3. Establishing technology fields

This book explores the institutional barriers to collaborative innovation. As a starting point, the previous chapter has introduced management strategies that have an impact on collaborative innovation processes. While open innovation essentially postulates that firms should exploit external sources of expertise and enrich their internal innovation processes by acquiring or sourcing external knowledge, knowledge integration scholars suggest that firms need to be able to establish routines, rules or standards for combining knowledge across boundaries. From this perspective, more or less institutionalized processes of integrating knowledge influence the outcome of innovative projects.

However, this hardly improves our understanding of institutional barriers to innovation. The highly normative approach of open innovation simply postulates that collaboration increases the innovativeness of firms. It does not take a closer look at the 'rules of the game' or 'ways of doing things' that are established in innovation projects. Knowledge integration scholars, without specifying how projects 'produce' a social outcome point to institutionalized processes and 'bridging' mechanisms.

This book takes a sociological perspective to advance our understanding of the management of innovation projects. It argues that, similar to social norms (Elster, 2007, 2011),[23] the social process of establishing common working standards normatively binds innovation partners and creates a common innovation praxis. This means that the establishment of such standards requires an informal process of constantly negotiating and monitoring the 'rules of the game' or 'ways of doing things' that inform project partners about the consequences of violating standards. For example, deviating from technical standards in order to increase innovativeness, fear of loss of reputation by violating established professional norms, or playing by the rules in order to secure future follow-on projects are possible motivations that drive the actions of experts in collaborative innovation projects, despite possible differences in cognitive frameworks and self-interests.

In short, the social process of establishing inter-organizational working standards is expected to have a strong impact on the outcome of innovation projects. In the empirical part of this book, this argument is evaluated on the

23 In contrast to legal norms, which have an obvious instrumental character and sanctions for violation are formally defined, social norms convey social meanings, their compliance is monitored by a social collective, and sanctions often remain diffuse (Elster, 2011).

basis of six technology development projects in three different institutional contexts of the wind energy industry.

Before doing so, the main argument of the book will be specified in this chapter. First, the concept of organizational fields is introduced to theoretically link working standards (which can be more or less institutionalized in a larger field of technology development) with practices of knowledge integration (section 3.1). Second, working standards are introduced as a particular type of rule that regulates an innovation praxis (section 3.2). Third, this book argues that depending on the prevailing type of innovation (incremental innovation, radical innovation or emerging technology), innovation projects are realized in three different ways. This argument is specified in terms of three propositions that will guide the empirical analysis (section 3.3).

3.1 The institutional elements of innovation projects

This book explores the institutional barriers to collaborative innovation. Unintended outcomes such as excessive time delays or serious quality defects are understood here as organizational phenomena which can be traced back to the innovation praxis and the application or non-application of standards for coordinating innovation projects. This section introduces the concept of organizational fields, which can be used to describe theoretically how work standards shape the everyday praxis of innovation and collaboration across organizational boundaries. This will serve as a basis for clarifying how the process of establishing shared norms works.

The author of this book assumes that complex technologies are introduced by at least three formally independent organizations. These innovation partners need to integrate knowledge across professional, organizational and/or sectoral boundaries. In the process of technology development, standards work to normatively bind the innovation partners together, despite any differences in the cognitive frames and self-interests attached to these actors' position in the field. The concept of organizational fields takes collectives of heterogeneous organizations as the unit of analysis and theories how the collective behavior of members of different organizations is regulated. Therefore, this concept is used here to show how the process of establishing such an innovation praxis might regulate the collective behavior of actors in innovation projects (cf. DiMaggio & Powell, 1983). According to Scott (2008, p. 86),

> *An organizational field refers to those organizations that collectively constitute a recognized domain of institutional life: key suppliers, consumers of resources and products, regulators, and other organizations that produce similar services or products.*

It should be noted that field theory has been developed to explain the behavior of organizations independent of the interests or decisions of individuals. The concept assumes that organizations cannot be understood as aggregates of human beings pursuing only selfish interests, constantly seeking to optimize their personal utility and acting on the basis of economically calculated rational decisions (DiMaggio, 1988). Instead, the field perspective assumes that institutions, understood as the taken-for-granted structures of society, influence the behavior of organizations. In the case of technological innovation, examples include 'best practices' for organizing innovation processes or 'blueprints' for successful product development. Institutions such as standards shape, mediate and channel collective choices and thus, according to the theory, lead organizations to act on "*a narrowly defined set of legitimate options*" rather than on efficiency criteria (Krücken, 2016; Wooten & Hoffman, 2008, p. 130). The dynamics of a social field unfold through networks, which are understood as "*the skeleton of fields*" (Owen-Smith & Powell, 2008, p. 596). For example, through networks, field members create hierarchies or coalitions through which actors can shape institutions.

The field concept has been applied to the analysis of technology development. Hoffman (1999) emphasizes that fields emerge around a common issue, which may be markets or technologies. Once members of different organizations interact regularly, exchange significant amounts of information and are aware that others are working on the same common issue, a field emerges (DiMaggio & Powell, 1983; Scott, 2008). Over time, a field acquires its own rationality and meaning system, leading scholars to refer to a field as a "community of organizations" (Wooten & Hoffman, 2008, p. 141). Within fields, competitors can also be members, as they are "bound together" by a common issue despite conflicting self-interests (cf. Meyer, 2016, p. 150). According to the seminal work of DiMaggio & Powell (1983), field organizations align their practices and become increasingly similar because coercive rules, mimetic behavior or social norms exert isomorphic pressure to conform to collective expectations or 'rationalized myths' (Boxenbaum & Jonsson, 2008; Krücken, 2016).[24]

From this perspective, it is not the aggregation of individual choices but more or less institutionalized 'rules of the game' (North, 1990, p. 3) or 'ways of doing things' (Elster, 2007, p. 427) that regulate innovation projects. For

24 According to Meyer & Rowan (1977, pp. 343–4), myths control the formal structures of organizations. Myths are defined as "impersonal prescriptions that identify various social purposes as technical ones and specify in a rule like way the appropriate means to pursue these technical purposes rationally. (...) [T]hey are highly institutionalized and thus in some measure beyond the discretion of any individual participant or organization."

example, innovation partners cannot freely choose product designs, development partners, manufacturing processes or R&D partnerships. Their options are limited by the regulative, normative and cultural-cognitive elements of institutions, such as technical standards or common design rules, which define a set of legitimate options for innovation projects. From this perspective, rules, social norms or shared beliefs can thus explain why innovation partners can work together despite differences in cognition or self-interest.

According to field theory, the regulative, normative and cultural-cognitive elements of institutions provide classes of mechanisms that explain how collectives of organizations behave (Lawrence, 2008). As Table 4 illustrates, such mechanisms include 'regulative rules' (coercion),[25] 'binding expectations' (social norms) or 'constitutive schemes' (mimesis). They limit social choices to legal, legitimate or believed options.

Table 4: The institutional elements of fields

	Regulative	**Normative**	**Cultural-cognitive**
Basis of compliance	Expedience	Social obligation	Taken-for-grantedness, shared understanding
Basis of order	Regulative rules	Binding expectations	Constitutive schema
Mechanisms	Coercive	Normative	Mimetic
Logic	Instrumentality	Appropriateness	Orthodoxy
Indicators	Rules, laws, sanctions	Certification, accreditation	Common beliefs, shared logics of action, isomorphism
Affect	Fear guilt / innocence	Shame / honor	Certainty / confusion
Basis of legitimacy	Legally sanctioned	Morally governed	Comprehensible, recognizable, culturally supported

(Scott, 2008, p. 51)

In order to analyse social collectives of organizations working together to adopt a new technology, this book looks at collaborative innovation. In such cases, it may be inappropriate to exaggerate the importance of isomorphism, conformity and homogeneity. Rather, innovation projects are characterized by heterogeneity of knowledge and interests, experimentation and contingent ac-

25 Coercive power is achieved by defining, monitoring and sanctioning rule systems or 'rules of the game' (North, 1990, p. 4).

tion, and deviance (cf. Wooten & Hoffman, 2008). In their empirical research on semiconductor manufacturing, Schubert et al. (2013) showed that new technologies do not simply emerge from interacting with each other. Rather, the establishment of a technological path is "*highly managed and reflexively mediated*" (ibid., p. 1402) (cf. Meyer, 2016).[26] In another empirical study of the German engineering industry, Beck & Walgenbach (2005) argue that firms' decisions on the organization of production processes may even be decoupled from their institutional environment.[27] The authors argue that the likelihood of an organization adopting an institutionalized approach decreases if internal routines bring higher efficiency (cf. Sandholtz, 2012). Thus, not only the institutional environment but also social processes play an important role in the management of innovation projects, as shown by Beck & Walgenbach (2005).

Isomorphic pressure implies homogeneous partners and stable fields. Agency underlines the influence of entrepreneurial action and institutional change. Regardless of which of the two social forces is dominant in a specific empirical case, it can be concluded that, from a field theory perspective, the management of innovation projects is also a regulatory process of institutionalization of rules, social norms or shared beliefs that are shared by the members of heterogeneous organizations (e.g. private firms, public agencies or universities), as Scott (2008, p. 52) claims:

> *[R]egulatory processes involve the capacity to establish rules, inspect others' conformity to them, and, as necessary, manipulate sanctions – rewards or punishments – in an attempt to future behavior.*

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26 "*A technological path is understood here as the patterned development of a technology that is, due to increasing returns and other positive feedbacks, difficult – if not impossible – to reverse*" (Schubert et al., 2013, p. 1391). With his notion of "innovation paths", Meyer (2016) takes a broader perspective. The author combines the historical context with micro-processes of institutionalizing technology development: "*Innovation pathways are industry or field-wide developments that not only affect a specific artefact, but also describe a general development trend.*" (p. 2; own translation)

27 This observation is supported by neo-institutionalist conceptions of organizations stating that organizations such as firms, universities or public agencies tend to pretend that their formal organization meets the expectations expressed by public opinion, thereby signaling conformity with the rules of the game and securing legitimacy, while inside the organization, the daily praxis might be different. Organizational practices can be decoupled from external expectations, as Meyer & Rowan (1991, p. 58) conclude: "*[D]ecoupling enables organizations to maintain standardized, legitimating, formal structures while their activities vary in response to practical considerations. The organizations in an industry tend to be similar in formal structure – reflecting their common institutional origins – but may show much diversity in actual practice.*"

In this book it is assumed that in innovation projects the regulative rules, the binding expectations or the constitutive schemes that bind the actors together according to the field theory, are embodied in common standards of work.

In summary, from a field theory perspective, innovation projects are organized around working standards. These are established and controlled in two ways: First, they can be imposed in the form of coercive rules, social norms or mimetic conduct. Second, they can be established through strategic agency or by socially skilled individuals who fashion shared meanings and identities. In this book, it is argued that in the context of technological development, standards are a special kind of rule. They function as 'rules of the game' or 'ways of doing things' that regulate the network of innovation and can explain the outcome of the development of technology.

3.2 Standards of technology development

On the basis of field theory, the previous section concluded that, despite potential differences in cognitive frameworks and self-interests, innovation projects can be co-organized on the basis of the imposition of coercive rules or social norms, or through mimetic behavior. In addition, new ways of doing things can also be established through the use of strategic agency. This book argues that in innovation projects, the social process of coordinating and monitoring the ongoing (re)creation of shared working standards is the normative power that binds innovation partners together (cf. Lawrence, 2010; Lawrence & Suddaby, 2006). In this section, we specify how such standards structure the interactions within innovation projects and thus create an innovation praxis.

First of all, in the literature, standards are associated with industrial norms. It is important to note that these types of standards are different from regulations. While regulations are legal restrictions enforced by government authorities, standards are introduced by private organizations such as the International Electrotechnical Commission (IEC) that regulate technologies (e.g. in terms of design, development, reliability or safety) (cf. Blind, 2012; Gallini, 2014; Narayanan & Chen, 2012; Tassey, 2000). For example, in the wind energy industry, the industry standard 'IEC 61.400' is a guideline for the construction of wind turbines. It also contains strict specifications for subcomponents such as gearboxes, or for the design of offshore wind turbines.

In addition to industry standards, another type of standard is widely discussed in the literature, namely technical standards, which are established by officially accredited organizations. These standards can be industry standards, but they are more detailed definitions of technologies and development

processes. Similar to 'design rules', technical standards define the architecture of technologies, how components interact (interfaces) or test procedures (cf. Hofman et al., 2016). Their main function is to ensure the compatibility and interoperability of technologies. They restrict the variety of technologies, limit the options for product development and force the integration of technologies into a common architecture or platform (Tassey, 2000). As Garud et al. (2002, p. 198) put it,

> *Standards are codified specifications that detail the form and function of individual components and the rules of engagement among them. Together, specifications about the components' form and function and the rules determining their interaction define a system's 'architecture'.*

The main function of technical standards is to impose compatibility between technologies and components, and thus to a large extent to pre-define an innovation project, as the above quote emphasizes. However, this potential to impose the rules of the game for a given innovation project is likely to depend on the type of innovation in question. For example, in mature markets where a technical infrastructure exists and innovation is often incremental, standards increase the conformity of firms to an established technological path, but also ensure the efficiency of innovation processes. In uncertain markets, where different technological paths compete with each other, technical standards can increase firms' ability to innovate because they provide firms with direction for technological development (Blind et al., 2017). Under such uncertainties, new standards may even be the result of co-operation between competitors. The parties involved may have a common interest in pooling patents and use this patent pool as a basis for their own innovation projects (cf. Gallini, 2014).

Thus, in contrast to their inherent function of imposing conformity, not only in mature markets, technical standards need not necessarily determine innovation processes, stifle creativity and reduce innovativeness, as firms may fear that new solutions outside existing standards are incompatible (Allen & Sriram, 2000; Garud et al., 2002; Ortmann, 2014). On the contrary, since technical standards constrain development options, they not only provide direction, as in the case of catalytic converters for automobiles. They also encourage creativity and experimentation by firms to optimize technologies beyond the technically defined limits and to discover profitable market niches.

It is interesting to note that standards have recently been discussed in organizational science as a tool for organizing the collective behavior of organizations (Brunsson et al., 2012; Ortmann, 2014). This book takes up this perspective. It argues that the social process of establishing shared working standards for the development and introduction of a new technology could function as mechanism. The organization literature emphasizes that the social process of norming implies that the management of innovation projects can-

not be reduced to a central authority that coercively imposes conformity on development partners, for example by defining technical standards that must be met. A sociological approach broadens this perspective. It implies that such working standards can structure innovation projects as they are negotiated and monitored in the everyday praxis of collaboration.

Brunsson et al. (2012) argue that standards should be understood as voluntarily adopted rules.[28] From this perspective, professionals working together in innovation projects do not apply a standard because of the hierarchical authority of an external standardizer, but because of the relevance, legitimacy or normative pressure of an actor who monitors compliance. Standard-setting organizations are a typical example of the latter, but an incumbent technology firm could also fulfil this role (Ahrne & Brunsson, 2010). For example, ISO quality standards adopted by a technology firm do not contain legally defined sanctions, but compliance could be mandatory for firms wishing to work with an ISO-certified partner. This example shows that the process of establishing common working standards can create a collective consciousness shared by organizations. Standards thus shape the behavior and identity of actors in an organizational field.

Ortmann (2014) takes a similar perspective. He also refers to recent debates on organizational routines as processes (cf. Feldman, 2016; Feldman & Pentland, 2003). In innovation projects, once institutionalized, standards could provide 'examples, models, levels or norms' that make it easier for the innovation partners involved to evaluate and assess development options, the actions of the partners or the outcomes of the project. From this perspective, standards could structure innovation projects because they impose design rules that are codified in technical standards, or because, once negotiated and established, they impose a praxis of innovation that is loaded with social norms.

Based on these theoretical considerations about standards in organizational life, the social processes of establishing an innovation praxis can be further specified. In fact, two variants, which are driven by social processes of establishing standards, can be distinguished. While the first refers to the

28 This understanding of voluntarily decided rules neglects other types of standards such as de facto standards. The latter describe a more or less consciously adopted uniform technical or social solution. This is typically illustrated by the example of the QWERTY layout for typewriters, which has been established as a de facto standard. The "*the concept of de facto standards refers to processes that lead to uniformity, in the sense that all or nearly all potential adopters eventually come to adopt the same solution and turn it into a model (or de facto standard) that it is difficult to deviate from*" *(Brunsson et al., 2012, p. 617). Such a standard "lacks formal approval by a recognized standards organization or organizations*" (Allen & Sriram, 2000, p. 173).

coercive imposition of technical standards on innovation partners, a second variant underlines the negotiation and monitoring of labor standards. Ortmann (2014) refers to the latter process as a process of establishing collective standards of behavior. These standards of behavior are understood as the generalized imposition of procedures or methods of a normatively connotated praxis, as expressed in the following quotation.[29]

Examples of working standards are practices of 'good management' or professional codes of conduct (Brunsson et al., 2012; Scott, 2008, p. 100). Other examples might be work process standards which have been adapted based on those standards that are monitored by the International Organization for Standardization (ISO) in Geneva in order to protect the environment (ISO 14001), guarantee the quality of products and services (ISO 9001) or provide guidelines of risk management (ISO 31000) or social responsibility (ISO 26000) (Beck & Walgenbach, 2005; Brunsson et al., 2012; Heras-Saizarbitoria & Boiral, 2012; Sandholtz, 2012). Apart from such process standards, Ortmann (2014, p. 34) also speaks of "*various organizational rules*" without further specifying them.

Table 5: Types of standards in innovation projects

	Technical standards	**Behavioral standards**
Logic of regulation	Indirect regulation of collective behavior within innovation networks based on explicit, codified, documented specifications (design rules)	Direct regulation of the collective behavior of innovation partners by establishing a normatively connotated praxis of innovation
Form of power	Coercive rules: imposition of design rules that are derived from the dominant design and which are controlled by third parties such as certifying bodies	Normatively binding expectations: Shared, normatively connoted procedures or methods of designing, building and testing that are established and controlled by the innovation partners

29 The idea that knowledge integration might rely on such behavioral standards is partly supported by research. Sankowska & Söderlund (2015) analysed knowledge integration among professionals (engineers). The authors maintain that the success of knowledge integration is not directly related with a trusted work environment, but – and maybe more importantly – also with the "*perceived value of the assignment*" (p. 5) which facilitates technical problem-solving. In the context of a public construction project, Swärd (2016) found that norms of reciprocity existing at the industry level or being developed in the course of the project suffice to coordinate action.

	Technical standards	Behavioral standards
Examples	IEC norm 61.400 that specifies the design of wind turbines (e.g., performance, safety, testing procedures)	Criteria of risk assessment, norms of professional work, ISO-process norms (product quality, environmental protection)

(own illustration based on Ortmann, 2014; Scott, 2008)

Table 5 illustrates how both standards can structure innovation praxis. In both cases, standards are imposed on technology development. Standards normatively bind innovation partners together despite differences in cognitive frameworks (expertise) or self-interests (tied to power positions in the field). Whether coercively imposed or horizontally negotiated, standards thus operate through shared expectations or collective consciousness and are created through social processes of (re)creating working norms that inform innovation partners about the 'rules of the game' for implementing a new technology, but also about the consequences of violating the 'ways of doing things' established within a given field (cf. Elster, 2011).

In sum, the expectation of being sanctioned for violating standards drives collaborative innovation. As an example of the use of technical standards to regulate technology development, a large technology firm could impose such standards on component suppliers and control that the supplier's products comply with these standards. In the case of behavioral standards, heterogeneous organizations might establish their own praxis for designing, building and testing a new technology, including norms of quality, safety or performance. However, the question remains: which norms are found in innovation projects and how do such norms hinder innovation projects?

The author of this book argues that the social process of establishing shared work norms gives structure and meaning to innovation projects by establishing a system of norms either through coercive imposition or through horizontal negotiation. Particularly in the context of radical innovation, the author of this book argues that the social process of creating shared work norms is key to the introduction of complex technologies. This means that the management of innovation projects is largely an informal process of constantly negotiating and monitoring the 'rules of the game' and the 'ways of doing things' that inform the innovation partners involved about how to implement a new technology in a given field and what happens in case of nonconformity (cf. Elster, 2011, 2007, pp. 353–371). As a result, this social process powerfully and normatively binds innovation partners together, despite any existing differences in cognitive frames (expertise) or self-interests (linked to the respective partners' position in the field).

A key assumption made in this study is that, depending on the type of innovation project, different norms of innovation projects can be found. For example, reflexive adaptation may be particularly important in radical innovation projects, which are typically characterized by high levels of uncertainty and the absence of technical standards. Rather than strictly following rules, playing by the book, or simply adopting a collective rationality or shared perception of what is normal (e.g. regarding acceptable risks or norms of professional work), a reflexive stance means critically assessing whether established rules, collective perceptions, expectations and shared beliefs are effective in dealing with a practical problem at hand. From such a perspective, what Ortmann (2014) calls 'practical drift' leaves the collective rationality or established social order of technology development (e.g. in terms of design rules, technical expectations or shared beliefs) open to improvised local rationalities and organizational change. Thus, because radical innovation projects tend to operate in conditions of institutional uncertainty and lack of applicable technical standards, they are likely to generate an innovation praxis that is characterized by negotiating new working standards and monitoring the collective behavior of the professionals involved. The coercive imposition of technical standards, on the other hand, is most likely to occur in incremental innovation projects located in highly established technology fields.

Table 6: Two forms of norming the innovation praxis

Coercive imposition: rule-following without questioning	**Horizontal negotiations:** *reflexive rule adaptation*
Typical in contexts of incremental innovation	Typical in contexts of radical innovation
Praxis is based on coercive power exercised by an incumbent actor	Praxis is based on the normative power of voluntarily decided rules
Professionals play by the book without reflection, reproducing established standards	Professionals reflect and interpret rules with regard to a given practical problem
Accepting a collective wisdom or rationality of technology development laid out in rules or blue-prints established in the field	Critically reflecting established rules of technology development and deviating from them if problem-solving requires this

As Table 6 illustrates, the norming of the innovation praxis differs according to the type of innovation. This means that in cases of incremental innovation, a logic of playing by the book without reflection and unquestioning acceptance of collective wisdom on how to implement a new technology may be followed in an innovation project where experts rely mainly on technical standards. This kind of project work can also be described as the adoption of a collective rationality, or acting according to the rules or blueprints that have been established in the field. This logic of action stabilizes a social order, such as

a project network, because it is formalized in the form of rules. In short, the social processes of establishing an innovation praxis cannot always be reduced to the negotiation and monitoring of standards. They often also imply the reproduction of an already established collective wisdom of technological development controlled by powerful actors in the field.

Conversely, in contexts of radical innovation, professionals work together solely on the basis of newly established standards of work. There is a different logic to the innovation praxis. The process requires a critical perspective on established rules of technology development. The professionals involved will reflect and interpret such rules in relation to a given practical problem, rather than simply playing by the book. Establishing new working standards involves deviating from or breaking rules, which is to be expected especially in fields characterized by a high degree of uncertainty or ambiguity. Ortmann (2014) gives the example of teachers or air traffic controllers who are not able to play strictly according to the rules in order to keep the 'system' running. Another example is that of surgeons who, in the event of complications during an operation, have to deviate from the operation plans and the established routines.

In short, two forms of establishing an innovation praxis can be distinguished. Imposing technical standards implies a logic of acting that can be described as following rules without questioning. The social process of horizontally negotiating working standards, on the other hand, describes a logic of reflexive rule adaptation, which in turn implies adapting rules to situational conditions or the practical problem at hand. In this way, an innovation praxis can emerge that is at variance with the work standards established in the field.

The social process of establishing an innovation praxis, i.e. the reproduction of existing work standards on the one hand or the reflexive adaptation of rules to a given technical problem on the other hand, is a key driver of innovation and new technologies. The question then is: Which institutional conditions favor one of these processes? The author of this book provide answers to this question.

One open question that the author of this book wants to address is whether strict rule-following and playing by the book on the one hand, or the erosion of standards through practice drift or reflexive adaptation of rules on the other, can be found in innovation projects.[30] So far, we have only established that in radical innovation projects, which are typically characterized by deviations from technical standards, project work is structured by the creation

30 Ortmann (2014) illustrates this question by two examples: friendly fire and US combat aircrafts shooting down two other American helicopters in Northern Iraq, and the Challenger catastrophe in 1986.

of shared working standards, whereas in incremental innovation projects the innovation partners involved rely mainly on established technical standards and simply reproduce the rules of technology development established in the field.

If we now assume that innovation projects are managed on the basis of a largely informal process of (re)creation of working standards, different types of innovation projects – incremental or radical innovations as well as emerging technology fields – may reveal different institutional barriers.

In summary, this section has argued that the social process of norming an innovation praxis strongly influences the outcome of innovation projects. This social process functions either on the basis of coercive imposition or on the basis of collaborative negotiation between professionals working together to solve new problems. These assumptions will be evaluated in the empirical part of this book through a comparison of three types of innovation projects: two examples of incremental innovation, two examples of radical innovation and two examples of technology development that is emerging in the German offshore wind energy industry (short: emerging technologies). It will be shown that the institutional configuration of the innovation praxis is an explanation for the dominance of a particular social process. The empirical analysis is guided by three propositions, which are presented below.

3.3 Three strategies of establishing an innovation praxis

The previous section concluded that the process of establishing shared working standards normatively binds innovation partners together in a similar way to social norms (Elster, 2007, 2011). A shared awareness of being sanctioned for violating standards is expected to be the main driver of this social process. In an innovation praxis, such a shared consciousness can be enforced by an incumbent who defines design rules and monitors compliance with them. Alternatively, it can be created through processes of negotiation and compromise.

The author of this book empirically analyses whether such an innovation praxis can be found in collaborative innovation, and how they differ, by looking at technology development in the wind energy industry.

The author of this book empirically analyses whether the social process of establishing shared working standards can be found in innovation projects in the wind energy industry. However, since the projects studied differ in the type of innovation involved, this section proposes three different strategies for establishing technology development standards. The author suggests that innovation occurs differently in different types of fields, drawing on field

theory. Fligstein & McAdam (2011, p. 11) state that fields "*tend to move into one of three states: unorganized or emerging, organized and stable but changing, and organized and unstable and open to change*". Here the emerging fields of technology development are related to Fligstein and McAdam's unorganized fields. Fligstein and McAdam's fields that are organized and stable but changing are associated with incremental innovation. Finally, radical innovation is possible in fields that are organized, unstable and open to change.

The empirical evaluation is guided by the following propositions.

3.3.1 Proposition 1: Monitoring technical standards and sanctioning their non-conformity

In incremental innovation projects – technology development within a technology life cycle (Foucart & Li, 2021) – it is common for a project team to improve on a dominant design or on an existing technological architecture (March, 1991; Nooteboom, 2014). In such contexts, the expectation is that technical standards will pre-determine technology development. Collaboration partners mainly use existing knowledge for the improvement of components or sub-systems. The processes of jointly designing, building and testing a new technology are realized through established R&D partnerships or component supplying networks. In such contexts, new technologies are typically introduced based on existing technical standards. Innovation projects reproduce existing technical knowledge and collaboration takes place between trusted partners. Incumbent technology firms are able to impose their technical expectations on other suppliers at the top of an innovation network.

In this context, innovation projects can be expected to be organized around technical standards. However, innovation networks are typically made up of formally independent organizations. They are 'bound' together by interdependencies and knowledge complementarities. For this reason, technical standards can rarely be imposed through hierarchies or through the authoritative directives of one partner alone – Cook & Gerbasi (cf. 2011, pp. 225–228). With regard to inter-firm collaboration, Huxham & Beech (2010) propose a relational concept of power, which means that coercion does not exist as a force that emanates from the external environment of organizations. Rather, power becomes manifest only as it is exercised in the daily interactions between members of different organizations. The authors define power as "the ability to influence, control or resist others' activities" (ibid, p.555). In everyday praxis, innovation partners combine the sources of power they perceive to be available to them and try to shape collective behavior according to their interests or to resist the activities of others (cf. Dörrenbächer & Gammelgaard, 2011).

This means that within innovation networks, partners with a lower position of power also organize cooperation.

All in all, since hierarchical coercion is not sufficient to drive innovation projects even in established technology fields with dominant incumbents, it can be expected that innovation projects are organized through practices of monitoring technical standards and sanctioning non-conformity. The first proposition is based on this theoretical assumption:

> *Proposition 1: The praxis of innovation is mainly shaped by the monitoring of technical standards and the sanctioning of nonconformity when innovation projects are initiated in organized and stable fields.*

3.3.2 Proposition 2: Establishing a praxis of collaborative problem-solving

A praxis of radical innovation – technology development happens beyond the present technology life cycle (Foucart & Li, 2021) – typically deviates from technical standards or changes an existing technological architecture. The technical knowledge needed to innovate is rarely institutionalized and needs to be explored or created from scratch (March, 1991; Nooteboom, 2014). Technologies are radically new when they reconfigure a dominant design. Or when they create what is later called a technological breakthrough. Because radically new technical knowledge is involved, specialists from outside the technological field may be approached and asked to collaborate (Cropper & Palmer, 2009; Johnsen et al., 2009). New social relationships are required.

Collaborating with new partners is associated with two relational risks: (1) hold-up and (2) spillover risks (Nooteboom, 2014). The former refers to investments in relationships. For example, building mutual understanding or personal trust. Hold-up risks also arise when sensitive information has to be exchanged or when new relationships have to be established with new partners. The latter risk refers to the loss of a company's proprietary knowledge as a result of collaboration. This can happen when former developing partners become competitors or when developing partners transfer new knowledge created in the joint project to competitors (Yang & Steensma, 2014).

In the literature, trust building is discussed as one option for the management of such relational risks. Personal trust, for example, is a type of trust that results from repeated personal interactions between agents (Bachmann & Inkpen, 2011; Zucker, 1986). Personal trust is understood as a psychological phenomenon, a state of mind, or an actor's belief that: "the other party has an incentive to act in his or her interest or to take his or her interests to heart" (Cook & Gerbasi, 2011, p. 220). However, since personal trust requires intensive and time-consuming face-to-face interactions, it has been criticized as a basis for the regulation of interfirm relations (cf. Bachmann & Inkpen,

2011; Bachmann et al., 2015; Bachmann & Zaheer, 2014). This is why the literature discusses institution-based trust as another possibility for the organization of interfirm relations. This type of trust results from encountering impersonal institutional arrangements such as "legal regulations, professional codes of conduct that may or may not be legally binding, corporate reputation, employment contract standards, and other formal and informal norms of behavior" (Bachmann & Inkpen, 2011, p. 285). From this point of view, the establishment of common standards of work provides innovation partners with institutional trust.

Huxham & Beech (2010) point out that inter-firm relationships based on institutional trust are less likely to emerge when collaboration is characterized by strong power imbalances. On the other hand, they are more likely to emerge when collaborative relationships are more balanced, which is typically the case in radical innovation contexts. Consequently, norms need to be negotiated and monitored in radical innovation projects, which typically do not have high power imbalances.

The debate on trust points to trust building as an important part of establishing an innovation praxis (cf. McEvily et al., 2003; Zucker, 1986). Therefore, the aim of this book is to understand how the social process of establishing shared normative procedures and methods facilitate collaboration in contexts of radical innovation. Once established, such work norms describe ways of designing, building and testing a new technology in collaboration with new partners. This process of establishing an innovation praxis involves informal rules of conduct for negotiating project goals, seeking compromises on technical solutions, or sharing proprietary knowledge, despite the relational risks involved in any new collaboration. The following proposition summarizes this:

> *Proposition 2: When a radically new technology is being developed, the praxis of innovation is likely to be shaped by newly created procedures and methods for solving collaborative problems.*

3.3.3 Proposition 3: Adapting technical standards from adjacent fields

Finally, a third proposition is introduced. It relates to emerging technology fields. The previous two propositions covered only incremental and radical innovation. However, innovation projects can also operate in emerging technology fields that emerge around a new issue. Typically, such fields emerge as a result of new regulations introduced by public authorities. An example of this is the mandatory use of catalytic converters in cars. A more recent example from the renewable energy sector is the introduction of environmental

regulations. These have created new issues and new technology fields in the offshore wind industry.

Projects operating in such environments are unlikely to have access to either technical standards or potential innovation partners for the development of new technology. Instead, they are expected to develop technology from scratch. In order to facilitate the introduction of new technologies, innovation projects adapt technical standards from adjacent fields, which – in the context of offshore wind energy, for example – refers to the oil and gas industry (cf. Mäkitie, 2019). As Fligstein & McAdam (2011, p10) state: "*Adjacent fields are a readily available and generally trusted source of new ideas and practices*." This is expressed in the following proposition:

> *Proposition 3: When an innovation praxis has to establish itself in an emerging sector, it is likely to adapt technical standards from adjacent fields.*

The three propositions presented above are empirically evaluated in the analytical part of this book. Six cases of innovation projects in the wind energy sector are combined into three pairs of similar cases, (1) two projects of incremental innovation, (2) two projects of radical innovation, and (3) two projects operating in emerging technology fields. For each context, it is shown which innovation praxis emerged and how these findings explain the unintended outcomes of innovation projects.