

# Managing knowledge in open innovation processes: an intellectual property perspective

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## Abstract

**Purpose** – As firms turn their innovation activities toward collaborating with external partners, they face additional challenges in managing their knowledge. While different modes of intellectual property right regimes are applied in closed innovation systems, there seems to be tension between the concepts of “open innovation” and “intellectual property rights”. The purpose of this paper is to investigate how firms best manage knowledge via intellectual property rights in open innovation processes.

**Design/methodology/approach** – Following a mixed methods approach, the authors review relevant literature at the intersection of knowledge management, intellectual property rights, strategic management of intellectual property rights and the open innovation process. The authors identify success drivers through the lenses of – but not limited to – intellectual property rights and classify them in five distinct groups. Expanding the view on open innovation beyond its *modus operandi*, the authors develop the Open Innovation Life Cycle, covering three stages and three levels of the open innovation process. The authors apply their findings to a case study in the pharmaceutical industry.

**Findings** – The authors provide four key contributions. First, existing literature yields inconclusive results concerning the enabling or disabling function of intellectual property rights in open innovation processes, but the majority of scholars detect an ambivalent relation. Second, they identify and classify success drivers of successful knowledge management via intellectual property rights in open innovation processes. Third, they advance literature on open innovation beyond its *modus operandi* to include three stages and three levels. Fourth, they test their findings to a case study and show how management leverages knowledge by properly using intellectual property rights in open innovation.

**Practical implications** – The findings support firms in managing knowledge via intellectual property rights in open innovation processes. Management should account for the peculiarities of open innovation preparation and open innovation termination to prevent unintentional knowledge drain.

**Originality/value** – This is one of the first studies to view open innovation as a process beyond its *modus operandi* by considering the preparations for and termination of open innovation activities. It also addresses the levels involved in managing knowledge via intellectual property rights in open innovation from individual (personal) to project and firm level.

**Keywords** Intellectual property, Knowledge management, Open innovation, Patents, Innovation process, Success drivers

**Paper type** Case study

## Introduction

In late 2011, personal care conglomerate Beiersdorf “celebrat[ed] the most successful deodorant launch ever seen in the almost 130-year history of the company” (Beiersdorf, 2011). The deodorant leaves no stains or white marks on clothes, but peculiar about the new product is that it was co-developed in an open innovation project with partners using the recently launched online platform Pearlfinder. It was established to guarantee a new level of openness in research and development (R&D) projects and to leverage new collaborations with external partners (Beiersdorf, 2014; Bilgram *et al.*, 2011, 2013;

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Mattes, 2011). From an intellectual property perspective, Beiersdorf's platform differentiates to competitor initiatives concerning the confidentiality of submitted knowledge. The intellectual property rights remain with the inventors and are not automatically assigned to Beiersdorf. Instead, a mutual agreement is signed that guarantees reciprocal confidentiality and no sole patent activity so that the benefits of the joint work are shared among Beiersdorf and the inventors. Conversely, when submitting to P&G's connect + develop initiative, knowledge can only be proposed if some form of intellectual property protection exists (Procter and Gamble, 2014b). Further, P&G will not sign non-disclosure agreements (Procter and Gamble, 2014a).

From these two prominent examples, it becomes evident that even though these firms are in the same industry, diverging approaches are used when it comes to the strategic management of knowledge via intellectual property rights in open innovation processes. Chesbrough (2003a) defined open innovation opposite to the vertically integrated closed innovation model in which all innovation activities, including entire R&D processes, are internal to firms. Here, firms innovate, subsequently protect new knowledge and appropriate returns through intellectual property rights. In open innovation, firms utilize internal and external knowledge by establishing upstream and downstream paths to markets, e.g. to suppliers and customers (Hagedoorn, 1993, 2002). Existing boundaries between firms and their environments become porous, wherefore knowledge flows between them. Hence, firms can commercialize knowledge generated outside their own R&D departments (Chesbrough, 2003b).

"Intellectual property [...] refers to creations of the mind, such as inventions; literary and artistic works; designs; and symbols, names and images used in commerce" (WIPO, 2015). In law, intellectual property is protected by intellectual property rights, specifically the different right regimes such as patents, copyrights and trademarks. In open innovation, value extraction from knowledge through intellectual property rights is possible on a broad scope, e.g. by selling, licensing or donating intellectual property rights and by collaboration with external partners (Conley *et al.*, 2013; Fisher and Oberholzer-Gee, 2013; Peters *et al.*, 2013). The reason is that firm boundaries become porous, wherefore firms can utilize knowledge generated in external entities as well as commercialize internally generated knowledge externally that would otherwise be on halt (Gassmann and Enkel, 2004).

Nonetheless, literature yields inconclusive results on the enabling or disabling function of intellectual property rights in open innovation. As a first contribution, we identify three strains of research. While one strain regards intellectual property rights to enable open innovation (Dubiansky, 2006; Lichtenthaler, 2010; Pisano and Teece, 2007) and a second strain identifies hindrance (De Laat, 2005; Simcoe, 2006; Von Hippel and Von Krogh, 2003), the majority of scholars detect an ambivalent role of intellectual property rights (Bogers *et al.*, 2012; Lee, 2009; Lee *et al.*, 2010). Here, a peak point for protection is reached turning positive effects negative. To understand what drives the success of the strategic management of knowledge via intellectual property rights in open innovation processes, we synthesize success drivers for open innovation activities from the literature as our second contribution.

Further, we identify that prior research focused, with few exceptions, on the *modus operandi* of open innovation (Granstrand and Holgersson, 2014; Manzini and Lazzarotti, 2015). Only few articles offer recommendations for management from the strategic management perspective (Al-Aali and Teece, 2013; Di Minin and Faems, 2013). Current literature is concerned with general behavior rather than systematically analyzing actual options to strategically manage knowledge with external partners, neglecting a process perspective on open innovation (Hagedoorn and Ridder, 2012). To address this matter, we develop the Open Innovation Life Cycle as our third contribution to contemplate open innovation activities during and beyond active collaborations. It structures the open innovation process into three stages: preparation, operation and termination. We also

distinguish three decision-making levels for all stages of the Open Innovation Life Cycle: individual (personal), project and firm level. For each combination, we assign relevant success drivers and analyze their impact during one or several of the three stages, classifying the success drivers in five categories: planning; partnering; governance; competence, culture and mindset; and competitive landscape. As our fourth contribution, we apply our process perspective on open innovation and the success drivers to a prominent open innovation example in the pharmaceutical industry, Pfizer's blockbuster drug Lyrica. We show that success drivers take effect during all stages and on different levels, impacting effective knowledge management strategies. Herein, we answer our research question how firms strategically manage their knowledge via intellectual property rights in open innovation processes and environments.

This paper is structured as follows. In the second section, we review and group the relevant literature in the three strains of research. The third section introduces the Open Innovation Life Cycle, whereas the fourth section comprises an overview of the success drivers. In the fifth section, we apply the Open Innovation Life Cycle to the Lyrica case. The paper concludes with a discussion in the sixth section.

### Review of relevant literature

Chesbrough *et al.* (2006) and Chesbrough (2012) defined the open innovation paradigm as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation". Gassmann and Enkel (2004) defined three core process archetypes how firms apply open innovation activities to source and commercialize internal and external knowledge: outside-in, inside-out and coupled (joint outside-in and inside-out) processes.

Firms' strategic management of intellectual property rights depends on their embeddedness in such open or closed innovation systems. Closed innovation firms generate and commercialize own inventions internally, wherefore the main purpose of intellectual property rights in this context is to protect this knowledge and exclude others (Chesbrough, 2003c). Contrastingly, open innovation firms pertain to broader scopes in managing intellectual property (Chesbrough, 2003c; De Jong *et al.*, 2008). All internal and external knowledge-related activities have to be considered. Decisions how to further develop inventions affect new knowledge utilizations and subsequent intellectual property right regime choices, e.g. patents, copyrights or trademarks. Consequently, scholars raised awareness for such challenges, governance and control within R&D processes, as well as strategic intellectual property management by multiple parties (Enkel *et al.*, 2009; Graham and Mowery, 2006; West, 2006). Porous firm boundaries result in less proprietary control and increased coordination costs, requiring a joint analysis of open innovation and intellectual property.

### *Intellectual property as disabler of open innovation*

Tension between intellectual property rights and open innovation persists (Georgiades, 2011). For example, coders in the sphere of open source software allow some use but exclude others by claiming their copyright (De Laat, 2005). Free revelation of technical solutions and no private returns from open source software sales are more beneficial for society than strict intellectual property protection regimes (Von Hippel and Von Krogh, 2003).

Shinneman (2010) explored open innovation by investigating issues involving global intellectual property rights, concluding that their integration becomes more relevant for firms in open innovation. However, current patent law does not support but even hinders this development and needs to be reformed to facilitate open innovation activities, to promote greater transparency and to consider open innovation's decentralized nature

(Boyle, 2012; Simcoe, 2006). Specific reforms to control patent law claims and the capacity of involved legal institutions are proposed (Boyle, 2012).

Salter *et al.* (2014) examined the challenges and resistances individuals face in open innovation. Individuals prefer to collaborate with partners they know and trust. A mutual understanding and a safe environment for information exchange are the main reasons for this skepticism. Also, individuals are hesitant to disclose information, but intellectual property needs to be disclosed externally to enable the willingness to cooperate.

### *Intellectual property as enabler of open innovation*

In a contrasting view, firms without intellectual property-based value capture strategies forfeit opportunities from open innovation activities, as Baum *et al.* (2000) showed for start-ups. Dubiansky (2006) identified positive effects of patents on relations among small innovators and established producers in open innovation and suggested further advancements in the legal domain because “patent protection alone is insufficient to facilitate open innovation systems” (Dubiansky, 2006).

As a manifestation of open innovation, open source software is characterized by intrinsic rather than value capture motivations (Maurer and Scotchmer, 2006). Open source software is advantageous due to the fast exchange of software code. Nevertheless, patent regimes prevent an under-supply of goods and increase the usability of software for non-programmers. The authors concluded that patent regimes and open source software do not substitute each other.

Pisano and Teece (2007) focused on the strength of the appropriability regime and industry architecture. Pushing technologies into the public domain can be a greater value creator than keeping those technologies proprietary. When examining the role of appropriability regimes and open business models, Pisano and Teece (2007) argued “strong appropriability based on strong [intellectual property [. . .] supports open innovation”. A clear definition of the scope and disclosure of property rights is essential for markets and knowledge exchange to work efficiently. Intellectual property boundaries foster innovators’ behavior to license-out property.

Lichtenthaler (2010) investigated the effect of firms’ strategic intellectual property rights management on the degree of their openness, i.e. the extent to which they engage in open innovation. He proposed a positive relation between intellectual property rights and open innovation, concluding that firms’ intellectual property right portfolios are main drivers of open innovation, as they foster the extent to which firms open up their innovation activities. Chesbrough and Chen (2013) showed that more open approaches foster the utilization of previously abandoned scientific discoveries and patents. Moreover, they proposed whether and when to license-out internal intellectual property rights and suggested proactive intellectual property rights management in open innovation. Confirming the positive relation between the degree of firm openness and preference for intellectual property protection, Hagedoorn and Ridder (2012) viewed intellectual property protection to enable open innovation.

### *Intellectual property as ambivalent to open innovation*

Other scholars discovered an ambivalent role of intellectual property in open innovation and contradictory treatment of collaborative innovation in patent law (Bensoussan *et al.*, 2013; Lee, 2009). For example, West (2006) identified that tight appropriability limits information exchange, increasing necessary communication efforts to attune strategies for effective collaboration while decreasing own abilities to capture value from open innovation. Only proactively oriented formal and informal governance mechanisms guarantee sufficiently fluid communication for open innovation to excel, hence intellectual property rights to foster open innovation (Lee *et al.*, 2010). Indicating an ambivalent role of

intellectual property, its management requires case-by-case approaches, e.g. patenting only valuable aspects of inventions or disposing patents via donations or licensing (Alexy *et al.*, 2009).

Intellectual property modularity bridges the gap between value capture and value creation (Baldwin and Henkel, 2015; Henkel *et al.*, 2013). The offsetting effect of intellectual property rights on open innovation is ascertained. However, the authors proposed to align firms' intellectual property right structures with the technical modules along production processes. This decreases intellectual property incompatibilities and conflicts with regard to ownership rights, hence, and enables collaborative engagement. West and Gallagher (2006) explained how strategies such as pooled R&D and product development, spin-outs, selling complements and attracting donated complements fit in the broader concept of open innovation, discovering conflicts between value sharing and value capturing. Value extraction from open innovation is facilitated by intellectual property protection, whereas it simultaneously diminishes innovativeness and the adoption and diffusion of knowledge (Bogers *et al.*, 2012). Firms need to combine their knowledge exploitation strategy, i.e. intellectual property management strategy, with their knowledge exploration strategy, in particular the mechanisms to exchange knowledge (Laursen and Salter, 2014).

Intellectual property rights set the boundaries of new knowledge and disclose its attributes, forming efficient licensing markets (Graham and Mowery, 2006). Nevertheless, strong intellectual property rights result in limited access to knowledge created by externals. Rao *et al.* (2011) investigated whether open source software and strict intellectual property protection can co-exist, identifying such a trend. Both, the patent holder and the open source community build on each other's strengths by extending their respective business models. For Evans and Layne-Farrar (2004), patents positively influence the funding of small firms, whereas opening up intellectual property portfolios to patent pools and cross-licensing decreases innovation hold-ups of intellectual property thickets.

### Success drivers

The relation between intellectual property rights and open innovation remains controversial. While some scholars view intellectual property rights as hindrance to open innovation activities, the majority discover at least some positive effect of intellectual property rights on open innovation processes. Nonetheless, that intellectual property rights are an integral part of open innovation processes is commonly shared in prior research at the interface of these two literature streams. To assess the role of intellectual property rights in open innovation processes and to enable the sharing of knowledge via intellectual property rights, we identify success drivers of open innovation activities and classify them in five distinct groups: planning; partnering; governance; competence, culture and mindset; and competitive landscape.

#### Planning

Planning covers the joint alignment of expectations and objectives (Mohr and Spekman, 1994). It includes aspects such as financial resource deployment, time allocation and information technology infrastructure (Chau and Tam, 1997; Dogson *et al.*, 2006; Kuschel *et al.*, 2010; Van de Vrande *et al.*, 2009). Wallin and Von Krogh (2010) recommended defining R&D process steps, to identify innovation-relevant knowledge and to select appropriate mechanisms for knowledge integration, creation and commercialization. As senior managements determine firms' objectives, they have to become convinced about the advantages of tailored and combined open innovation and intellectual property strategies for such knowledge integration (Nakagaki *et al.*, 2012). Serving as a role model, the senior management contributes to the success of open innovation activities (Chesbrough and Crowther, 2006). This part of corporate strategy implies that firms discover if and how they can participate in open innovation activities (Chesbrough and

Crowther, 2006). Firms benefit from corporate entrepreneurship, especially corporate venturing, spin-off activities to commercialize internal knowledge externally and intrapreneurship, in particular to encourage employees to become more innovative (De Jong *et al.*, 2008). This is fostered by changes in human resource management when preparing to engage in open innovation, for example, in providing R&D employees with more flexibility in developing their career paths and staffing R&D teams with complementary, intellectual property-knowledgeable team members (Petroni *et al.*, 2012). These corporate entrepreneurship and human resource activities enable open innovation and therein provide new value creation opportunities.

Alexy *et al.* (2009) suggested a case-by-case intellectual property approach. Multiple options exist for firms to extract value from in- and external intellectual property, share, or even donate their property (Peters *et al.*, 2013). Examples are licensing forms, e.g. cross-licensing and patent pools, or smart patenting, i.e. strict value focus when deciding what to patent (Alexy *et al.*, 2009; Bogers *et al.*, 2012; Lichtenthaler *et al.*, 2011). Herein, modular intellectual property systems are an option, as they are effective to overcome some intellectual property challenges in open innovation (Henkel *et al.*, 2013; Salter *et al.*, 2014). Intellectual property modularity aims at protecting and capturing value through intellectual property and is based on the idea that different firms are responsible for different modules of the innovation activities (Henkel *et al.*, 2013). Consequently, firms are able to operate parts of their R&D process alone (internally) but open other parts. This results in distinct modules of the R&D process and enables firms to keep sensitive core knowledge proprietary while releasing less sensitive information to the open innovation community.

### Partnering

To generate compatibility between partnering firms, prior research pointed to the importance of partner selection (Erzurumlu, 2010; Hoffmann and Schlosser, 2001; Ollila and Elmquist, 2011). Similarities with regard to approaches, priorities, and processes are beneficial for external relations (Munsch, 2009). Further, proximity between firms, i.e. similarity with regard to knowledge, organizational arrangements, institutional frameworks or physical distances, supports open innovation and mutual learning (Boschma, 2005). Identifying and negotiating with potential partners requires networking skills, i.e. the “ability to develop and use technology-oriented inter-organizational relationships to link [. . .] competencies with those of [. . .] partners in the innovation network” (Ritter and Gemünden, 2004). As a source for new knowledge, networking supports the commercialization of internal knowledge and is regarded as a key characteristic of open innovation firms (De Jong *et al.*, 2008). Modes of networking include the placement of technology scouts, co-funding activities at incubators and the creation of collaboration internet portals (Fetterhoff and Voelkel, 2006). Salter *et al.* (2014) focused on challenges by claiming that networking capabilities are often decreased through individuals’ tendencies to prefer collaboration with existing, long-term partners. Consequently, firms can miss out on new opportunities for external partnerships. To overcome the complexity of integrating new partners and binding intellectual property arrangements, networking capabilities are fostered through the formation of transaction-light partnerships (Salter *et al.*, 2014). These involve non-essential development areas and standard intellectual property protection contracts, hence supporting to build relations without deep commitment. Contracts need to clarify control appropriations and contingencies, intellectual property ownership and the allocation of rights (Granstrand and Holgersson, 2014; Hagedoorn and Zobel, 2015; Lee *et al.*, 2010). The establishment of separate internal business groups dealing with open innovation improves the utilization of in- and external knowledge (Kirschbaum, 2005). To maintain their absorptive capacity and their attractiveness for partners, firms have to strengthen their internal R&D departments (De Jong *et al.*, 2008; Grimaldi *et al.*, 2013; Newey, 2010).

## Governance

Effective governance mechanisms improve the coordination of open innovation activities (Bogers *et al.*, 2012; Hoffmann and Schlosser, 2001; Lee, 2009). Scholars considered obstacles such as information and communication cost among partnering firms and the alignment of different objectives as key challenges to open innovation (Mohr and Spekman, 1994; Rodríguez and Lorenzo, 2011). Chesbrough and Crowther (2006) underlined the importance to assign business ownership via intellectual property and responsibility among involved parties. Senior management decisions, contracts to formally codify responsibility and balanced control mechanisms are tools available to systematically govern open innovation and confidentially share knowledge (Chesbrough and Crowther, 2006; Granstrand and Holgersson, 2014; Hagedoorn and Zobel, 2015; Lee *et al.*, 2010; Wallin and Von Krogh, 2010; Wang *et al.*, 2011).

Standardizing and publicizing the out-licensing process supports open innovation activities because resources necessary for intellectual property management are reduced (Chesbrough and Chen, 2013; Lichtenthaler *et al.*, 2011). To overcome information asymmetry and uncertainty, Feller *et al.* (2009) proposed governance through intermediaries acting as brokers between partnering firms actively engaged in joint innovation activities (Agogue *et al.*, 2013). These brokers integrate knowledge among the involved firms, provide value-added services, reduce transaction costs due to economies of scale and expedite the emergence of open innovation communities in controlled environments. Bogers *et al.* (2012) recommended layered collaboration schemes to reduce the coordination complexity by differentiating close from distant partners. With the number of partners increasing, the imitation risk rises, but the risk can be mitigated by the proactive management of appropriate protection mechanisms like patents (Foege *et al.*, 2017; Veer *et al.*, 2016).

Providing incentivizing governance mechanisms enhances employees engagement in open innovation (Ollila and Elmquist, 2011; Rodríguez and Lorenzo, 2011). Aligning metrics and incentives to encourage success and the communication on how open innovation practices are integrated in corporate strategy and objectives is important. Informing employees of the gains achieved from specific open innovation activities before and installing flexible reward and promotion systems during and after the collaborations foster their commitment (Chesbrough and Crowther, 2006; Salter *et al.*, 2014). Modifying management systems through structured governance mechanisms to prevent separate structures for open and closed innovation activities further reduces reluctance toward open innovation (Chesbrough and Crowther, 2006; Van de Vrande *et al.*, 2009).

## Competence, culture and mindset

Ritter and Gemünden (2004) defined competence “as a potential, or qualification, to perform activities”, highlighting the significance of firms’ networks and technological competences. Individuals need to understand the strategic and operative linkages within open innovation activities, external environments and contextual factors (Ollila and Elmquist, 2011). To integrate external knowledge, employees need relevant competencies, i.e. absorptive capacities (Cohen and Levinthal, 1990). Training in fields like interpersonal, project, content and self-management help professionals to adapt to knowledge sharing challenges in open innovation (Du Chatenier *et al.*, 2010; Salter *et al.*, 2014). Cooperating with lawyers and ensuring a balanced relation between lawyers and employees sharpen the necessity for and understanding of knowledge sharing via intellectual property rights in open innovation (Alexy *et al.*, 2009; Lee *et al.*, 2010). Shifting the organizational mindset toward an open innovation culture enhances the success of open innovation (Nakagaki *et al.*, 2012). When innovating with external partners, the not-invented-here syndrome and its consequences affect the collaboration (Katz and Allen, 1982). R&D employees are unwilling to accept solutions developed by external partners because this is equated with internal R&D failure (Nakagaki

*et al.*, 2012). Gatekeepers assist in building trust to overcome the syndrome and influence attitudes of whole communities (Salter *et al.*, 2014). Trust, teamwork and entrepreneurship are prerequisites for functioning knowledge sharing in open innovation (Hoffmann and Schlosser, 2001; Kirschbaum, 2005; Mohr and Spekman, 1994). The mindset shared in firms is also influenced by inherent absorptive capacities, where high absorptive capacity is an indicator for the successful adoption of open innovation (Grimaldi *et al.*, 2013; Huang and Rice, 2009).

### Competitive landscape

When firms emerge as key players out of open innovation activities, competitive landscapes structurally shift (Munsch, 2009). For instance, direct competition between open innovation partners results from the exchange of knowledge. Therefore, potential issues arising after the termination of open innovation activities are to be anticipated when beginning open innovation activities. Specifically, firms considering engaging in open innovation activities keep possible implications for competition with external partners in mind, such as information leakages after collaboration termination (Lee *et al.*, 2010; Ollila and Elmquist, 2011). Furthermore, the management of intellectual property should be integrated into the structure of the knowledge exchange mechanisms (Laursen and Salter, 2014). Situations in which partners turned competitors can be avoided by considering disruptions to the competitive landscape.

In alliance management, success drivers on closing such collaborations are identified (Hoffmann and Schlosser, 2001). These are transferable to knowledge sharing in open innovation. Drivers include the termination of the partnership only upon approval by all involved partners to prevent loss in reputation and trustworthiness. Another aspect is the early and long-term planning of the termination. Codified agreements are recommended to clarify termination procedures (Hoffmann and Schlosser, 2001). During these procedures, involved parties can consider potential extensions of the collaborations (Fetterhoff and Voelkel, 2006). Hence, closing open innovation activities can become the start of new open innovation initiatives.

### The Open Innovation Life Cycle

Prior research identified success drivers of knowledge sharing in open innovation. Various drivers involve the strategic use of intellectual property rights and thus support the integration of knowledge sharing in open innovation. However, prior research focusses on actual collaboration activities up to commercialization (West and Bogers, 2014). Scholars neglected to regard the entire innovation process of open innovation, i.e. from preparation to termination (Granstrand and Holgersson, 2014; Manzini and Lazzarotti, 2015). The open innovation paradigm concentrated on the *modus operandi* of open innovation (Chesbrough, 2012). Up- and downstream activities, i.e. preparing and terminating collaborations among partners, are neither deliberately excluded nor explicitly considered at the interface of intellectual property and open innovation (Granstrand and Holgersson, 2014). Exceptions such as the assessment which form of intellectual property protection should be applied at which stage during the open innovation process are rare (Manzini and Lazzarotti, 2015).

To successfully integrate open innovation and knowledge sharing via intellectual property rights, we regard the entire open innovation process. Consequently, we integrate intellectual property-related success drivers, as classified into five groups (Table I), not only in the *modus operandi* of open innovation but synthesize the entire process of open innovation into three stages: preparation, operation and termination. Preparation covers the front-end activities that lead up to an active collaboration, e.g. ideation and discovery, and constitute a necessary part of the innovation process (Cooper, 2008). The focal perspective of the open innovation paradigm covers tasks such as the development, launch, and commercialization and is presented in the operation stage (Chesbrough *et al.*, 2006,



**Table I** Open Innovation Life Cycle: Success Drivers

Category	Success drivers	Sources
Planning	<p>Careful strategic planning for partnership preparation requires senior management support, long-term planning and joint alignment of expectations and goals</p> <p>Case-by-case IP approach is profitable through licensing and layered cooperation schemes</p> <p>Define R&amp;D process steps and identify and integrate relevant knowledge by changing recruiting and human resource management practices</p> <p>Establishment of modular IP systems and alignment of technology and IP modules are integral parts of planning</p> <p>Use multiple options to extract value, e.g. donation and disclosure</p> <p>Building and maintaining networking competence generate firm abilities to source external and commercialize internal ideas</p> <p>Clarification of control appropriation, IP ownership and allocation of rights, e.g. in transaction-light partnerships, is securable via standard IP protection contracts</p> <p>High absorptive capacity is obtained and maintained through internal innovation activities</p> <p>Placement of technology scouts, co-funding incubators in the technology sector and creation of internet portals for collaboration proactively generates opportunities</p> <p>Strategic compatibility and proximity concerning organizational, social, institutional and geographical aspects is a prerequisite for successful partner selection</p> <p>Appropriate governance mechanisms and layered collaboration schemes support the alignment of partners</p>	<p>Chesbrough and Crowther (2006), Hoffmann and Schlosser (2001), Mohr and Spekman (1994), Nakagaki <i>et al.</i> (2012)</p> <p>Alexy <i>et al.</i> (2009), Bogers <i>et al.</i> (2012)</p> <p>Petroni <i>et al.</i> (2012), Wallin and von Krogh (2010)</p> <p>Henkel <i>et al.</i> (2013), Salter <i>et al.</i> (2014)</p> <p>Peters <i>et al.</i> (2013)</p> <p>De Jong <i>et al.</i> (2008), Ritter and Gemünden (2004)</p> <p>Lee <i>et al.</i> (2010), Salter <i>et al.</i> (2014)</p> <p>De Jong <i>et al.</i> (2008), Grimaldi <i>et al.</i> (2013)</p> <p>Feiterhoff and Voelkel (2006)</p>
Partnering	<p>Contracts encompassing IP and compliance regulations standardize and publicize out-licensing processes</p> <p>Governance through intermediaries, e.g. lawyers, reduces uncertainty</p> <p>Modifying existing management system allows for consideration of coordination problems and communication of open innovation link to corporate strategy without the creation of separate management structures</p> <p>Proactive IP management, based on strong but adaptable IP regimes and protection, is used to assign business ownership and responsibility for success</p> <p>Introducing formal practices to deeply immerse in partner organizations resolves communication problems and builds mutual trust</p> <p>Shifting organization's mindset and people's understanding toward an open innovation culture enhances identification of potential external IP by R&amp;D personnel</p> <p>Teamwork, entrepreneurial culture and communication via gatekeepers to external R&amp;D communities is critical to keep up long-term project performance and to overcome the NIH-syndrome</p> <p>Training employees to build IP, interpersonal management, project management and technological and networking competence provide incentives to engage in an open innovation culture</p>	<p>Boschma (2005), Munsch (2009), Hoffmann and Bogers <i>et al.</i> (2012), Hoffmann and Schlosser (2001), Lee (2009), Van de Vrande <i>et al.</i> (2009)</p> <p>Chesbrough and Chen (2013), Munsch (2009)</p> <p>Alexy <i>et al.</i> (2009), Feller <i>et al.</i> (2009)</p> <p>Chesbrough and Crowther (2006), Ollila and Elmquist (2011), Rodriguez and Lorenzo (2011)</p> <p>Alexy <i>et al.</i> (2009), Chesbrough and Crowther (2006), Dubiansky (2006)</p> <p>Mohr and Spekman (1994), Salter <i>et al.</i> (2014), Van de Vrande <i>et al.</i> (2009)</p> <p>Chesbrough (2003a), Nakagaki <i>et al.</i> (2012), Ollila and Elmquist (2011)</p> <p>Katz and Allen (1982), Kirschbaum (2005)</p>
Competence, culture and mindset	<p>Integrating IP into knowledge exchange mechanism structures raises the competitive fit</p> <p>Keeping possible implications for competition with external partners in mind prepares for direct competition and possible structural shifts</p> <p>Obtaining market exclusivity or purchasing core technology ensures firms' competitive positions</p> <p>Open innovation project termination is only feasible upon approval of all involved partners and needs to consider deferred obligations</p> <p>Termination activities determine successful extensions of collaborations</p>	<p>Du Chate nier <i>et al.</i> (2010), Ollila and Elmquist (2011), Ritter and Gemünden (2004), Salter <i>et al.</i> (2014)</p> <p>Laursen and Salter (2014)</p> <p>Munsch (2009), Ollila and Elmquist (2011)</p> <p>Chesbrough and Crowther (2006)</p> <p>Hoffmann and Schlosser (2001)</p> <p>Feiterhoff and Voelkel (2006)</p>
Competitive landscape		

Note: IP: intellectual property

Chesbrough 2012; Cooper, 2008). The termination stage comprises of steps to terminate the active collaboration and to account for deferred obligations (Granstrand and Holgersson, 2014). At each of the three stages, we identify factors at the individual (personal), project and firm level (Figure 1).

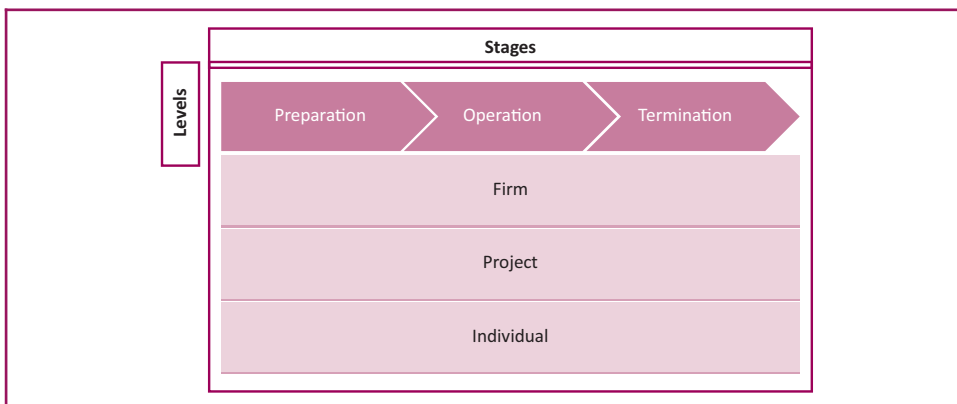
### Preparation

During the preparation stage, strategies at the firm level predefine firms' R&D objectives and approaches (Chesbrough, 2003c; Conley *et al.*, 2013). Part of this are the choices of firm specific knowledge creation and protection mechanisms, i.e. the decisions whether firms specific situations allow, require or hinder engagement in open innovation activities and which intellectual property right regimes, e.g. patents, copyrights or trademarks to utilize (Chesbrough and Crowther, 2006; Wallin and Von Krogh, 2010). Top management support, human resourcing for competence building, the installment of intellectual property departments, as well as networking and technical competence affect the attainment of these firm objectives.

Setting and communicating these firm objectives is crucial for all stakeholders involved in open innovation activities, so that targets are known and become achievable. As role models, senior management shapes the success of open innovation (Chesbrough and Crowther, 2006). Particularly, top management is able to encourage employees to become more innovative and geared toward open innovation (De Jong *et al.*, 2008). Top management can also reshape the human resource strategy when preparing to engage or expand open innovation activities. For example, the human resource department provides R&D employees with more flexibility, time and training to familiarize themselves with open innovation activities, consequently also affecting the individual level (Petroni *et al.*, 2012; Salter *et al.*, 2014). This effect can be facilitated by staffing R&D teams with intellectual property-knowledgeable team members. Otherwise, intellectual property departments or external experts provide expertise and guidance. These intermediaries act as brokers between partnering firms and departments (Agogue *et al.*, 2013). These decisions are shaped at the firm level because they are long-term oriented and costly to reverse, as it requires time and financial resources to build up internal intellectual property departments.

On project level, project objectives define the scope, methods and targets of focal open innovation projects. Together with the intellectual property strategy, they are to be aligned with the overall corporate strategy (Nakagaki *et al.*, 2012). Thereby, firms are able to reduce costs, raise efficiency, and avoid brand or reputational delusion. To account for project specifics, Alexy *et al.* (2009) suggested a case-by-case intellectual property approach from as early as the preparation stage. Decisions on individual cases impact, for example, the scope of the project, the achievable target attainment and target congruency, hence

**Figure 1** The Open Innovation Life Cycle



partner selection. In accordance with decisions on the firm level, decision makers define appropriate innovation steps, identify innovation-relevant knowledge and select appropriate knowledge protection mechanisms (Wallin and Von Krogh, 2010).

### *Operation*

On individual level, absorptive capacity, networking competence, as well as intellectual property secrecy and intellectual property-based incentives are success drivers during the operation stage. Competence refers to skills of individuals actually involved in open innovation activities. The absorptive capacity of the individuals involved in focal open innovation activities predefines project outcomes, wherefore basic intellectual property knowledge should be enrooted in each open innovation team member (De Jong *et al.*, 2008; Grimaldi *et al.*, 2013). Networking skills are another success driver, as individuals have tendencies to prefer collaboration with existing, long-term partners (Ritter and Gemünden, 2004; Salter *et al.*, 2014). Consequently, firms can miss out new opportunities for external partnerships, with a possible solution being the formation of transaction-light partnerships (Granstrand and Holgersson, 2014; Lee *et al.*, 2010; Salter *et al.*, 2014). Individual awareness of intellectual property rights can be fostered by intellectual property-based incentives and governance mechanisms (Rodríguez and Lorenzo, 2011; Ollila and Elmquist, 2011). Specifically, the mindset should incorporate the sensitivity for intellectual property secrecy, not only toward external partners but also internally to minimize the risk of leakages and early exposure. In this context, a buddy model between intellectual property-knowledgeable gatekeeper that influence attitudes of whole communities supports the trust building between the parties and enables the exchange of sensitive information (Salter *et al.*, 2014).

On project level, up- and downstream partner selection and the choice of the applied intellectual property right regimes define the level of intellectual property openness (Conley *et al.*, 2013; Hoffmann and Schlosser, 2001). Modular intellectual property and layered collaboration schemes are means to differentiate partners and the closeness of collaboration (Baldwin and Henkel, 2015; Bogers *et al.*, 2012; Henkel *et al.*, 2013). Using different strategies for these partners facilitates the knowledge exchange coordination among involved firms.

When multiple partners are involved, business and intellectual property ownership are influenced by absorptive capacities and exchange mechanisms (Chesbrough and Crowther, 2006; De Jong *et al.*, 2008; Grimaldi *et al.*, 2013). Individuals are resistant to engage in open innovation projects that involve the collaboration with new partners. They face a paradox when disclosing intellectual property, as intellectual property needs to be disclosed to enable an external partner's willingness to cooperate. However, individuals are hesitant to disclose too much information.

On firm level, networking and value extraction are fostered by high absorptive capacity and standardized intellectual property contracts. Possible metrics for value extraction include the size of the intellectual property right portfolio and strategic considerations on value capture such as partial or exclusive sharing, donating or licensing of intellectual property rights (Peters *et al.*, 2013). The size of firms' intellectual property right portfolios acts as a key promoter of open innovation as it fosters the extent to which firms opens up their innovation processes (Lichtenthaler, 2010).

Responsible for the coordination and standardization of intellectual property related issues can either be the intellectual property or R&D departments, whose presence, strength and level of knowledge constitute the absorptive capacity of the firm, which in turn defines the firm's "ability to value, assimilate and apply new knowledge" (De Jong *et al.*, 2008; Grimaldi *et al.*, 2013). As described, standardizing out-licensing and contracts support the management of open innovation processes (Chesbrough and Chen, 2013; Granstrand and Holgersson, 2014; Lee *et al.*, 2010; Lichtenthaler *et al.*, 2011).

## Termination

Terminating open innovation activities results in less proprietary control and increased coordination costs (Almirall and Casadesus-Masanell, 2010; Enkel *et al.*, 2009). On firm level, strategic considerations like brand spillover effects and deferred obligations like potential collaboration extensions are key activities during the termination stage. Losing control over own or jointly created, associated intellectual property rights endangers the reputation of the whole firm and its brands beyond the open innovation activities of the focal partnership. For example, the reputation associated with trademarks contributed to the open innovation project may be damaged through spillover effects from unsuccessful open innovation initiatives. Examples of the strategic consideration comprise intellectual property monitoring, intellectual property maintenance, intellectual property revenue recognition and intellectual property disassembly, solving questions such as intellectual property ownership, rights enforcement against infringers or on giving up or contributing to, e.g. patent pools (Granstrand and Holgersson, 2014).

As described, the competitive landscape can structurally change after the termination of open innovation activities in focal partnerships and direct competition might emerge (Munsch, 2009; Lee *et al.*, 2010; Ollila and Elmquist, 2011). Through these exchanges, firms may become active in additional, previously unserved industrial fields or strengthen their positions in their core industries at the cost of their open innovation partners. Therefore, firms account for possible implications of competition with external partners by integrating intellectual property strategies into knowledge exchange mechanisms (Laursen and Salter, 2014). On the contrary, experiences from fruitful open innovation activities motivate firms to identify other opportunities in collaborating with their previous partners, which can result in new open innovation projects. Besides initiating new projects from scratch, firms may use jointly created knowledge further to expand and extend into new endeavors, i.e. products and markets, which is fostered by the size of the firms intellectual property right portfolio (Conley *et al.*, 2013; Fetterhoff and Voelkel, 2006; Lichtenthaler, 2010).

## Case: Lyrica

To illustrate the phases and levels of the Open Innovation Life Cycle, it is beneficial to analyze a specific case on how the success drivers have been applied. For this purpose, we rely on the example from the pharmaceutical industry, the drug Lyrica. We chose this case for multiple reasons. First, it was developed in a public-private partnership between Northwestern University, Professor Silverman and his team on one and the pharmaceutical multinational Pfizer on the other side. Public-private partnerships are typical for open innovation as they allow for the realization of projects that partners themselves cannot independently develop and commercialize successfully (Hunter and Stephens, 2010; Perkmann and Walsh, 2007). Second, innovations in the pharmaceutical industry are typically developed in open innovation projects (Gassmann *et al.*, 2010; Hunter and Stephens, 2010). As Professor Silverman noted: "Academic scientists are not constrained by the requirement of making products to remain viable," but "if successful [. . .] larger companies [will be interested] to bring these technologies to the market [. . .] especially in the case of new pharmaceuticals" (Silverman, 2016). Third, as can be seen below, Lyrica is a prominent case of open innovation collaborations: An inventor who by basic research identifies new knowledge without precise applications and teams up with external partners covers all aspects of open innovation. Together with Pfizer, the Northwestern University team did not only solely commercialize its knowledge through an incumbent but also jointly developed it. Fourth, the case is illustrative for the Open Innovation Life Cycle, as it encompasses the majority of the identified success drivers. By its nature, it is unlikely to find a case where all success drivers are applicable, hence underlying the need for case-by-case intellectual property approaches (Alexy *et al.*, 2009).

In the late 1980s, Richard Silverman, professor for chemistry at Northwestern University and visiting scholar Ryszard Andruszkiewicz discovered the compound pregabalin through a series of laboratory tests, which was later marketed by Pfizer as the drug Lyrica (Lorin, 2016; Silverman, 2016). Meanwhile, the drug has been approved in 120 countries for treatment of various conditions, including diabetic nerve pain, post herpetic neuralgia, fibromyalgia, neuropathic pain and partial seizures in persons with epilepsy (Pfizer, 2012). Today, it is considered as a blockbuster drug, as its revenues are exceeding the \$1bn threshold annually (Silverman, 2016). For example, it was Pfizer's best-selling drug in 2015, generating \$4.8bn in revenue (Lorin, 2016). For Northwestern University, the invention generated 18 per cent of the university's endowment (Lorin, 2016). As can be seen below, Silverman, Northwestern University and their collaboration partners made extensive use of intellectual property on all three levels throughout the three stages of the open innovation process that was used to further develop the original invention and subsequently market the drug.

During the preparation phase with the initial compound discovery, Silverman and Northwestern University approached various potential industrial players to select partners for future development (Silverman, 2016). Herein, they assessed the strategic compatibility and proximity of potential partners, hence the strategic fit, at the project level. In 1989, the Parke-Davis unit of Warner-Lambert, subsequently acquired by Pfizer in 2000, offered to further test all compounds, whereas competing Upjohn was only interested in testing a single, pre-selected compound (Northwestern University, 2013; Silverman, 2016). For this reason, Silverman preferred to collaborate with Parke-Davis. With their careful, long-term strategic planning and joint alignment of expectations and objectives, which resulted in the comprehensive tests of the compound, the collaboration partners found "that the compound was effective for a reason entirely different from Silverman's initial goal" (Northwestern University, 2013). The initial agreement between the partners allocated 6 per cent of net sales to Northwestern University, of which 25 per cent were shared with the two inventors Silverman and Andruszkiewicz.

At the time, i.e. before engaging in the operation phase, no formal intellectual property protection for the compound had been sought for (Silverman, 2008). Patent application for the compound had only been filed a year later, in 1990, and a patent option agreement followed only in 1991 (Silverman, 2008). The upfront clarification of intellectual property ownership and the allocation of rights before entering open innovation activities would have been preferable, as could be seen by the discourse that followed and almost jeopardized any future revenue streams from the open innovation project. Several times, the patent application (US patent no. 6,197,819) was denied by the US Patent and Trademark Office (USPTO). One reason was discourse on which persons actually invented the compound, hence who was to be included in the patent as inventor (Chen *et al.*, 2008). USPTO patent examiners objected the inclusion of Parke Davis' scientists as inventors. From the USPTO patent examiners' view, Parke Davis' scientists contributed to the treatment development not the invention conception for which protection was sought in this specific patent (Chen *et al.*, 2008). Instead of Parke Davis' scientists, Northwestern University's Andruszkiewicz was named as inventor, in addition to Silverman.

The knowledge's additional development and subsequent commercialization through open innovation was operatively managed by Northwestern University's Technology Transfer Office, today known as INVO – Innovation and New Ventures Office. It expanded from one to over 30 trained employees, developed an entrepreneurial spirit and corporate culture geared toward open innovation (INVO, 2016). Thus, this affected both the individual and firm level. Today, intellectual property-knowledgeable persons that particularly focus on licensing aspects in technology commercialization are part of the INVO team, just like scouts and patent attorneys with intellectual property and technology licensing experience

(INVO, 2014, 2016). Today, Northwestern University has for years been the most successful generator of royalties of all American universities (Lorin, 2016).

Through a recent court decision, Pfizer will continue to exclusively market Lyrica until US patent expiry on December 30, 2018 (Pfizer, 2012), wherefore the open innovation partners maintained market exclusivity to ensure their competitive positions. As Amy Schulman, Executive Vice President and General Counsel for Pfizer, described, “[t]he Court’s decision recognizes the infringement and validity of our [Lyrica] patents and affirms the value of [Lyrica] as a distinct and important innovation for patients. [ . . . ] Protecting our intellectual property is vital to our ability to develop new medicines that save and enhance patient lives” (Pfizer, 2012).

However, as patents are limited in enforceability and are only valid for a specific time period, Northwestern University sold a portion of their worldwide royalty interest for \$700m to Royalty Pharma in 2007 to reduce risk during the termination phase at the firm level (Cubbage, 2007; Lorin, 2016). In fact, it is still unclear when termination has or will start because litigation on various Lyrica patents remained pending (Pfizer, 2012). Also, potential danger of unexpected side-effects or superior competing treatment entering the competitive landscape existed, wherefore the sale decision was made by the university (Lorin, 2016). It was “the largest sale ever of a royalty stream for a pharmaceutical product” (Northwestern University, 2013). Thus, the proactive intellectual property management via the partial sale was used to assign business ownership and responsibly handle success. In fact, Northwestern University used this revenue stream and invested it into its endowment (Cubbage, 2007). As then Northwestern University president Henry Bienen described, “[t]he idea was that growing the endowment would be good for the long run” (Lorin, 2016). To mitigate risk in the transaction, both Northwestern University and Royalty Pharma relied on intermediaries acting as brokers in the open innovation transaction, including Morgan Stanley as structuring advisor, Covington & Burling LLP as legal advisor to Northwestern University and Goodwin Procter LLP as legal advisor to Royalty Pharma (Cubbage, 2007). An additional sale of a royalty portion followed for similar reasons in 2013 (Lorin, 2016).

## Discussion

The examples of Lyrica, Beiersdorf and P&G demonstrate that firms use diverging approaches to successfully managing knowledge to enhance their market performances. With this paper, we researched the question how firms manage and apply their knowledge via intellectual property in open innovation and identified that the practical examples confirm our findings.

As a first contribution, we reviewed the relevant literature at the intersection of open innovation and strategic management of intellectual property rights. Literature yielded inconclusive results concerning their enabling or disabling function. Intellectual property rights are perceived to allow for open innovation activities (Lichtenthaler, 2010) but conflict between value capture and value creation is identifiable (West and Gallagher, 2006). Only carefully-crafted decisions are appropriate to account for this ambivalence in open innovation processes (Bogers *et al.*, 2012; Lee, 2009; Lee *et al.*, 2010). Further, we detected that the majority of scholars view the role of knowledge management via intellectual property rights in open innovation as ambivalent, where a peak point of protection is reached where enabling factors turn disabling.

Managing knowledge via intellectual property rights is integral to open innovation processes. To further disentangle its controversial role, we identified success drivers as our second contribution. We classified the success drivers in open innovation processes into five distinct groups: planning; partnering; governance; competence, culture and mindset; and competitive landscape. Planning comprises the alignment of expectations and

objectives, including aspects such as resource deployment and time allocation (Mohr and Spekman, 1994; Van de Vrande *et al.*, 2009). Partnering is the selection of appropriate partners to generate strategic fit and compatibility (Hoffmann and Schlosser, 2001; Ollila and Elmquist, 2011). Governance mechanisms are used to guide and steer coordination within open innovation activities (Bogers *et al.*, 2012; Hoffmann and Schlosser, 2001; Lee, 2009). Competence, culture and mindset focuses on the internal perspective of open innovation, like employees and soft factors in collaborations, including relationship management between internal and external stakeholders to integrate knowledge (Nakagaki *et al.*, 2012). By contrast, the competitive landscape refers to the external perspective of open innovation, including structural shifts in the numbers, composition and abilities of competitors (Munsch, 2009).

During the review of relevant literature, it became evident that most research concentrated on the *modus operandi* of open innovation, hence neglecting preparation and termination tasks that lead to or end open innovation activities. Thus, we find that literature on the preparation and termination stages of open innovation processes is, despite its relevance to the development of knowledge, scarce (Cooper, 2008; Granstrand and Holgersson, 2014). Firms partner and agree on terms for smooth collaboration but spillover effects directly resulting from termination are forfeited in their considerations. Shifts in the competitive landscape through newly emerging competition and conflicts with partners in other collaborations due to diverging interests are only two of the challenges firms face in this context. To address this matter, we advanced the literature by examining the entire open innovation process as our third contribution. We structured the process into three stages: upfront activities in the preparation stage, active collaboration in the operation stage and termination tasks in the termination stage. Moreover, prior research neglected the levels where decisions concerning the management of knowledge are made, i.e. on individual (personal), project and firm level. Thus, we developed the Open Innovation Life Cycle to jointly account for the levels and stages.

As our fourth contribution, we apply the findings to a case in the pharmaceutical industry: the development of pregabalin (Lyrica). The open innovation partners Northwestern University and Pfizer made extensive use of the options familiarity with the intellectual property system creates to best leverage their knowledge. As depicted by the Lyrica case, this does apply not only to larger corporations like Pfizer but also to smaller- and medium-sized entities such as a university. Failures in converting knowledge properly into intellectual property rights, as Northwestern University and Pfizer almost experienced when seeking patent protection for their pregabalin compound, can not only jeopardize the innovation process but also harm the marketing of the invention. Without the patent protection, commercialization and leverage would not have been realized to the extent intellectual property right protection made possible, both in terms of length and amounts of revenue streams.

To reduce risks of intellectual property-related failures, firms may integrate their intellectual property activities in specialized departments, as Northwestern University did by creating and expanding their technology transfer office. Analogous to technological gatekeepers that evaluate and foster the development of new technologies, firms may introduce intellectual property gatekeepers to ensure that chances are leveraged and risks mitigated. When using securitization to hedge against risks of unforeseeable events concerning their drug Lyrica, e.g. the rise of better treatment, unknown side effects or partial patent invalidation, as it occurred for Pregabalin in the UK, Northwestern University relied on brokers' experiences (Hirschler, 2015). Moreover, carefully crafted contracts and non-disclosure agreements are formal governance means that support the risk mitigation (Hagedoorn and Zobel, 2015). As contracts are inherently incomplete due to their future orientation, it is important for open innovation partners to include as many intellectual property and other success driving considerations as possible right from preparing for

engagement in open innovation activities. The effectiveness of contracts can be extended with well-conceived partnering based on mutual trust and commitment. An additional option is to set up specialized, separate business units for knowledge management via intellectual property. These can be set up as joint legal entities between the open innovation partners. The entities can be an effective solution to prevent the dilution of knowledge.

The Open Innovation Life Cycle with its distinction of the three stages and three levels supports firm management in pertaining to intellectual property-related success drivers to best manage knowledge via intellectual property rights in open innovation. Management should account for the peculiarities of the preparation and termination stages to prevent unintentional knowledge drain to partners and (partners turned) competitors. Using the intellectual property options, like generating specialized entities, integrating intellectual property-knowledgeable employees, clarifying control and intellectual property ownership allows for successful knowledge management in open innovation, as intellectual property is integral to strategic and managerial components. Firm management should support the appropriation of competence and experience concerning intellectual property across functional and managerial departments (Salge *et al.*, 2012). The Open Innovation Life Cycle is a tool that raises awareness for the different stages and levels of open innovation and supports managers in navigating the challenges firms face when integrating intellectual property and open innovation to manage their knowledge.

Innovation policy makers should foster open innovation collaborations, e.g. by encouraging partners of different sizes, experiences and origins to leave beaten tracks. As open innovation allows for the realization of projects partners are unable to realize independently, an possibility for policy makers is to create and finance exchange opportunities, e.g. by providing meeting spaces, organizing mutual events or allowing for special tax deductibles. As intellectual property rights not always favor open innovation collaborations, firms have to assess if open innovation is advantageous for them. Policy makers are able to support this decision process. Moreover, policy makers have to ensure that intellectual property becomes enforceable for firms regardless of their resource endowment. Particularly, small- and medium-sized firms have to be able to successfully defend their intellectual property despite fewer available resources. Policy makers can support this target by lowering fees for intellectual property registration, maintenance and subsidized litigation aid.

Scholars may devote more attention to the managerial considerations of knowledge protection via intellectual property in open innovation. Based on our research, scholars could derive recommendations for decision makers how to successfully integrate strategic intellectual property considerations in open innovation. For this purpose, the success drivers, their integration in the Open Innovation Life Cycle and their classification into the different levels and stages could be empirically tested.

Our findings were applied in the context of a discrete industry in a developed economy, the US pharmaceutical industry. This opens a multitude of opportunities for future research to validate the findings in other industries, discrete or complex, as well as other geographical regions or in emerging markets. All of these relations may be moderated by the diverging strengths of appropriability regimes that pertain to different legislative regulations and environmental circumstances, opening additional arrays of future research.

The lack of research on preparation and termination of open innovation activities opens up additional potential research endeavors. Hence, the question arises how to manage intellectual property rights after open innovation, i.e. when the process of collaboration is already terminated. Solutions and insights with regard to monitoring intellectual property rights after termination and also operative issues concerning the long-term payment of royalty fees are topics that appear relevant when conceptualizing this contrast. Also, the



timing when to incorporate termination considerations needs additional attention. It is likely that the phases of the Open Innovation Life Cycle will partially overlap, wherefore the time when *modus operandi* becomes dominated by termination should be identified to derive meaningful strategies. In the Lyrica case, Northwestern University hedged itself against the risk of unforeseeable events prior to patent lapse using securitization, i.e. the partial sale of future royalty streams. This seems to be a promising approach not just for discrete industries and could be empirically tested in large-scale empirical projects.

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