeten worden in multi-organisationele ecologieën. Daarmee draag ik bij aan de literatuur (Hoofdstuk 4).

Management implicaties

Het proefschrift heeft ook management implicaties.

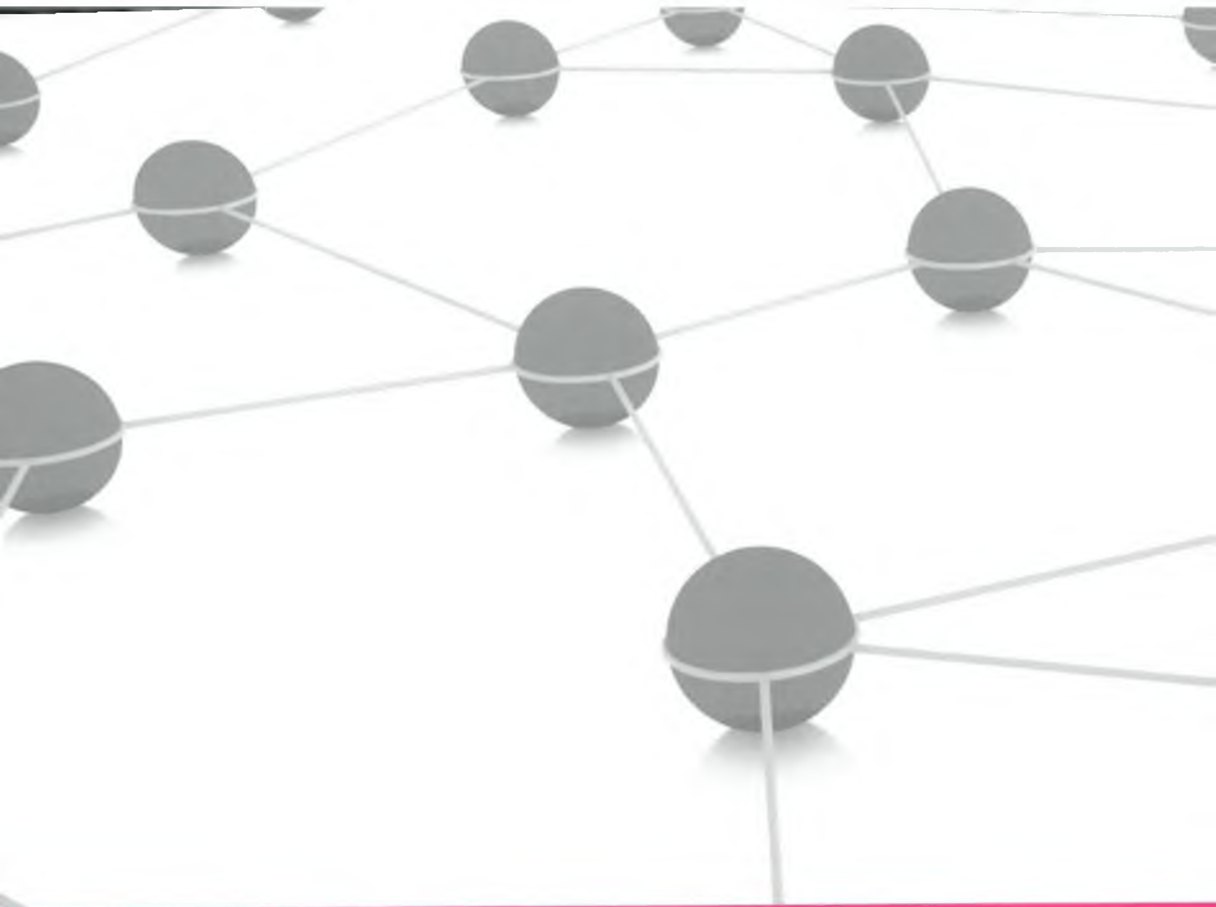
Ten eerste, het conceptuele raamwerk helpt managers begrijpen hoe verschillende actoren innovatie performance kunnen beïnvloeden. Managers begrijpen nu beter dat er samenstellingen van rollen zijn die beter zijn voor innovatie performance; dit wetende kunnen ze proberen de role configuratie te beïnvloeden en de juiste organisatie voor de juiste rol aan te trekken (Hoofdstuk 2).

Ten tweede, de taxonomy van network governance biedt een repertoire van mogelijke oplossingen en stijlen die actoren kunnen gebruiken wanneer ze een netwerk managen (Hoofdstuk 3).

Ten derde, de classificering van activiteiten helpt managers en beleidsmedewerkers. Managers kunnen nu zien welke activiteiten belangrijk zijn voor de succes van een innovatie. Beleidsmedewerkers kunnen de inzichten op projectniveau gebruiken wanneer ze verschillende innovatieprojecten evalueren en moeten bepalen welke projecten ze willen financieren en welke niet. Bovendien kunnen de gedetailleerde inzichten in de activiteiten actoren helpen om hun innovatie project in te richten (Hoofdstuk 4).

CURRICULUM VITAE

Kristina Manser (née Janzen) was born on 11th August 1980 in Kleve, Germany.
She obtained her Bachelor's degree in International Business and Management (2004) from HAN University of Applied Sciences in Arnhem, The Netherlands, and the Ecole Supérieure de Commerce Extérieur in Paris, France. Afterwards she studied Business Administration with a major in Marketing at the Radboud University in Nijmegen, The Netherlands, and obtained her Master's degree in 2007. She wrote her Master thesis on the success factors of brand extensions.
In 2008, she started her PhD research at the Nijmegen School of Management. She has presented her work at several international conferences, including the European Marketing Academy Conference (2009, 2010), the European Group for Organizational Studies Conference (2011), and the International European Forum on System Dynamics and Innovation in Food Networks Conference (2011).
Kristina currently works as a lecturer in Marketing and Research at the HAN University of Applied Sciences in Arnhem and Nijmegen, The Netherlands.



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