OPEN INNOVATION IN THE BIOMEDICAL SECTOR: AN ALTERNATIVE APPROACH TO ORGANIZATIONAL VALUE EXTRACTION

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Abstract: The concept of Open innovation is a phenomenon gaining momentum among pharmaceutical companies, university research consortia and other for-profit and non-profit organizations in order to address increasingly complex, uncertain and changing R&D projects. In medicine, open innovation projects may provide incentives for creativity, adaptability and easier access to knowledge as well as to generate quicker and cheaper innovation cycles for defined products and services. Also, projects and products may be better adjusted to the markets and provide flexible cost structures in developed as well as developing countries. There are today growing efforts for non-profit foundations to participate and establish co-operation in complex research and development efforts such as bringing new medical drugs or new technology to public use. Interestingly, such incentives might open up for new and creative open innovation models. In this paper, we discuss how the open innovation model differs from the classical closed innovation model in respect to; type of project, organizing aspects and value creation and value extraction aspects. We also illustrate 3 different value extraction concepts relating to open innovation in the pharmaceutical sector, representing different strategies and degrees of openness; the Medicine for Malaria Venture (MMV); InnovationXchange; and InnoCentive. Further, we discuss how the term "openness" can be understood in levels; in terms of the extent of control a collective upholds for ownership as well as the access and utilization of platform content that is jointly aggregated,

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created and developed. Collective innovation can be described as; open for all (openness with little, or no, limitations); open IP groups (openness within R&D groups); open IP projects (openness within R&D collaboration projects); open IP communities (openness within certain communities); and open IP platforms (structural arenas for openness). Our case examples illustrate how open innovation networks may provide new possibilities to generate value from academic – industrial networks. However, the open innovation model builds on involvement from a variety of external sources, such as independent researchers and experts, R&D institutes, universities and contract research organizations, customers, partner companies or even competitors. In the transition from a closed to an open innovation model, the pharmaceutical industry needs to develop flexible boundaries to allow a creative exchange of knowledge and experience from the outside to the inside of their organisation.

Keywords: *Open Innovation, Pharmaceutical Industry, Biomedicine, Open Capital, Drug Discovery, Drug Development, Business Model.*

INTRODUCTION

Characteristically, drug development is costly, time-consuming and associated with high project as well as financial risks and usually runs over long periods before societal or company returns of investment can be achieved and the failure rate is high (DiMasi, 2002; DiMasi et al., 2003; Adams & Brantner, 2006). Today, the classical linear business model of the pharmaceutical industry can no longer sustain the increasing costs and inherent project risks that are associated with an increasingly complex new drug development process. During recent years, the introduction of new innovative drugs derived from radical innovations has remained constant despite significant efforts to increase it (Munos, 2009). Decreasing productivity and increasing costs currently forces large companies to reevaluate how value generation may be organized in pharmaceutical and biomedical sectors (Cuatrecasas, 2006; Fitzgerald, 2008).

In the process of bringing a new drug to the market, the drug discovery process results in new chemical entities (NCEs). If such new molecules show promising effects against molecular targets of importance for human disease, a process of drug development often follow. The drug development process includes research on toxicity and safety, pharmacokinetics and metabolism as well as formal clinical studies to elucidate the

clinical properties and utility of the putative new drug. The development process is characterized by complex logistics and increasing cost associated with increasing regulatory requirements (DiMasi et al., 2003; Adams & Brantner, 2006). Recent cost estimates derived from 68 randomly selected new drugs from 10 pharmaceutical firms provided a pre-approval out-of-pocket cost estimate of 403 million USD and an 11% discounted cost of 802 million USD to bring a new project to the stage of a market approval application. These estimates have been debated, and other studies (Adams & Brantner, 2006) have arrived at a cost per new innovative drug of between 500 million and 2 billion USD. Such cost estimates are dependent on the therapy area as well as the industrial complexity and regulatory requirements and include all cost efforts, which did not result in the development a new drug as well some 400 million USD of opportunity costs. Moreover, the 800 million USD new innovative drug development estimate approximation also been challenged by other authors (Angell & Relman, 2002), who argue that the costs of developing a new drugs are much less and in the estimate range of 100 million USD, since R&D on truly innovative drugs are usually supported by public and taxpayer financing at academic and governmental medical centers.

In addition to the rising costs to bring new innovative drugs to the market, the pharmaceutical industry faces a number of other challenges, such as shorter product lifecycles, increased knowledge intensity, new technological opportunities, convergence of industries, higher consumer knowledge and demands (Hedner et al 2011a). Such developments have put high pressure on the pharmaceutical industry and other actors to adjust their innovation processes. Successful drug development is dependent on use of existing knowledge that to an increasing extent is spread across various stakeholders in the industry as well as in academia; in large multinational pharmaceutical companies ("Big Pharma"), health care, small and medium sized enterprises (SMEs), regulatory authorities and university laboratories. The complex drug development process also requires substantial creativity and innovative development of new knowledge, which can be enhanced by cross-boundary and cross-disciplinary open discussions and collaborations (Hedner et al 20011a).

The pharmaceutical sector has a long history of cross-organizational collaborations in development of drugs and biomedical innovations. Commercial corporations have had much interaction with universities in the development process, and structured bilateral and multilateral agreements for knowledge sharing and joint innovation work among several actors are common. The standard practice, however, is that Big Pharma companies have been keen on maintaining much (or all) of their innovative capacity and generated intellectual property rights for themselves to ensure full control over the end product value. This has led corporations to apply a dominantly closed innovation approach with a focus on control and well-tried managerial steps and secluded or proprietary attitudes toward collaboration. The classical innovation model, defined in this paper as *closed innovation*, has been dominating in the pharmaceutical industry from its start more than a century ago until recent years.

The rapid development of information technology (IT) and computer-based software started to facilitate new ways of organizing and coordinating knowledge production and dissemination. IT acts as an enabler for less hierarchical structures and enhanced communication across boundaries. These developments have increasingly lead to changes in the innovation model for the pharmaceutical sector, where much more of the biomedical development happens outside of the R&D units of large corporations. The notion of *open innovation* (Chesbrough, 2006) is gaining wide attention in high-tech industries for its encapsulation of how companies invite actors from outside their previously closed R&D labs to contribute in shared value creation and commercialization of ideas.

This paper aims to provide an overview and discuss the potential impact of open innovation approaches in the highly knowledge intensive biomedical sector (Hedner et al 2011a; Hedner et al 2011b). In particular we aim to introduce at the concepts of *"openness"* and *"open innovation"*(Abouzeedan et al 2009) and discuss how such novel paradigms may have a potentialto transform and revitalize the innovation practice across organizational borders and research disciplines. In addition, we are displaying some examples of open innovation in this sector

and discuss the rationale of supporting such approaches in the pharmaceutical industry.

THEORETICAL BACKGROUND

The concepts of "openness" and "open innovation"

The history of the Big Pharma industry R&D model is the history of an early successful open innovation model that became increasingly closed. Today, however, the pharmaceutical industry R&D business model again shows signs of opening up towards the outside academic and business world.

Early in its infancy, about one century ago, the emerging pharmaceutical industry utilized an open approach to drug discovery and new product development. Research collaboration between academic medical centres and the chemical and pharmaceutical industry resulted in landmark discoveries such as penicillin, cortisone and the polio vaccine. Discoveries were made in academic settings and product development and marketing was left to the emerging industry. With increasing regulatory requirements, developmental costs and market ambitions, the prevailing innovation concepts and business models became more closed starting from the mid 1900s and on. This approach to pharmaceutical business served the markets well and delivered major innovative drugs such as the beta-blockers, ACE inhibitors and lipid lowering statins, to name a few. This was also in line with prevailing business and management models. For example, Coase (1937) argued that the main reason for actors to maintain activities, such as innovation work, inside organizational boundaries instead of utilizing the full and more extensive capacity on the marketoutside the organisation, was due to the increased cost linked to external or open innovation and management activities. Coase (1937) called them 'transaction costs', which would include for instance cost of searching, collecting, negotiating, and controlling the information and relations to be exchanged or established. Some representative closed and open innovation perspectives with relevance for the pharmaceutical industry are given in Table 1.

With the rapid development of new information and communication technologies (ICTs), such as e-mail, mobile phones, web tools, and advanced

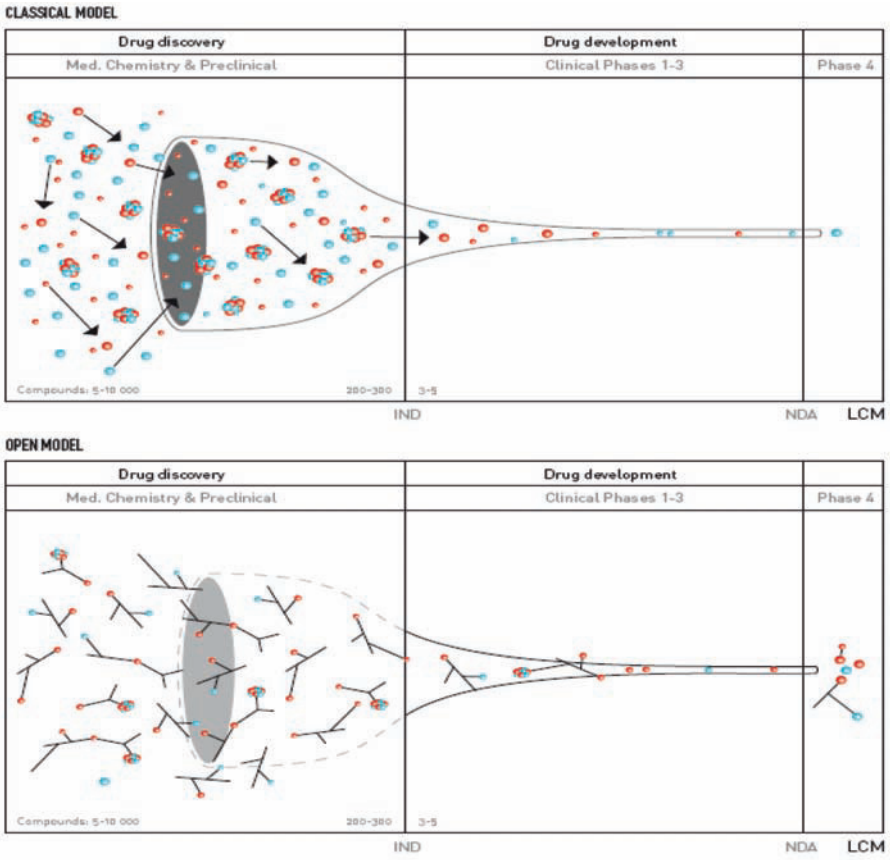
Table 1. Some examples of open vs closed innovation paradigms in the pharmaceutical sector. Classifications and dimensions arise e.g. in respect to project definition, organizing aspects and value creation and value extraction.

	Open dimensions	Closed dimensions
type of project		
	collective origination	single origination
	large scope	small scope
	late phase	early phase
	third world	industrialized world
organizing aspects		
	large network	small network
	decentralized structure	centralized structure
	non-monetary driving forces	monetary driving forces
	emergent operating principles	planned operating principles
	leadership	employeeship
	talent attraction	talent coordination
	lack of templates	existence of templates
	existence of IT-tools/platforms	lack of IT-tools/platforms
aspects on value creation and extraction		
	collective output/productivity	individual output/productivity
	public project owners	private project owners
	public funding	private funding
	open platform IP	closed platform IP

software and database systems, it is clear that such transaction costs have been considerably reduced (Globerman et al., 2001). The process of finding, spreading, and storing information in order to build new relationships for communication across distant geographical areas is today neither difficult nor expensive. These new technologies are thus acting as disruptive forces toward in-house work practice, fuelled by the fact that emerging as well as existing organizations realize that they can accelerate value creation and extraction by increasing its interactions with the surrounding stakeholders (Cuatrecasas, 2006; FitzGerald, 2008).

This has created a new setting for the Big Pharma industry, where the notion of 'open bioscience and open innovation' (Thornblad et al 2011) started to gain attraction in innovative high-techindustries such as the pharmaceutical industry (Figure 1).

Figure 1. Open innovation perspective on pharmaceutical



product and project development emphasizing the combination ofinternal and external ideas as well as internal and external paths to new uses and new markets. The classical closed development perspective is given in the upper panel and the emerging open innovation perspective in the lower panel.

Abbreviations used: IND – Investigational New Drug; NDA – New Drug Application; LCM – Life Cycle Management

Initially, the definition of open innovation was suggested by Chesbrough (2006);

> *"Open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively.* [This paradigm] *assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology."*

The original emphasis in open innovation research was laid on the organization´s ability to trade with intellectual property as commodity with other actors on the market. The idea is that companies may have unused patents 'in the attic' that would be of much greater use to others than to oneself, suggesting a trading opportunity. New market functions such as trade auctions and matchmaking websites have been introduced to simplify the knowledge exchange in practice. Also several variations of cross-organizational collaborative activities across the value chain have nowadays been promoted under the umbrella of, or in close relation to, open innovation (Thornblad et al 2011).

The concept of open innovation, has increasingly been adopted by the telecom industry (Rohrbeck et al., 2009), and to an increasing extent also attracts the pharmaceutical industry (Munos, 2006). These industry sectors are along with other actors developing new structures and instruments, such as corporate venture capital funds, foresight workshops, executive forums, spin-outs and spin-ins, to capture innovations from actors outside the firm.

One open innovation approach is coined "crowd-sourcing" (see Howe, 2006). This concept describes the act of involving a large, external and undefined group of people or community to solve specific innovation challenges. The utility of this method is supported by recent empirical evidence and theoretical explanations relating to the so-called "wisdom of crowds" concept (Surowiecki, 2004). The "wisdom of crowds" concept argues that aggregated crowds of people collectively make sound judgments and better predictions as compared to individuals or smaller groups. Thus, informed groups of people can use their collective wisdom and knowledge to strengthen a specific innovation process.

"User-driven innovation" (von Hippel & von Krogh, 2006) is another approach to involve possible consumers or users early in the development process. Here, companies invite knowledgeable and vocal potential buyers, so called lead users, to have a say in the design and application of the future product or service. In this way, a specific innovation has a greater potential to be tailored to the customer needs and the organization receives a rich source and influence of new perspectives, which

may challenge taken-for-granted assumptions. The same exercise can be made with suppliers, partners and other stakeholders.

Cross-border "open" innovation also spurs initiatives that do not necessarily have a starting point in one focal firm, but are organized in more network centric structures such as academic or user-centered collaborations. The Open Source movement (see Weber, 2005) is probably the most well-known form of this endeavor, with the LINUX project as a functioning example of how it can work in practice. Various other ways of more or less structured forms of innovation collaboration has also evolved, spanning from contract-based alliances to loosely organized virtual communities.

Linked to these changes in innovation practice is the rise of new "open" business models (Chesbrough, 2006), which are regularly introduced as guiding examples for others to be inspired by. Some examples are users paying for perceived value, or that content is free and income is generated from additional services and commercial ads.

Innovation activities in the modern globalized economies tend to be more interconnected and open in their nature, and our understanding for the innovation process has to reflect on that. The concept of cross-border openness in innovation processes is related to the inherent openness of an individual or organization. This may be defined as the "open capital" of that actor (see Abouzeedan et al., 2009) and may constitute a defined and specific asset inconducting cross-border innovations and managing open innovation systems.

Open innovation challenges

Open innovation networks may provide new possibilities to generate value from academic – industrial networks. Such value extraction requires new forms of business management models to arrange and optimize virtual interactions between project managers and problem solvers in the specific projects. Provided that leadership and infrastructure can be assembled, such value creation models can be highly effective and reduce time, risk and cost associated with a specific project.

There is a need to identify new techniques, modes and system solutions that would provide a more systematic approach to

create random efficient interactions between problem identifiers and problem solvers in the structured phases of drug discovery as well as drug process/product development. Such interactions may be organized horizontally (between disciplines) as well as vertically (within disciplines) to allow optimal conditions for collective learning as well as radical new value creation derived from random collaboration within the network. Open networks may thus allow for enhanced possibilities for lateral input from other fields of knowledge that could provide an impetus for improved problem solving. Project management in open innovation platforms need to be able to secure virtual data in a way that would secure optimal data quality in order to satisfy regulatory requirements during audits and inspections as well as according to due diligence requirements in business transactions (Thornblad et al 2011). Such open innovation networks could derive funding from industrial sponsors, governmental and public-private-partnership as well as grants from patient organizations. Optimally well-managed open innovation platforms would provide scientists to combine or go from idea development and scientific publishing priority towards a concept of product development and value creation in a more global context. Also, it may create risk sharing and reward-sharing models of drug discovery and development.

Open innovation network solutions may be able to expand the concept of drug development in the biotech/pharmaceutical industry from solving individual problems for outside actors to an integrated concept that may generate value for patients as well as PPP-stakeholders. By optimizing creative capacity and business leadership new radical solutions may be provided in therapeutic areas of great medical need. There is an urgent need to find models to create new platforms to enhance innovation capacity within the risk of failure as well as to cut costs for creating new innovative drugs. Such platforms or business models need to be adjusted to each specific discovery/development program. Further, the business models need to be credible and open which enables each participant to become part of a value creating chain that optimizes the personal monetary/non-monetary intellectual or process input. Importantly the model needs to address a number of issues and potential problems. Among these are (see Thornblad et al 2011);

— Revenue sharing from real value input,

— Value definition of continuous within project spin-in and project spin-out IP

— Value estimation of discovery and development work

— Monetary as well as non-monetary rewards in innovation and process work,

— Implementing effective virtual project management

— Common resource utilization and remuneration for process work

— Defining project milestones and implementing process activities

— Incentives for stable and long-term commitment,

— Quality assurance in virtual discovery and development settings,

— Common exit definition and negotiation.

In particular, the "open" concept differs from traditional innovation concept in terms of emergence and sharing of results and outcomes as well as intellectual, monetary and physical resources. In addition, in a model characterized of openness, there is a need to share a mind-set of risk-taking and risk sharing as well as to consider sustainability vs. commercialization. Also open models need to create new aspects on organisation and leadership in order to make coordination, decision-making, motivation and communication a long-term commitment among actors.

METHODS

In order to illustrate the alternative value extraction concepts relating to open innovation in the pharmaceutical sector, 3 examples representing different strategies and degrees of openness were selected; 1) Medicine for Malaria Venture (MMV) exploring drug development to prevent or cure malaria disease; 2) InnovationXchange an open innovation R&D and innovation network model with an aim to identify and facilitate new business opportunities; and 3) InnoCentive, an open web-based arena facilitating match-making between independent researcher capacity and corporations that are in need to solve concrete R&D challenges (Figure

2). These examples were selected based on a recent overview (Thornblad et al 2011), where available Internet sources such as Google Scholar (scholar.google.com), PubMed (www.pubmed.com), Nature (www.nature.com) and Elsevier (www.elsevier.com), were scanned to identify open biomedical platforms. The three examples were selected to represent different types open biomedical platforms, in terms of platform purposes, driving factors, typical actors, and IP strategies (see Thornblad et al 2011).

RESULTS

Examples of open innovation in the pharma sector

Also in the Pharma sector, open innovation and project-work has received attention due to the possibility to attract entrepreneurial talents on a global scale. The notion "Open Biology" was coined by Hessel (2005) to illustrate development models based on symmetrical collaborations between non-profit organizations, universities and big or small pharmaceutical companies. The concept of open biology models for large-scale problem solving is receiving an increasing interest by the pharmaceutical R&D community as a tool for new drug development in areas of medicine where "willingness-to-pay" by classical western health economy standards is low. Such important areas include e.g. tuberculosis, lassa fever, dengue fever, Chagas disease, lechmaniasis, malaria and similar disorders (see Munos, 2006).

Three different examples of open innovation platforms are given in Figure 2. The first example is Medicine for Malaria Venture (MMV), which started in 1999 with the aim to develop cost-efficient drugs for treatment of the malaria disease (see Munos, 2006). It is today estimated that a child dies from malaria every 30 seconds. The official statistics point to over 250 million malaria cases per year, but most probably the real number lies closer to 600 million (see Munos, 2006). Most of them, approximately 90%, break out in Africa and the market forces have so far not been able to supply these underprivileged groups with treatment and preventive treatments due to their insolvency. MMV, based on only a few fixed employees, has since its start been able to mobilize more than 20 active projects, which includeglobal participants from prestigious universities as

well as commercial actors. Their vision, "curing malaria together", is based on the aim to discover, develop and deliver cures for the disease through the mechanisms of public-private partnerships and projects.

Another notable example is InnovationXchange an open innovation network that originated in Australia with a global focus (Davenport et al., 2008), which is now extended to New Zealand, Europe (UK, the Netherlands, Germany, Italy), USA as well as Asia (Taiwan, Malaysia). The InnovationXchange model provides business opportunities for its member organisations by identifying and facilitating new business opportunities, providing insight into what R&D, IP, innovations, intentions and technologies that are available in participating organisations to meet needs of other participants, works to avoid duplication of R&D andalso identifies opportunities in international markets. The InnovationXchange model builds on a "trusted intermediary" conceptaiming to find R&D collaboration between different organisations without exposing confidential intellectual property information. This non-for-profit network has a focus of improving commercial outcomes across boundaries of academia, industry and government through intermediaries who work inside its organisation to search for opportunities to create external connections for business creation and growth. The clients linked to the InnovationXchange network have benefited in various ways in their R&D efforts and projects. This network recently organised a Pharmafood forum to explore product possibilities of foods with specific health benefits.

A third example of Open Innovation linked to the Life Sciences is InnoCentive, which is a web-based arena founded by Eli Lilly & Co in 2001. The purpose of the platform is to match researchers' knowledge with corporations' concrete R&D challenges. Through this IT-platform, "seeker" companies gain access to a large network of external intellectual resources. The "solver" network consists of some 120 000 scientists in 150 countries who get opportunities to gain academic as well as monetary recognition. Recently, InnoCentive and Nature Publishing Group announced a partnership to facilitate greater scientific collaboration and open innovation (Bingham & Ekins, 2009).

4.2 Different forms of openness

The three listed platform examples (Figure 2) illustrate the versatility of the many forms of open IP platforms that exist. Even the term "openness" in itself can be understood in levels. Openness levels typically differ in terms of the extent of control a collective upholds for ownership, access and utilization of platform content that is jointly aggregated, created and developed (Thornblad & Hedner, 2011). Collective innovation can be described as;

- *Open for all:* openness with little, or no, limitations,
- *Open IP groups:* openness within R&D groups,
- *Open IP projects:* openness within R&D collaboration projects,
- *Open IP communities:* openness within certain communities, and,
- *Open IP platforms:* structural arenas for openness (Petrusson et al, 2010).

Two interesting perspectives on openness are the levels of platform governance and public responsibility. The greater the level of formal governance structure on an open IP platform, the easier it is to establish control through other means than patents. To understand the level of platform governance, it is possible to categorize the control of the platform content as;

1. placed on the individual stakeholders who govern access to, development and usage of the content,
2. placed on the stakeholders who contractually have decided how they jointly should govern ownership issues,
3. placed on the stakeholders, but the formal platform organisation has on behalf of the stakeholders the organisational capacities and formal procedures for monitoring, assessing and governing the intellectual assets in the platform, or
4. a formal organisation that assumes full ownership and control of intellectual assets included in the platform (Petrusson et al, 2010).

From the perspective of measuring the levels of public responsibility, the use and regulation of

patents provide important tools in the construction of the platform per se. The patents are tools to be used when the stakeholders decide whether the platform should be:

1. project-oriented and controlled ad hoc in project contracts,

2. driven by network control according to a contractual model implemented in a web of contracts,

3. controlled by a jointly created and relatively informal organisation,

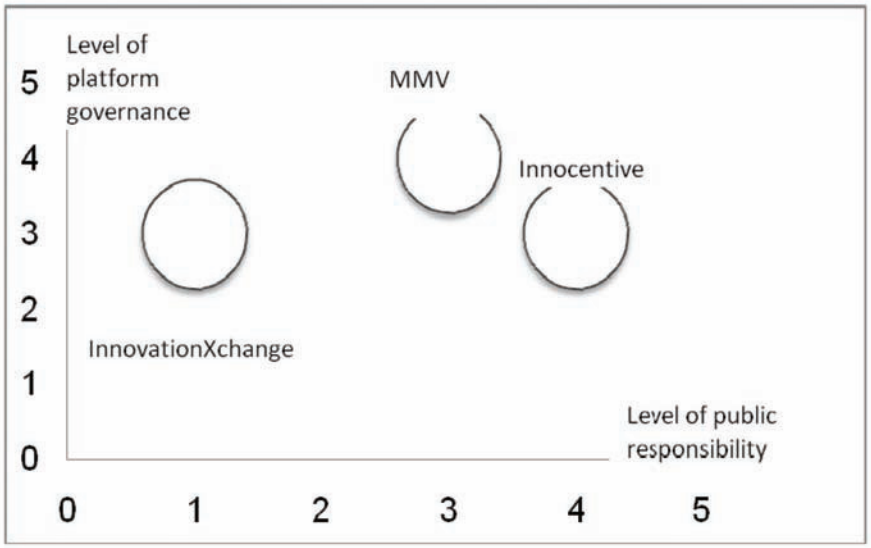
4. controlled by a formally strong and hierarchical organisation which presents policies and enters into contracts with stakeholders, or

5. a formally strong structure supported by the public and acknowledged in public policy/regulation (Petrusson et al, 2010).

Figure 2. Three examples of open innovation platforms; Medicine for Malaria Venture (MMV), InnovationXchange and InnoCentive (open circles), visualized in terms of a) level of platform governance, and b) level of public responsibility.

DISCUSSION

Openness – construction and value creation



An important realization is that open biotechnology is not necessarily antagonistic to intellectual property rights (IPRs) (Joly, 2010). It is fully possible, and in many cases even necessary, to use IPRs to ensure that access to underlying intellectual assets remain open (Pamp, 2010). A variety of licensing schemes with or without IP (e.g., patent pool, non-assertion covenants, public domain, protected commons agreement, contractual licenses) can theoretically be used as engines to support the open nature of open source projects (Joly, 2010). Intellectual concepts such as a patentable invention, patent, or patent license, all provide useful tools from this perspective. In particular, when it comes to governing R&D collaborations, commercialization, strategic partnering, and technology standardization (Petrusson, 2004). Restating the definition from this perspective, the patent can be described as a right to regulate openness (Merges, 2008), rather than a means to exclude. In essence; a right to regulate who that should have access to which aspects of a patented invention, and on which terms. This alternative view to the traditional perspective can also be seen within economics, particularly in those discussions where the patent is discussed as a mechanism for rent seeking (Dam, 1994). Openness must therefore be constructed (Petrusson et al, 2010).

The rationale for an Open Innovation approach in the pharmaceutical sector

What the open innovation notion is highlighting for the traditional pharmaceutical industry is that companies can no longer sustain a R&D portfolio by relying solely on their own internal research abilities, but need to open up for conversations and external influence from new directions, such as independent researchers, inventors and SMEs. Big Pharma as well as individual researchers, are today under great pressure to embrace external influences and resources (intellectual property, ideas, products, people, institutions) into their still rather closed innovation mindset. In the complex world of widely distributed knowledge, there is a need for an awareness of and strategy reorientation towards a culture of more open approaches to innovation. This includes a willingness to acquire or license outside knowledge or inventions (e.g. patents) and incorporate them into the development process (Petrusson et al 2010). It also includes

packaging and distributing internal knowledge which otherwise would not being used within the firm´s core business. In this way, the under-used assets have the potential to become eligible for continuing development outside of the organization, through licensing, joint ventures or spin-offs. This will be a contribution not only to the balance sheet of each company, but also for the shared knowledge base and benefit for the society as a whole.

Optimally, scientists working on a common scientific medical issue need to work together on problem-solving and share results for the good of society. In reality however, there is substantial competition for priority of publication and protection of intellectual property that may come out of the research. All this would tend to slow the generation and dissemination of knowledge. By increasing openness in scientific problem solving, i.e. if the scientific problem is communicated or introduced to outsiders, effective solutions may appear (Weber 2005). Often people with expertise at the periphery of a specific problem field are the most likely to find quick and innovative answers (Cabrales et al., 2008). One reason for this is that innovations happen at the intersection of disciplines, and by "broadcasting" the problems to others, somebody else can make sense of the problem and preliminary results and come up with an alternative and promising solution. Such innovation and working practice-thus allows people with diverse backgrounds and competences to interact in a creative manner to achieve complex problem-solving (Hedner et al 2011b).

The open innovation paradigm differs from the closed one in respect to type of project, organizing aspects as well as aspects on value creation and value extraction (see Table 1). According to the Open Innovation paradigm, incentives and activities are no longer unilaterally directed from top down and from the core of the company and externally, but to an increasing extent from the bottom up and from the outside in towards the core of the organization itself. This has strong efficiency potentials for individual firms. First, it provides access to a vast amount of resources and knowledge bases that the firm need not pay for to maintain and coordinate on a daily basis. Second, much of the external actors' trial-and-error efforts and learning processes, including costly

failures and waste of resources, do not burden the internal organization. This suggests that the open innovation approaches disseminate the risk held within the innovation process to a large number of distributed actors, and not solely to one single organization.

Finally, the motivations for people to participate in the open innovation processes have been widely discussed by academicians from various sciences (see Munos, 2006;Uitdenhaag, 2008). In particular, the question why people would be attracted to participate in these communities has been raised, since there usually is no guaranteed outcome or monetary reward. The simple answer is that these models are based on *sharing* and that achieving a reputation for solving a problem matters. Also, many individuals feel that they are part of a community and that solving a problem is by itself intellectually appealing. Moreover, a strong stimulus for spending time on problem-solving is the perception of how challenging the issue is by itself and how the person assessed the need for creativity in the project. Apparently, the fun, enjoyment and entrepreneurial challenge of problem solving appears to be important driving forces in open source innovation processes, which can enhance the working climate for both companies and individual researchers, inventors and entrepreneurs (Surowiecki 2004).

CONCLUDING REMARKS

Knowledge as a resource is said by economists to be non-rival, suggesting that its value is not depreciated (but rather the opposite) when consumed and spread. By opening up the internal issues to external people in a systematic way, a problem in one area may receive problem-solving contribution from other areas and perspectives. The utilization of these underlying epistemological values have been shown in open innovation models in the software and high-tech industry, which in turn have served as inspiration for many other industries such as the biosciences.

Moving toward an open innovation model requires involvement from a variety of external entities of which might not been in direct contact with the company before. Contribution may be asked for from a variety of external sources, such as independent researchers and experts, R&D institutes, universities and contract research organizations, customers, partner companies or even competitors.

In order to achieve this, it is essential that organizations develop flexible boundaries to allow a creative exchange of knowledge and experience from the outside to the inside of the organisation (Bennet & Bennet, 2004). As mentioned earlier, there are several benefits with opening up specific R&D problems to outsiders, and in particular, this process may facilitate for novel and quicker solutions than the individual firm or R&D lab might create by itself. However, one obvious need when dealing with open innovation platforms in the pharmaceutical industry is the structuring of the ownership of intellectual property (Thornblad & Hedner 2011). It is therefore important to highlight that open innovation approaches do not prescribe to be open in *everything*. Rather, it raises the need for reflection and sound judgement in order to invoke deliberate choices for what should be open and what should be not. These choices are not easy to make, but organizations that are prepared to deal with them will have a potential competitive advantage over less agile organizations.

BIOGRAPHY

Professor Thomas Hedner holds MD, PhD and MBA exams from the University of Gothenburg in Sweden. He is currently responsible for Innovation and Entrepreneurship at Sahlgrenska Academy. He has published extensively in medicine, especially in cardiovascular medicine and new drug development. In economics, his research interest extend to open innovation, entrepreneurship orientation and decision analysis in complex project management.

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