

1. Introduction

Collaborative innovations are realized by networks of different organizations. Because of the technological interdependencies between the components of a technological system, such as a car or a wind turbine, the development of such technologies involves different component specialists. In addition, technologies must be adapted to individual customer needs and regulatory requirements, drawing on complementary knowledge from different disciplines, such as information technology, sensor technology, or new materials. As a result, innovation processes in technology-based industries such as wind energy tend to involve specialists both inside and outside the innovating organization.

However, as postulated by the management paradigm of open innovation (Chesbrough, 2003, 2006a), collaborative innovation is not simply achieved by increasing knowledge flows across the organizational boundaries of the innovating firm. If technical standards are not compatible or if development partners do not have a common set of rules to facilitate collaboration, the opening up of firm innovation processes may be hindered. The argument of this book is thus: The management of collaborative innovation is largely based on a social praxis. In fact, the authors of this book argue that the process of establishing shared norms is a key competence required of innovating firms.

The establishment of a collaborative innovation praxis is particularly important when pursuing radical innovations. That is, any project that aims to introduce a complex technology based on knowledge from new fields of expertise must successfully define common social norms that are shared by organizations from other fields. Such an innovation praxis is then expected to provide, first, the skills necessary to adapt existing technical standards to solve new technical problems that may arise during the innovation process (cf. Berger & Luckmann, 2009, pp. 44–45) and, second, the power to normatively integrate representatives of different organizations with different interests, bodies of knowledge, and worldviews.

The author of this book assumes that firms only risk to create innovations, to deviate from established paths of technological development and even to implement radically new technologies if there is an innovation praxis based on inter-organizational shared norms, as Esser (2000, p. 17) might put it. This argument is tested by comparing cases of incremental, radical and emerging technologies in the wind energy industry in the empirical part of the book. It will be shown that the outcome of collaborative innovation is less the result of managerial decisions than of field structures, which influence the extent to which innovation partners are able to establish a shared innovation praxis. This chapter introduces the reader to the topic of the book.

1.1 The research question

No organization can introduce new complex technologies on its own. Complex technologies are a special type of technology that can be better described as technological architectures that consist of different components and subsystems, whose design and interfaces are defined by design rules (Hofman et al., 2016). Examples are drive systems for automobiles, gas turbines, jet engines or electrical generators for wind turbines, but also large technological equipment or facilities that are integrated into industrial production processes (Berggren et al., 2011b; Kash & Rycroft, 2002; Powell, 1996). The innovation of complex technologies is associated with high risks, because even if new materials or production tools can improve such technologies, changes in one subsystem can lead to significant adjustments in the neighboring subsystems. Complex technologies are also characterized by often unpredictable outcomes and long innovation processes (Dougherty & Dunne, 2011; Nightingale, 2000), yet they can take years to bring to market and require large investments. As a result of these challenges, complex technologies are often introduced through networks of organizations in which firms work together and share some of the risks associated with them (Sydow et al., 2016, pp. 233–236).

The introduction of complex technologies is not primarily a task of technical problem-solving carried out by product engineers. It is a collective achievement of professionals from many organizations working together. Thus, projects are the main locus of collaborative innovation. Innovation projects can be defined as temporary social systems in which professionals from different organizations are part of the system. They have an institutionalized start (project launch) and finish (deadline) (Sydow et al., 2016, p. 236).¹ While inventions may well originate in the heads of autonomous individuals, complex technological innovations (whether in the production processes of firms or in markets) are a collective achievement, which logically requires relational activities between representatives of different organizations.

As a result, even the smallest improvements to individual components require product engineers to interact both with customers to understand their needs, and with colleagues in marketing, R&D or other technical departments involved in designing, building and testing the system architecture (Baldwin

1 The introduction of complex technologies is more than a simple invention, it is defined as a recursive process of perception and treatment of technical problems until solutions are transformed into physical artefacts. artifacts (Arthur, 2007). While the process of invention is the creation of new ideas for products or processes that have not yet been articulated elsewhere, technological inventions only become innovations when they are commercialized in markets or integrated into production lines (Fagerberg, 2005).

& Clark, 2000; Foss et al., 2011). Innovation projects also often involve external partners such as researchers or representatives of public authorities or certification bodies. This is why introducing complex technologies tends to be based on an inter-organizational collaboration. Once institutionalized, such collaboration can provide the organizations involved with the typical actions and types of actors that make it easier to solve the technical problems at hand, as Berger & Luckmann (2009, p. 58) specify:

Institutionalization takes place as soon as habitual actions are reciprocally typified by types of actions. Every typification carried out in this way is an institution. (...) Institution postulates that actions of type X are performed by actors of type X (own translation).

The innovation praxis then combines “*not only the explicit, systematic knowledge of scientific disciplines, but also practical, applied and experiential skills*” (Heidenreich, 1997, p. 1). The development and introduction of a complex technology requires technology-specific and accumulated knowledge. This knowledge is spread across component and material suppliers, manufacturing companies, technology users, research institutes or certification bodies. Such knowledge is not easily shared or leveraged because it takes time to acquire, can be difficult to articulate, is typically passed on through personal instruction, and is learned through the practical, hands-on manipulation of artefacts, prototypes and models’ (Nightingale, 2014, p. 4). As such, the innovation management literature (see Chapter 2) intensively discusses the process of establishing rules, standards, and routines for how professionals should learn from and collaborate with each other.

The author of this book takes a sociological perspective on innovation management. It focuses on the institutional barriers to collaborative innovation. The literature on innovation management is usually positively biased towards the successful introduction of new technologies, which is said to be a driver of firms’ productivity and their competitive advantage in global markets (Kriegesmann & Kerka, 2014; Salter & Alexy, 2014). From such a perspective, an innovation project can be considered as successfully completed once a new technology has been sold on markets or applied in a production process (cf. Dodgson et al., 2014; Freeman & Soete, 1999, p. 6). In contrast, the author will show that, depending on the field structures in which an innovation project operates, the innovation praxis can be highly constrained and institutional barriers can be observed.

As a result, the introduction of complex technologies often suffer from excessive time delays or serious quality defects. Such outcomes are instructive for understanding the innovation praxis which can be dominated by coercive power or other innovation strategies to socially close the innovation process.

While scholars of innovation management are primarily interested in increasing the efficiency of innovation processes, the author of this book analyses the ‘rules of the game’ or ‘ways of doing things’ that are shared between different organizations. In essence, the author argues that the process of institutionalizing shared working standards of collaborative problem-solving influences the outcome of innovation projects. In the specific context of innovation projects, shared working standards can be seen as institutional elements that are powerful enough to bind the involved professionals together despite different cognitions and interests, as Esser (2000, p. 3) indicates:

Institutions are rules for solving everyday problems, they ‘define’ what is possible and meaningful, and soon gain an objective power over people’s actions that they can hardly escape, even though they have created the rules and the institutions based on them and constantly reproduce them through their actions (Esser, 2000, p. 3).

This study seeks to advance our understanding of managing collaborative innovation from a social science perspective. As will be shown in *chapter 2*, the debate on open innovation in particular overestimates the commercial benefits of collaboration. It neglects the institutionalized conditions for which specific strategies must be found. Management scholars like to postulate: Open Innovation, if actualized, will increase the competitiveness of firms. However, from a sociological point of view, collaborative innovation is based on a social praxis that is based on working standards that are shared by the professionals representing the different organizations. Engaging in time-consuming technical discussions or micro-politics due to conflicting interests can lead to unintended outcomes that are not predicted by the normatively connoted image of open innovation, whose perspective is limited to capturing business value from knowledge sharing (cf. Langhof et al., 2014). Therefore, in order to better understand the outcome of innovation projects, one needs to look at the social process of establishing a collaborative innovation praxis.

Looking at institutional barriers is a particularly appropriate research strategy to identify more clearly the ‘rules of the game’ or ‘ways of doing things’ that shape innovation strategies (cf. Edquist, 2005; Elster, 2007; North, 1990, p. 427). From a management perspective, such barriers can be identified against the ‘iron triangle’ of initially defined time, cost and quality targets. However, taking a sociological perspective, Sage et al. (2013) suggest that within organizations, even criteria for project failure are “*negotiated, even pre-configured, to favor or disfavor particular actors, their interests, agendas and identities*” (p. 284). This perspective underlines that rules or standards of collaborative innovation might also be a social construction (cf. Bijker et al., 1987; Rammert, 2007). They can include or exclude actors from collaborative innovation.

The author of this book expects institutional barriers – understood as rules or norms that hinder innovation process to achieve their objectives – to be strongly related to regulatory, normative and cognitive-cultural elements. They are more or less shared between experts representing different organizations (Habersang et al., 2018; Scott, 2008). For a sociologist, the study of institutional barriers to collaborative innovation is particularly revealing. As Ortmann (2014, p. 32) puts it, such a perspective on barriers – Ortmann even speaks of failures – provides insights into the more or less shared 'ways of doing things' or 'rules of the game' that are expected to make the outcome of an innovation project understandable.

I am concerned here with that particular type of failure which is not – not primarily, not ultimately – attributable to individuals, but to (initially imperceptible) shifts and ultimately to a failure of the basic social safeguards for success, namely institutions as 'rules of the game' and organizational sets of rules, norms and routines.

From this perspective, the author of this book identifies the institutional barriers to collaborative innovation. Due to their complexity and related uncertainties innovation projects need to find strategies to overcome these barriers. The author evaluates this assumption by analyzing six empirical cases of innovation projects in the wind energy industry. It is expected that excessive time delays or serious quality defects can be related to institutional barriers. By looking at this more or less established innovation praxis, the observed outcomes are analysed. Thus, the following research question guides the empirical analysis:

What are the institutional barriers to collaborative innovation?

1.2 The social process of collaborative innovation

From a sociological perspective, the introduction of a new technology cannot be reduced to a single point in time, such as the signing of a purchase contract for a new product or production facility. It is necessary to look at the social processes that preceded this moment. New technologies are introduced through an evolutionary process involving sequential events (Dosi & Nelson, 2010; Williams & Edge, 1996). In the early stages, an innovation process is highly contingent. It is undetermined and open to new inputs. In later stages, the process becomes streamlined around a shared and more or less congruent technological frame² that guides how agents think, practice and decide (Bijker,

2 Frames contain the underlying assumptions, expectations and knowledge of actors regarding a new technology (Orlikowski & Gash, 1994).

2010; Davidson & Pai, 2004; Hughes, 1987). In an ongoing sequence of events, professionals collectively decide what a new technology will look like. The results are then manifested in technical drawings, specification sheets, 3D animated designs or prototypes. Collaborative innovation are thus based on a social process in which powerful interest groups make decisions. In the process, alternative technical solutions are gradually excluded, which leads to social closure.

If unintended outcomes occur, this can be explained by decisions made under specific institutionalized conditions. Sociology has argued that new technologies cannot be understood as material objects that are developed and universally applied regardless of the context in which they are used (cf. Edgerton, 2008). Instead, technologies are defined as *"material artefacts that are socially defined and socially produced, and thus relevant only in relation to the people who engage with them"* (Orlikowski, 2010, p. 131). From this perspective, outcomes are produced during the social process of collaborative design, construction and testing of a new technology. Due to the high degree of uncertainty involved in innovation processes and the interdependence of innovation partners, collaborative innovation are hardly controllable by central authorities. Nor are their outcomes predictable. Rather, the praxis of collaborative innovation is characterized by interactions in which meanings, interests and authority systems are socially constructed (cf. Dougherty & Dunne, 2011; Maitlis & Christianson, 2014; Weick et al., 2005). Therefore, we need to look at the praxis of collaborative innovation to identify the institutional barriers.

The innovation praxis is typically characterized by horizontal relationships or based on the image of concerted action,³ which is why networks of organizations have been established as the primary site of innovation (Powell et al, 1996).⁴ As knowledge becomes more specialized and dispersed, complex technologies such as renewable energy are often introduced through such

3 Such an image might question established models of hierarchical control, centralized authority and top-management leadership that are typically associated with mechanistic or bureaucratic forms of organizing (cf. Dougherty, 2001). Instead, the image of collaborative innovation can include experts from different organizations who concentrate on technical problems and define standards of how to solve them.

4 Within such networks, specialists from different organizations and professional communities such as marketing managers, product and production engineers or project controllers work together. Across organizational boundaries (which are defined by the formal structures of organizations), these specialists are integrated through similar working issues. For example, specialists might deal with problems such as those arising during product development and manufacturing, basic and applied research or quality control and commercialization (Dokko et al., 2012, p. 697). Such networks are particularly suited for introducing radically new ideas. As Hage & Hollingsworth

networks (cf. Dougherty & Dunne, 2011).⁵ Besides markets or hierarchies of individual organizations, the network literature considers networks as typical institutional arrangements that coordinate the economic behavior of formally independent organizations on the basis of a long-term orientation and shared norms of reciprocity. In this book, collaborative innovation are assumed to be based on such networks, in which professionals belonging to formally independent organizations work together to introduce a new technology.

Despite the often horizontal character of networks, power asymmetries are common in collaborative innovation. This is due to the fact that professionals belonging to different organizations pursue egoistic motives, self-interests and often conflicting goals. These are linked to the position of their organization in the network or the field. For example, strong power asymmetries prevail when a dominant technology firm defines technical specifications for suppliers of components or materials (Hollingsworth, 2000; Powell, 1990; Windeler, 2001).⁶

Besides power asymmetries, collaborative innovation are shaped by social norms and authority systems. Network knowledge is not freely available. Instead, formal or informal norms of knowledge protection, such as intellectual property rights, copyrights, licenses or confidentiality, define who has access to the knowledge created within a network (Baldwin & von Hippel, 2011). As a result, collaborative innovation are expected to be characterized both by horizontal relationships between professionals sharing their expertise and by power asymmetries, with incumbent actors controlling the technical standards and the 'rules of the game' (cf. Edquist, 2005).

(2000) point out, the successful introduction of radically new products depends on frequent and intense communication across different areas of expertise.

- 5 The increasing specialization of knowledge drives the emergence of networks. Firms reorganize their internal structures as well as the interfirm division of labor with other partners. They downsize internal R&D capacities, spin off specialized organizational units and collaborate with research institutes that master little pieces of the knowledge that is used in an innovation process. As a result, the number of potential collaboration partners grows and firms must use the knowledge of an increasing number of sub-specialists for developing and introducing new technologies (Hage & Hollingsworth, 2000).
- 6 A single organization engages in networks for two reasons. First, the network partners assume that the knowledge of the partners complements their own competences, thereby creating synergy effects. Second, through network ties, organizations expect to strengthen their power position by gaining access to, or control over, additional resources (Kappelhoff, 2014; Meyer, 2016; Powell et al., 1996; Sydow et al., 2016; Windeler, 2014). Networks are thus not static interorganizational structures, but highly dynamic; organizations actively decide to establish new ties or withdraw from partnerships to pursue strategic interests.

All in all, from a sociological point of view, collaborative innovations are realized by professionals working together in spite of different interests and cognitions that are linked to the position of their organizations in a network. The author of this book argues that the normative power necessary to bind such professionals together is exerted by working standards for the design, construction and testing of a new technology. In turn, uncoordinated ‘rules of the game’ or ‘ways of doing things’ that arise when professionals from different organizations are not sufficiently integrated into the project can lead to unintended outcomes.

By taking a sociological perspective, the author of this book advances our understanding of innovation management. This debate has so far been dominated by management scholars, who often perceive institutionalized rules, routines or standards as merely instrumental means to increase the efficiency of learning and innovation. The sociological perspective adopted here rejects this view and analyses the (management of) collaborative innovation as a largely social process of establishing common working standards across organizations.

1.3 A sociological approach to innovation management

After the introduction to the sociological perspective on collaborative innovation, this section is a brief overview of the management perspective on this issue.

In the management literature, collaborative (or open) forms of innovation are intensively discussed. The main question is how firms can use external knowledge to transform their own ideas into new technologies. In particular, scholars explore the organizational ability to use external knowledge efficiently to improve products or processes under the heading of “absorptive capacity.” Management scholars seek routines that enable firms to identify, acquire and assimilate knowledge from the firm’s external environment (Cohen & Levinthal, 1990; Ebers & Maurer, 2014; Egbekokun & Svin, 2015; Lewin et al., 2011; Volberda et al., 2010).

The classical concept of absorptive capacity focuses on individual organizations. Contributions to the open innovation debate emphasize that new technologies are developed by collectives of organizations. These scholars ask how firms can manage knowledge flows in more open forms of innovation (Bengtsson et al., 2017; Chesbrough, 2003). For example, Chesbrough (2003) postulates his belief that in the 21st century, innovating firms depend on increasing collaboration and knowledge flows across organizational boundaries to ensure their survival: “[c]ompanies that don’t innovate, die” (p. xxvi). From

this perspective, open innovation is the new paradigm of innovation management.

In a similar vein, other scholars of innovation management believe that the ability to develop new technologies is embedded in inter-organizational relationships with external partners who have different interests and are specialized in different ways. This implies that an innovating firm is embedded in inter-firm relationships and operates in networks of organizations. As a result, it is no longer at the center of the innovation process. Instead, innovation management is expected to shift 'towards distributed or community-based models of innovation' (Salter & Alexy, 2014, p. 27). This has led to an intensification of the discussion about how companies should manage such open forms of innovation.

Unfortunately, because innovation management is rooted in economic theory, the view of the firm underlying the literature on innovation management is often rather simplistic.⁷ This makes it difficult to understand how the innovation praxis actually influences the outcomes. Companies operate in perfect markets and make rational decisions based on cost-benefit calculations, while social norms seem to have no effect on economic behavior, according to the neoclassical economic view. However, some economists criticize their own discipline for lacking analytical tools to understand how the management of inter-firm relations affects the outcome of collaborative innovation. Productivity gains, for example, can result not only from investment in tangible goods but also from investment in intangible assets such as knowledge creation or diffusion processes (Freeman & Soete, 1999, pp. 1–25). At the same time, the monopolization of learning and innovation in large, professionalized R&D departments, as suggested by Freeman & Soete (1999), is seen as an innovation strategy of the past, practiced by technology firms such as General Electric, Kodak or AT&T that dominated the 20th century (Chesbrough, 2003; Powell & Giannella, 2010; Takeichi, 2002).

Obviously, the institutionalized 'rules of the game' or 'ways of doing things' in innovation projects seem to have become more sensitive in the management literature (as well as in the absorptive capacity literature). Particularly in the mid-1990s, the economist Robert M. Grant was the founder of the knowledge integration management approach. He emphasized (cf. Kogut

7 Economists recognize that institutions are a means of controlling economic behavior in organizations in an instrumental way. For example, North & Thomas (1976, p. 1) state: "Efficient organization involves the establishment of institutional arrangements and property rights that create incentives to channel individual economic effort into activities that bring the private rate of return close to the social rate of return." Sociologists such as Swedberg & Granovetter (2018) criticize that this economic conception of organizations and institutions remains fixated on efficiency gains.

& Zander, 1992) that knowledge is the primary strategic resource of firms. Instead of maximizing shareholder value, firms should focus on building internal capabilities for the coordination of knowledge integration (Grant, 1996b, a). According to Grant (1996a, p. 377), “*organizational capability is defined as the ability of a firm to repeatedly perform a productive task related either directly or indirectly to the firm’s ability to create value by transforming inputs into outputs.*” As the term ‘repeatedly’ suggests, management scholars appear to acknowledge that a more or less institutionalized praxis somehow reproduces the results achieved, such as solving technical problems by using external knowledge.

For management scholars, one way to increase the efficiency of learning and innovation within firms is through institutionalized routines, rules or standards. Management theorists argue that coordinating mechanisms such as rules and guidelines, the sequencing of decisions, or problem-solving routines “*explain and predict*” why some firms are more competitive than others (Grant, 1996a, p. 100). Grant has established the concept of knowledge integration, which emphasizes that firms can ‘manage’ the efficient learning of the professionals who work together in the firm. However, the classical conception of knowledge integration has been criticized for its methodological individualism (cf. Tell, 2017, p. 38). It also remains fixated on learning within firms and on management priorities such as efficiency, competitiveness and business success.

In contrast, this book’s author takes a broader perspective. He argues that managing innovation projects can be better understood as an ongoing social process of establishing working standards shared by professionals from different organizations. To evaluate this assumption, the author analyzes the ‘rules of the game’ or ‘ways of doing things’ that are expected to make the outcome of innovation project understandable

More recent contributions to the debate on the management of knowledge integration emphasize the need for such a social analysis, as well as the need to look beyond the organizational boundaries of firms to networks of organizations (cf. Berggren et al., 2017). In addition, these management scholars also look at complex technologies as an example of the integration of knowledge. Empirical studies show that firms in technology-based industries (defined as industries that rely on complex technologies) must know how to integrate expertise from different organizations (Berggren et al., 2011a). More specifically, it is argued that new technologies emerge through “*a process of collaborating and purposefully combining complementary knowledge*” (ibid., p. 7). In the globalized economy, knowledge is increasingly distributed along value chains as well as between scientific and engineering communities. Therefore,

management scholars assume that knowledge integration practices need to be in place to 'bridge' or 'cross' knowledge boundaries.

In the context of collaborative innovation, management scholars have identified knowledge combinations as a mechanism for 'bridging' knowledge boundaries. In fact, according to Tell (2017): Combining knowledge means configuring technical knowledge in two ways. The first way is through the incremental improvement of technologies – within its technology life cycle (Foucart & Li, 2021). For example, an innovating firm uses the knowledge of partners, decomposing and creatively (re)combining it to define the technical specifications of a module that is intended to improve the technological architecture. A second possibility is to create an entirely new technological architecture by decomposing it and re-configuring the way in which the modules or components interact with each other (Foucart & Li, 2021). The result is the creation of new design rules. These must be coordinated with the partners responsible for the other subsystems of the architecture (Hofman et al., 2016).⁸

In short, management scholars suggest that the strategy of knowledge integration differs across contexts. Innovation projects decompose knowledge, either through its transformation into new modules or through the reconfiguration of a technological architecture. However, these combinations remain at the micro level of professionals working together, as described in the management literature. It tells us little about how knowledge combinations are influenced by the 'rules of the game' or 'ways of doing things' that are more or less institutionalized in the organizational field in which an innovation project takes place. The author of this book will fill this research gap by analysing the institutional barriers to collaborative innovation and knowledge integration.

The literature on knowledge integration, which has its roots in economic theory, would emphasize that the combination of knowledge is essential for innovation. The idea that new technologies are the result of new combinations of knowledge has its origins in the work of the economist and sociologist Joseph A. Schumpeter. He understood economic change as the result of individual entrepreneurs with unique characteristics such as visionary thinking and assertiveness, which enable them to introduce innovative ideas against social resistance (Blätzel-Mink, 2015; Schumpeter, 1934). However, the majority

8 When an engineering project is set up to solve technical problems, such knowledge combinations are often supported by digital tools such as Computer Aided Design (CAD), CFD or Finite Element Analysis (FEA), which can be used to model, simulate and visualize technical designs (Arthur, 2007; Dodgson & Gann, 2014). To solve technical problems, knowledge is then combined in a virtualized environment. The first prototype is produced and ready for testing. However, it is outside the virtual environment that a social practice is established that facilitates technical problem solving.

of innovations are not radically new, but introduce novelty through creative combinations of elements that have been produced in the past (Edgerton, 2008; Schumpeter, 2006). A basic definition of innovation is: “*New creations of economic significance, either tangible or intangible. They may be entirely new, but are often created by combining existing elements in a new way*” (Edquist, 2002, p. 219). For example, Henry Ford’s assembly line for the production of the Ford Model T was a novelty in the automotive industry. It combined existing technologies of the electric motor, continuous flow production, the assembly line and interchangeable parts. As Salter & Alexy (2014) point out, the iPhone, which was mainly a product of the visionary power of Steve Jobs, was a breakthrough in the telecommunications sector not because of its innovative design, but because of the creation of a market for knowledge combinations that constantly innovate software applications (apps), leading to what Teece (2018) calls an innovation platform. These software innovations are based on combinations of existing technologies. They complement the look and feel of the iPhone, thereby enhancing its overall commercial success.

From this perspective, knowledge combinations represent first and foremost a type of economic behavior whose goal it is to create new technologies that can be sold on markets or introduced into production processes. This economic perspective which is limited to capturing business value from innovation, however, tells us little about the social dynamics that are inherent in the social ‘production’ of new technologies. In addition, person-centered ‘stories’ about the development of the Model T Ford or the iPhone barely tell us anything about the institutionalized conditions of innovation.

In order to improve our understanding of the management of collaborative innovation, the author of this book adopts a sociological perspective. Empirical cases are used to show how social norms influence the outcome of such projects. The study rejects any ‘best practices’ or technocratic thinking of innovation management, but rather acknowledges the social dynamics inherent in such processes (cf. Luhmann, 2006; Mattes, 2014; Ortmann, 1999).

Thus, based on sociological theory (Berger & Luckmann, 2009), the author of this book will argue that the management of collaborative innovation must be understood as a social process of norming a shared praxis of technical problem-solving. As Elster (2011, p. 196) argues, this process can be expected to exert the normative power needed to bind professionals together, despite likely differing cognitive frameworks and vested interests:

Social norms are social both because they are maintained by the sanctions the others impose on norm violators and because they are shared – and known to be shared with others (Elster, 2011, p. 196).

In particular, the social process of establishing shared working standards is expected to normatively bind professionals representing different organizations together, creating a shared consciousness of being sanctioned in the case of standard-violating behavior. In particular, the social process of establishing common working standards is expected to bind together professionals representing different organizations in a normative way and to create a common awareness that norm-violating will be sanctioned.

1.4 The praxis of collaborative innovation

A closer look at the praxis of innovation is needed to identify the barriers to collaborative innovation and knowledge integration. Practice-based conceptions of organizations show how professionals working together on the development and introduction of a new technology institutionalize 'rules of the game' or new 'ways of doing things' (cf. Orlikowski, 2010). In fact, research has shown that innovation projects institutionalize working relations and power structures through the daily practice of collaborative work (cf. Ortmann et al., 2000).⁹ In this book, the author expects that this praxis largely makes the outcomes of collaborative innovation understandable.

Indeed, practice-based conceptions of organizations assume that innovation projects socially construct both new technologies and organizational rules based on shared practices (cf. Jackwerth, 2009; Orlikowski, 2001, 2007). From this perspective, the knowledge that is created in innovation projects does not stick, leak or flow, nor can it be captured, stored or transferred (Ortmann et al., 2000; Sydow, 2014b).¹⁰ Instead, innovation projects integrate knowledge by establishing shared praxis of designing, building and testing a new technology (cf. Brown & Duguid, 2001; Giddens, 1984; Orlikowski, 2010). Therefore, to

9 In his seminal work, Barley (1986) introduced new technologies as an "*occasion for structuring*" work relations. The author took a similar perspective on organizing collaborative innovation. However, he focused on the introduction of technologies within organizations, analyzing the introduction of new computer tomography in two American hospitals. Barley (1986) showed that such innovation projects are an occasion for reorganizing work relations. He stated that the application of technologies can disrupt existing professional knowledge, introduce new power relations among technical experts and doctors, and lead to new processes of taking decisions during medical examinations. The author of this book takes a similar perspective, but assumes that to be successful, the introduction of a new technology depends on establishing a division of innovative labor that facilitates the coordination of knowledge integration across organizations.

10 In contexts of innovation-related problem-solving, information sticks to a locus if it is costly to transfer, acquire or use (von Hippel, 1994).

identify the rules or norms that may hinder (or promote) innovation projects, we look at the practices involved in the introduction of new technologies.

There are several different conceptions of practices in the literature. Some management researchers adopt Reckwitz's (2002) definition of practice, which states that 'practices' refer to shared routines of behavior, including traditions, norms and procedures for thinking, acting and using 'things' (Whittington, 2006, p. 619). The author of this book adopts a different perspective and understands practices as typical, ongoing, shaped and regulated activities of social actors dealing with technical problems, such as the development of a new technology (Giddens, 1984; Orlikowski, 2002; Windeler, 2014).

This perspective implies that in order to understand the outcomes of collaborative innovation, it is crucial to look at organizational practices. Specifically, practice-oriented research argues that socially skilled individuals can manipulate meanings and identities through their cognitive, empathic and communicative skills to create, maintain or disrupt institutionalized ways of doing things (cf. Fligstein & McAdam, 2011, 2012; Lawrence, 2010; Lawrence & Suddaby, 2006). Such knowledgeable agents or socially skilled individuals practically exclude, improvise, modify and reject established 'rules of the game' or 'ways of doing things' in solving problems, making decisions, setting deadlines or assuming roles. In the context of collaborative innovation where members of different organizations work together, professionals are expected to actively and strategically establish not only working relationships but also an innovation praxis (cf. Sydow, 2014b; Windeler, 2001; Ortmann et al., 2000; Giddens, 1984).

The establishment of an innovation praxis has been the subject of empirical studies. For example, Mariotti & Delbridge's (2012) longitudinal empirical study of the European motorsport industry found that firms take strategic actions to form new or reactivate existing ties. Interestingly, the authors found that motorsport firms view reactivating latent ties as a quicker and smoother approach to problem-solving than working with unfamiliar partners. Problem solving goes more smoothly when the network partners share the same standards of work, such as "*unique expertise, high reliability and quality of work*" (p. 525). While in this example the agents are reacting to the network ties, other examples show how the agents are creating common practices. Powell & Giannella (2010) argue that when a future technological path is unknown, individuals form communities of practice in which even experts pursuing "*competing intellectual property interests*" (p. 578) are integrated and engaged

in collective invention.¹¹ In other words, when the future technological path is unknown, individuals form communities of practice in which even experts pursuing “*competing intellectual property interests*” (p. 578) are integrated and engaged in collective invention.

Thus, based on practice-based conceptions of organizations managing collaborative or open innovation projects means establishing an inter-organizational shared praxis of collaborative innovation. The process of establishing such a praxis then follows a logic of negotiation and compromise with regard to “*formal and informal rules of co-operation*” (Sydow, 2010, p. 397). Scholars of network management consider negotiations as a “*functional requirement*” or “*constitutive element*” of networks: “[T]hey bring together diverse individual and collective actors with a variety of interests, cultures, histories or belief systems that form the basis for ongoing processes of bargaining and negotiation” (Sydow et al., 2016, p. 21). Thus, as Mayntz (1993, p. 13) points out, negotiation is not directed towards maximizing egoistic self-interest, but towards achieving collective outcomes and generally accepted compromises:

The network logic of negotiation is a logic of compromise. It has the advantage of permitting cooperation in spite of conflicting interests, but also the possible disadvantages of painful slowness, suboptimal results, and even stalemate.

Establishing a praxis of collaborative innovation in a reflexive and active way is then the ‘management’ of innovation projects. An established innovation praxis implies that standards are in place for negotiating solutions and structurally excluding actors who deviate from the shared standards of design, construction and testing of a new technology (cf. Ortmann et al., 1990; Stones, 2009). Such standards then narrow down the design rules, the choice of project partners, the technical ideas, the quality standards and so on. In daily meetings, workshops or discourses, development partners may negotiate such design rules, define intellectual property rights (IPR) or agree on sanctions in case of norm violation, thus controlling risks or zones of uncertainty (Bijker, 1995; Crozier & Friedberg, 1979; Davis & Eisenhardt, 2011). It can be predicted that an innovation project is likely to suffer from unintended outcomes if such ‘rules of the game’ (North, 1990) or ‘ways of doing things’ (Elster, 2007) are not shared by development partners.

The author of this book empirically analyses how a less widely shared innovation praxis influences the outcome of collaborative innovation. Such a praxis includes the power to cognitively and socially complete an innovation process, despite the high level of uncertainty involved. Power should not be

11 “*Collective invention is technological advance driven by knowledge sharing among a community of inventors who are often employed by organizations with competing intellectual property interests*” (Powell & Giannella, 2010, p. 578)

understood as something owned or possessed by individuals who might use it to satisfy egoistic motives such as status, freedom, wealth or happiness. In the context of inter-firm collaboration, Huxham & Beech (2010) see power as a relational concept that involves agents from different organizations (cf. Windeler & Sydow, 2001). Power is rooted in social norms. It does not result from top-down rational planning, centralization of authority and hierarchical control to maximize individual profit gains. Rather, innovation projects derive their power from a system of norms that mobilize knowledge and resources, thereby creating opportunities but also structurally excluding those who are not members of the social system of collaborative innovation (Knights, 2009). The social process of establishing a shared innovation praxis thus draws organizational boundaries around the relevant development partners through the definition of shared working norms. This excludes outsiders.

In summary, the author of this book seeks to identify the institutional barriers to collaborative innovation. The social process of establishing a collaborative innovation praxis involving professionals from different organizations is analyzed to answer this question. In essence, it is argued that establishing shared working standards strongly shapes the outcome of innovation projects, because it facilitates the definition of technical specifications, excludes alternative development options, and thus socially and cognitively closes the innovation process, creating organizational boundaries around the relevant innovation partners and excluding outsiders. The author analyses six empirical cases of innovation projects in the wind energy industry to evaluate this argument.

1.5 Structure of this book

There are eight chapters in the book, which are briefly reviewed below. *Chapter 2* introduces two management approaches of ‘open innovation’ and ‘knowledge integration’, both of which discuss how firms should manage knowledge flows across organizational boundaries. The chapter critically assesses what management research tells us about the institutional conditions of (open) innovation processes. The chapter concludes by presenting the research gap that informs the present study, which relates to the institutional barriers of collaborative innovation.

Chapter 3 introduces the book’s own approach. Drawing on field theory, it argues that unintended outcomes such as excessive time delays or quality defects are understandable by uncovering the institutional conditions of innovation projects. In particular, it is theorized that common working standards, like social norms, bind innovation partners together despite differences

in expertise (cognitions) or self-interest (positions in the relevant field of technology development). For three types of innovation, namely incremental innovation, radical innovation and innovation in an emerging field of technology development, different strategies of establishing an innovation praxis.

Chapter 4 is a presentation of the methodology and empirical data on which this research is based. A multiple case study design was used as this book seeks to understand the institutional barriers to collaborative innovation and knowledge integration. The empirical part of this thesis is based on a case study of an innovation project in the wind energy industry. The data collection was part of the COLLIN research project at the University of Oldenburg. For the present work, six cases have been selected and grouped into three pairs that represent three different types of innovation: incremental innovation, radical innovation, and emerging technologies. The explanatory objective of the present empirical evaluation is met by an embedded multiple case study design.

The *Chapters 5 to 7* analyse three pairs: increment, radical and emerging technologies. In chapter 5, the examples of two different component suppliers working with a large European windmill producer (WTM) show how distributed knowledge is integrated in incremental innovation projects. However, neither case shows strong signs of collaborative innovation. On the contrary, the cases show how coercive rules reduce the innovation potential of collaborations between component manufacturers and system integrators. A WTM that imposes its technical expectations on supplier firms tends to control both innovation projects centrally. The examples illustrate how WTMs use standards as an instrument to control technology development. They reduce innovation projects to a rather simple form of development, instead of collaboratively creating innovative technologies. In these cases, coercion can be identified as the dominant strategy of technology development.

In *Chapter 6*, two examples of radical innovation will be presented. In the first case, a rotor blade factory of a large European WTM introduces a robot-based rotor blade coating system. In the second case, a small German start-up company develops a 'wooden wind turbine'. In both cases, the focal firms collaborate with various specialists from different fields of expertise (e.g. component and material suppliers, testing and certification institutes), thus creating a new innovation network. However, both cases suffer from serious quality defects (rotor blade coating system) or project delays (wooden wind turbine). It was found that in both projects not all relevant partners, including the customer or the approval authorities, were involved in the development praxis. The cases thus provide empirical evidence that an innovation praxis which does not involve all relevant partners can lead to unintended outcomes. In both cases, the focal firm relied on personal trust to gain some control

over technology development, rather than establishing a shared innovation praxis. The findings point to personal trust as an alternative strategy to the development of radically new technologies.

Finally, *Chapter 7* presents two examples of engineering service providers trying to establish a position as system suppliers in an emerging technological field. Firstly, the cases show how public regulations for the protection of marine fauna by the German authorities gave rise to a new field of technology development in the offshore wind energy industry. Most importantly, the two cases show how innovating firms struggle to introduce their product ideas because they are unable to establish a power position in the new field of offshore wind energy technologies through collaboration with incumbent energy firms. In terms of their innovation strategy, the two engineering service providers studied are completely different. In the first case, an entrepreneur relies on his individual skills to quickly invent new technical solutions. In the second case, an offshore specialist uses professional engineering skills to realize a technology transfer from the offshore oil and gas industry to the wind energy industry. In both cases, however, a coherent approach to co-innovating together with strong local partners could hardly be identified. At least at the time of the research, both companies remained excluded from innovation networks that were powerful enough to set a new technical standard in the emerging field of offshore wind energy technologies.

Chapter 8 summarizes the empirical findings of this book. The answer to this question is given in the form of testable hypotheses. In addition, the chapter discusses three degrees of openness of the innovation praxis as a critical factor for understanding the outcome of innovation projects, which can be realized depending on the regulatory, normative and cognitive-cultural conditions of technology development in a given field. Finally, there will be a critical assessment of the theoretical and practical relevance as well as the limitations of this study.