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KNOWLEDGE IN OPEN INNOVATION PROCESS ON AN EXAMPLE OF PHARMACEUTICAL INDUSTRY

WYKORZYSTANIE WIEDZY W OTWARTYM PROCESIE INNOWACYJNYM NA PRZYKŁADZIE PRZEMYSŁU FARMACEUTYCZNEGO

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Summary: The innovation models develop over time, due to market and industry needs. As the main "product" of knowledge economy, innovations (as a concept) are symbolic goods, founded in symbols, not in atoms. This notion causes some consequences typical for information goods, like ease of replication or exchange, zero-marginal replication costs and cheap storage. On the other hand, there is a growing innovation production cost and uncertainty and risk of innovation activity that discourage companies from being innovative. Open innovation model shows the knowledge flows in the "inner" and "outer" sphere of the innovation process. The knowledge has been showed in some aspects: as private good, public good and also as "the commons". The transition spheres have been showed too. Opening the innovation process is addressed to the costly and risky projects that cause risk aversion amongst entrepreneurs, but without which useful products might have never been produced. The goal of the article is to show the knowledge flow and knowledge transition between innovation actors, its "common" nature and the trial to show the value added in the open innovation process. Methods used are literature and data analysis as well as case study.

Keywords: the commons, open innovation, knowledge, innovation process.

Streszczenie: Zmiany w modelach innowacji podążają za potrzebami rynku i przemysłu. Ufundowanie innowacji w symbolach – nie w atomach (materii) – niesie takie konsekwencje, jak łatwość kopiowania czy wymiany, zerowy koszt krańcowy kopiowania czy łatwość przechowywania. Z drugiej strony koszty innowacji rosną, a ryzyko i niepewność działalności innowacyjnej zniechęcają podmioty do takiej formy działalności. Opisany model otwartych innowacji pokazuje przepływ wiedzy w wewnętrznej i zewnętrznej sferze procesu innowacyjnego. Wiedza została ukazana w kilku aspektach – dobra prywatnego, publicznego oraz dobra wspólnego. Pokazano sfery przemiany poszczególnych rodzajów wiedzy. „Otwieranie" procesu innowacyjnego jest adresowane w szczególności do kosztownych projektów, które swoim poziomem ryzyka odstraszają potencjalnych przedsiębiorców, ale bez których nie by-

łoby produktów zaawansowanych technologicznie. Celem artykułu jest ukazanie przepływu wiedzy i jej przemiany oraz próba wskazania wartości dodanej w tak rozumianym procesie. Zastosowano analizę literatury, danych źródłowych oraz studium przypadku.

Słowa kluczowe: dobra wspólne, innowacje otwarte, wiedza, proces innowacyjny.

1. Introduction

We are witnessing the great change in the modern economies' attitude to the production model now. The determination in the search for new, pro-growth areas of economic performance, the necessity of meeting humans' eternally evolving needs resulting in the abundance and variety of new products, increasingly pushes companies to novel solutions in production process adoption. It is also noteworthy that modern economies are the knowledge economies. The term "knowledge economy" is only seemingly trivial. Modern industries, often being the result of laboratory discovery, are the vital evidence of the influence of pure knowledge on economy [Machlup 1962]. This "new knowledge" phenomenon broadens the definition of traditional economy, based on the physical goods exchange, with symbolic goods, embodying the knowledge itself. Basing the economy on a foundation of knowledge has to have consequences for the goods production process. The symbolic character of knowledge, the ease of its exchange, replication and flow are features differing this resource from physical ones. Knowledge, opposite to rare goods, is free from scarcity. Its use or creation differs significantly from using or producing physical goods. The idea of "the commons" seems to be useful here.

It is noteworthy that the idea of the commons penetrates the aspects of knowledge creation in modern companies. The idea of open source in the ICT sector can be a vital example as well as open innovation aspects discussed further.

The process of opening fundamental knowledge creation process (this kind of knowledge has often been identified as basic research) is not a new concept. Basic research predominantly conducted by public scientific entities like universities, state-owned laboratories etc., is freely available in the form of publication. The open innovation issue is a more composite problem. Not only public institutions guarantee open access to the knowledge base. Private companies that act in high-risk industries also create the common, open knowledge base, which can be even called the "knowledge flow platform" or (as used further) the "knowledge cloud". Using common knowledge in some industries (like biotechnology, pharmaceutical industry) is a solution improving efficacy of the innovation process, accelerates the pace of introducing new product to the market and reduces the risk of conducting the high-cost research within the company and, surprisingly, does not exclude profitability of the industry itself.

2. The commons in "open" process

Garrett Hardin in his seminal work has first raised the issue of unavoidable necessity of using common-pool resources. The fact that only private property can ensure efficient solution of economic problems can be simply proved in relation to Hardin's considerations [Hardin 1968]. It is noteworthy that Hardin's considerations were based on natural science, and that his conclusions were adopted to the economics thereafter. The major defect of his theory is the assumption of the lack of regulation in 'the commons' issue. The commons, by Hardin, do not have the nature of joint-ownership resources, but rather of "no one's goods". Hardin himself admits that he should have formulated a thesis about "tragedy of unregulated commons", not only "the tragedy of commons". Moreover commons themselves constitute a kind of property, so, in essence, the form of regulation of scare resources.

The sophistication of the commons issue has been better shown in the work of Elinor Ostrom, especially in her most important book "Governing the Commons" [Ostrom 1990] . She proves that there is more than one determined solution opposite to the Hardin's understanding of "tragedy" in which there is always one result. Empirical proof of theoretical model of Ostrom gives a reason to claim that the commons can be efficient, but only when exact assumptions are true. The main problem is a scarcity, which is the reason of conflicts and competition between users of the commons. Thus, the issue is more associated with the commons of the physical form than with those of abstract one. It is noteworthy that only physical ("real") goods are scarce. It derives from the rarity of atoms. The world of symbols is more flexible, because symbols are not the subjects of physical goods limitations.

"The commons" concept can be used in various situations, not necessarily in the common-pool area of physical resources. Let us say that the intellectual property can be also understood as a kind of the commons. This kind of property is not scarce, because it is made up not of atoms but of knowledge creating symbols. This difference causes consequences in resource management. It opens also a new area of studies related to the institutional economics. One needs to understand that the intellectual property is in fact one of major decision making elements of economic entities. Apart from the scarcity problem, the commons constituted by intellectual property can give a new understanding of common knowledge enclosed in private resources.

Knowledge, opposite to rare goods, is free from scarcity. Moreover, it can be constantly replicated. Thus, the question is how to manage intellectual property in order to receive best results. In the contemporary economics it is very "trendy" to use some "open" strategy for profit. But it is also very important to remember what is the exact meaning of the term "profit", and who benefits most.

Openness is a really new way of thinking about the commons in the aspect of using symbolic resources instead of physical ones. This concept is not exactly defined, but some guidance can be found in the literature of various science fields. "Open" conception is often used in order to clarify ambiguities in the new goods development

process. There are at least three terms directly related to the concept of openness. The first one is an "open source" concept. It refers to the idea of software development in global partner production process The second one is "open development" associated with more general activities of development process. David M. Waguespack and Lee Fleming indicate a key concept here, which exposes the developed project to the external entity comments and criticism. This solution is helpful, because it gives the opportunity to improve problematic issue or reveal unknown mistakes [Waguespack, Fleming 2009]. The third term – "open innovation" is for sure the most comprehensive approach to the discussed matters. Henry Chesbrough defines open innovation as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation" [Chesbrough 2006]. In this context open innovation is something opposite to the vertical integration model. Internal research and development that traditionally lead to internally developed products are replaced by the business model that utilizes internal and (even more important) external ideas to create new and unique value. In a certain sense open innovation constitutes an open system that resembles an open network of creators working on a chosen issue.

The open innovation paradigm has been introduced by Chesbrough. He framed it in opposition to closed innovation model. He also broke the traditional paradigm of internal innovation [Chesbrough 2003]. It is worth noticing that some of the rules and theories constituting the open innovation paradigm were well known before Chaesbrough's findings [Herzog 2011]. However, it was Chesbrough that compiled a holistic approach to innovation management describing internal and external sources of innovation as an opportunity to receive measurable benefits.

3. Open innovation paradigm

The open innovation paradigm consists of four elements: (1) the knowledge cloud (established as a kind of the common pool-resource), (2) innovations, (3) undeveloped innovations, and (4) open knowledge platform of IP decomposition (as the institutional solution) [Bianchi 2011].

The first one − the knowledge cloud, is determined by the rule of importance of both internally and externally established knowledge. Internally established knowledge is similar to the public domain scientific output (e.g. publications). Externally originated one comes from companies' failed or stuck projects – unfinished, of undisclosed market potential, unmarketable according to present conditions.

The second element of this paradigm are innovations (successfully commercialized scientific research results). Such an attitude to the innovation process does cause its discontinuity. Opposite to the closed (traditional) model of innovation, open innovation model implies the interruption of the innovation process. Discovery does not necessarily have to be made within the same firm that introduces product to the market.

The third of the examined components − undeveloped innovations, consists of all projects that stuck in the laboratory without the possibility of market entry. It is a common practice to free the firm's temporarily redundant knowledge in order to broaden the common pool resources (knowledge cloud) that could benefit further discoveries (in-licensing example).

It is worth underlining here that both marketable and undeveloped innovations state the rule of capturing and adding the value by the firm involved in the innovation process. It is noteworthy that this aspect of open innovation paradigm differs from open source idea where the main objective is to create (add) value, not to capture it.

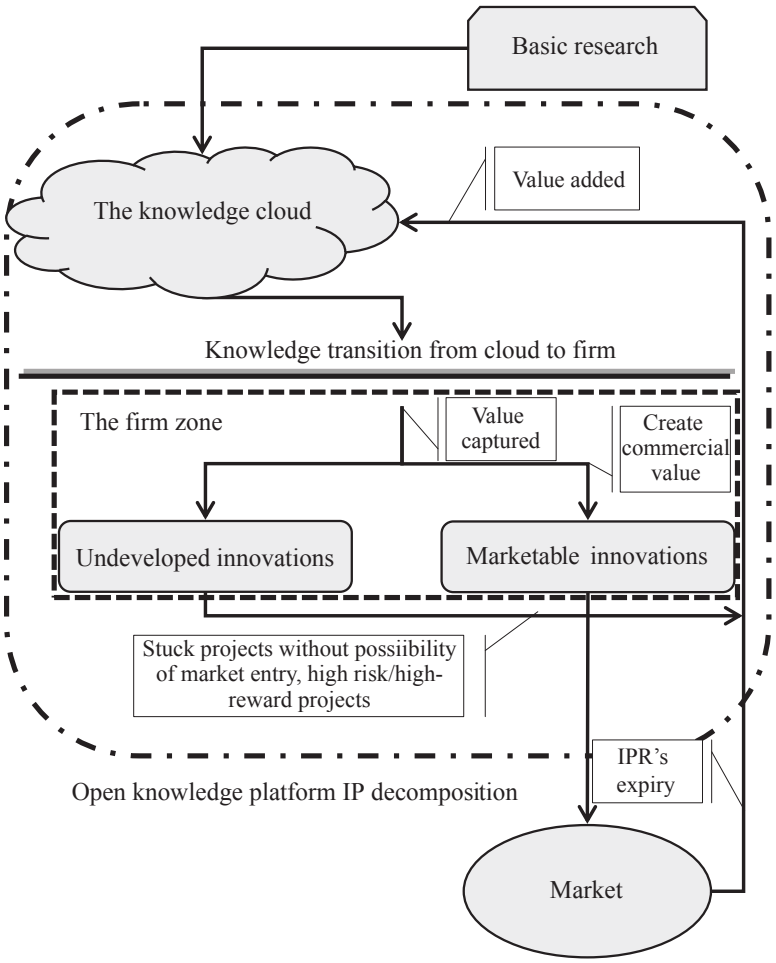

Fig. 1. Knowledge flow in open innovation

Source: own work.

The fourth element of open innovation paradigm − open knowledge platform of IP decomposition, combines all previews rules into the institutional order, without which the commercial dimension of open innovation model could not be achieved.

4. Knowledge cloud as an open source for the pharmaceutical industry

The first element of the open innovation paradigm is the knowledge flow platform (knowledge cloud). This is the first step of the opening process in each area of interest. The open platform of transferring information, ideas and opinions is one of key factors influencing scientific progress. Only the dialog between various actors can provide a new, sometimes extraordinary or even surprising discovery. The advantage of "openness" over "closeness" is the fresh, outsider look on the problem, often breaking stereotypes, accelerating the positive change.

The openness is in the contemporary economics often identified to the network. As a matter of fact open protocol of communication is necessary to establish network. According to Kelly, decentralization is the driving force of the dynamic development of today's society.

Interdependence characterizes all aspects of human activity. This feature is the basis of the logic of networks (formulated by Kelly) where open communication between the nodes is the process of superior value [Kelly 2001]. Manuel Castells describes the same phenomena as crucial factors of Internet development and success. Castells claims also that "the openness" is a culture-determined phenomenon, and that it is a base of key technological feature of global communication − a common use [Castells 2001]. Castells' insights on the culture-determined aspects of "openness" imply the great change in the existing way of thinking about all areas where exclusiveness (closeness) was considered to be an effective action scheme. It is noteworthy that it was the scientists society that influenced today's image of the openness. In Castells' nomenclature scientists' society formed "techno-elites" of a specific culture. "[…] merit results from contribution to the advancement of technological system that provides a common good for the community of discoverers" [Castells 2001]. This new approach differs in every aspect from industrial-era principles applied by industrial-era entrepreneurs. It is worth noticing that in the age of globally distributed information dominance the openness culture is the valid foundation for modern society.

Academia is and has always been the vanguard in applying the "openness" idea, but under present conditions this is a global scale activity. Also the "open source" idea is at the heart of academics. Moreover, the initiatives have a significant impact on the shape of modern communication.

In production and development, open source as a philosophy promotes a universal access via free license to a product's design or blueprint, and universal redistribution of that design or blueprint, including subsequent improvements to it by anyone. Open source code is typically created as a collaborative effort in which programmers

improve upon the code and share the changes within the community. Open source has sprouted in the technological community as a response to proprietary software owned by corporations. The main characteristics in the open source production model is that each open source modification constitutes a new product. It means that product develops instantly thanks to the "open" culture of independent researchers (hackers in ICT).

In the pharmaceutical industry the "open source" idea has to be reconsidered. Unlike the software creation – in the pharmaceutical industry "the source" or none modification of it can be regarded as a final product.

The basis for the distinction between ICT and pharmaceutical industry in this issue is the fact that they produce products based on different foundations. The foundation for software is not material. Those are bits of information that construct the virtual product, e.g. the digital information good. In the pharmaceutical industry the product is a physical drug, produced in a traditional production process. The foundation of it are the laws of nature because it is based on scarce atoms of real matter. In this context it is noteworthy that "open source" idea in the pharmaceutical industry can be implemented only on the pre-initiatory stage of product conceptualization, when the study focuses on the properties of a natural phenomenon. It means that "openness" occurs only on the level of pure science based basic research.

Building the common base of knowledge is not an easy process, because the most critical information is often protected by privacy concerns. It is all locked up in insurance companies, academic and research centres, and government health agencies, and it is very difficult to get because there is no conduit by which this information consistently reaches the research community [Waldron 2012]. What research scientists want is information on health outcomes, mortality, health conditions of patients, and their behaviour in the context of a disease. Scientists also want information from gene banks or tissue banks from those patients for whom a history is known. At present even a wider scope of information is more and more often the subject of the collaborative "openness" in the pharmaceutical industry research sector. For the purpose of this article it will be called "the knowledge cloud".

4.1. "Knowledge cloud" inflows

The substance of knowledge cloud inflows and outflows is information. The information inflow to the knowledge cloud can be of three types. First type of information comes from Academia. Information of this type is embodied in publications which represent the university research results. This type of research is mainly the basic research. It is connected with a traditional profile of university's activity. "The knowledge cloud" benefits here form the new, unchecked, unverified data.

The second information stream comes from collaborative projects. In those partnerships public actors (universities, research institutes) meet private ones

(pharmaceutical companies) in order to discover new areas of knowledge, solve problems of "stuck", potentially innovative projects, and stimulate new growth areas by public finance support [Allrakhia 2011]. This sort of information is a result of private (company) knowledge "release" and forwarding it to public institutions.

The third knowledge inflow source is a result of different agreements between specific business players. This last type constitutes the body between open and close concept. It is noteworthy that the results of such relations are more in the type of a "club good" than of a public domain. Still the openness in this issue appears in diffusion of knowledge between competing firms. The example of these are: licensing, joint R&D agreements, corporate venture capital, joint ventures and acquisitions [Castells 2001].

The first source of knowledge inflow is the most open one, strongly connected to the science ethos emphasized by Castells. As he claims, scientists, as science producers have created their own values, where "sharing" is the value of the highest range (sharing of thoughts, sharing of research output etc.). On the other hand, a good opinion in the professional environment can make a scientist an expert who, thanks to his/her scientific reliability, can benefit on the labor market. This mechanism works similarly on the software market where young programmers get involved in an open project in order to create a brand themselves. Yet it is noteworthy that this "basic science research" knowledge inflow is an example of different dimensions of academic science [Pohulak-Żołędowska 2010]. First of all, pure academic science in the shape of educated staff and basic research such as the mission of Academia has always been advancement of science through teaching and research. Therefore publicly funded, unintentional, widening of the scope of useful knowledge research is often found as the attractive target. Post-academic science is when the Academia begins to play a vital role in the economic system. The core strength of universities in strengthening the biotechnological and pharmaceutical capabilities lies in its pursuit of all known and rare aspects of biology and systems biology. This gives an edge to the academic scientists in identifying and validating novel molecular targets for various diseases, developing assays and to some extent, in probe discovery. In general, the mission of the industrial sector is not set up to do comprehensive basic research on biological targets, which warrants active collaboration between industry and academia [Roy et al. 2011].

The second source of knowledge − cloud inflow can be understood as an extension of basic research output inflow to the knowledge cloud. The difference here lies in the company's attitude to the problem. The "undeveloped innovations" are understood as failed company's projects or company's projects that stuck in the conceptual phase of company's R&D department, or they can be understood as joint, multidimensional research on high-risk/high-reward life science areas. The knowledge that inflows to the knowledge cloud is very often a fruit of different forms of cooperation between private and public entities. The common feature of all mentioned partnerships is the fact that they function in the high risk environment, because of the type of projects they are formed for. The "undeveloped innovations" part of the chart concerns the projects

for which the innovation process takes on the characteristics of "openness". It is noteworthy that the opening of innovation process breaks the rule of innovation process continuity (within one firm, using one firm's capabilities) [Pohulak-Żołędowska 2011]. Opening innovation process empowers the knowledge cloud with the institutional support, because many public or semi-public institutes and organizations are formed in order to meet the challenges of multithreaded research on tool molecules (like small molecules), new chemistries, antibodies or biomarkers. An example here can be the Novartis Institutes for Biomedical Research (NIBR), an associate of about 300 members from different academic disciplines. Creating by NIBR "research home" gives an opportunity to solve still undeveloped technologies. This initiative is supported by private enterprises, universities and public sector. It also provides on-line platform with working papers, articles, and post documents[1]. Another form of such a collaboration in research is NIH Roadmap Initiative in the USA and its European counterpart – EU-OPENSCREEN [Roy et al. 2011], which resulted in the emergence of probe discovery in Academia, as well as high throughput screening (HTS) centers harbored in universities all over the USA and compound libraries like PubChem [Roy et al 2011]. It is worth noticing here that the described "openness" concept in the sphere of pharmaceutical industry is not the openness in the meaning of public good. As it refers to specialized organizations and institutes chosen thanks to their intellectual and technical potential and, of course, fundraising capabilities (mainly public), the notion of openness is restricted to the 'involved' club, which makes this sort of knowledge inflow more a club good than a purely public one. It means that in some aspects of knowledge creation in the "undeveloped innovations" part of the chart "open" does not mean "free".

The last (but not least) portion of knowledge inflow to "the knowledge cloud" is the result of company's successful innovation activity – a product know-how. This is the most exclusive method of knowledge creation, and for a wide range of potential users, available only after intellectual property rights expiry. The knowledge inflow concerns the complete data on developed products after they lose their law protection that gives their owners the right to monopoly profits. The private knowledge passes to the public domain and increases the public knowledge available in "the knowledge cloud".

Thus, those three types of knowledge inflows augment "the knowledge cloud" in three different ways: (1) as brand new information that can be a source of market-potential idea – they are the scientific publication of basic research output, (2) as unsolved problems free to the general public in hope to find a collaborative solution which can be used in the future to gain profits, (3) and finally, as a part of the public domain knowledge that is automatically added to the knowledge cloud after intellectual property rights expiry. Of course this value inflow mechanism proposition is not a perfect image of economic reality. It is still an abstract model that explains the

[1] Novartis Repository, http://oak.novartis.com.

main relations among actors creating "the knowledge cloud". In practice, for sure, the knowledge inflows are not that simply constructed.

4.2. Knowledge transition from cloud to firm

"The knowledge cloud" described in the hereby article considers mainly the pharmaceutical industry, but the rule is valid for a wider spectrum of business activities, with an indication on the high risk/high-reward ones. If "the knowledge cloud" has strong basis and is built responsibly on the reliable knowledge sources, the value migration from the cloud is benefitting all recipients. This kind of knowledge transition can be compared to decoding "the source code" to the public in software industry according to "the open source" idea. The knowledge transition from cloud to firm implies the value capturing by the firm from "the cloud". It means that the company's value is increased by the value of knowledge captured from "the cloud" and used in the production process. The production process is about to ensure the synergy of knowledge transformation within the firm – the input value (value captured from the cloud) is smaller than the output value (value added to the cloud). The value added to the cloud develops and enriches the knowledge in "the knowledge cloud", which provides the continuity in knowledge base development.

"The firm zone" consists of two parts, which is the consequence of uncertainty of business activity effects achieved in the pharmaceutical industry. The assumption of the production process is to produce, but research and inventions – a vital part of drug's development − do not provide obvious solutions and only to a limited extent become innovations. The part of "undeveloped innovations" concerns all "troublesome" innovations which have not become innovations yet. Those can be drugs that stuck somewhere in the drug discovery lifecycle. The fact that not all inventions become innovations does not mean that the value captured from the cloud is wasted. If the trials fail, "the unmarketable innovations" go back to "the knowledge cloud". It does not also mean that in this case there is no value added. Defeat of some is an opportunity for others. That is why in a circle of the knowledge transfer different entities can start the process of drug discovery and others can put finished innovation to the market. All that happens in form of alliances between public and private actors.

On the other hand, there are "marketable innovations" which include all drugs that became developed and introduced to the market smoothly.

The phenomena presented in the hereby article have been widely described in literature. The graphical representation of the open innovation phenomena is the open innovation funnel (see Fig. 2). The wide part of the funnel is the place where the value from "the knowledge cloud" is absorbed. It is the pre-discovery, target identification, target validation as well as early drug discovery comprising all medical chemistry research and preclinical tests on molecules. The middle part of the chart represents the space of early phase of clinical trials and preclinical safety of laboratory and animal testing. The last part of the funnel, or better "a tube", represents the advanced phase

of drug development. Those are clinical tests as well as manufacturing matters that lead to a new drug discovery.

The inner part of the funnel contains internal innovation projects. The walls of funnel stand for company's boundaries. Outside the funnel there are external innovation projects on different stage of development. It is noteworthy that only at the end of the funnel the product is fully IPR protected. The wide parts of the funnel show different shades of openness in the drug discovery and development process. The molecules that leave the funnel in the middle of it, are innovations that, for some reason, leave the boundaries of the firm (as spin-offs, out-licensing) and find a new tube of development in different firms. Sometimes the knowledge formed in this part of the funnel needs further investigation because of weak value for the drug development process, and goes back to "the knowledge cloud" in the form of some contract between the company and a public or private contractor. These can be in-licensing procedures and these are types of feedback to "the knowledge cloud" in the dynamic flow of ideas.

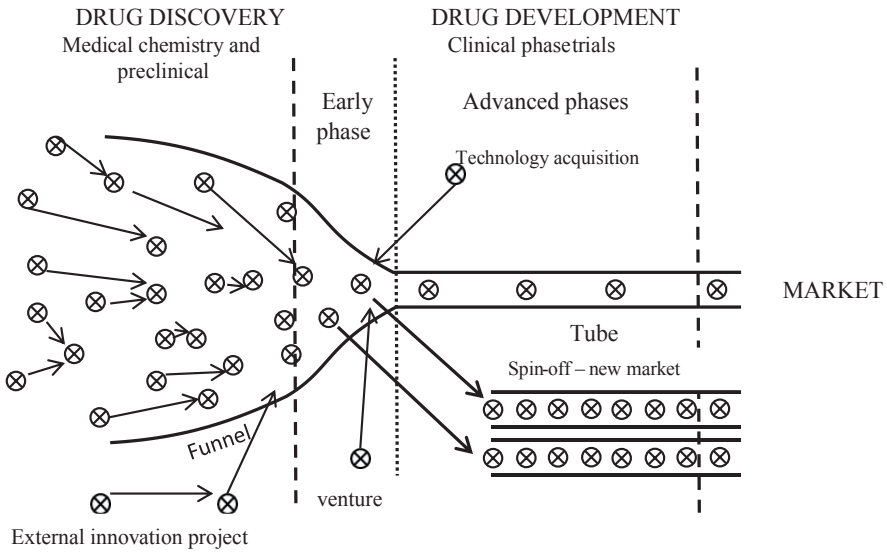

Fig. 2. Open innovation model

Source: [Hedner 2012].

In general, this approach to innovation makes the boundary between the firm and its environment more porous, turning the former solid boundary into a semi-permeable membrane. In contrast to the Closed innovation model, the launch of an innovation project can be triggered by either internal or external idea and technology sources. Those ideas and technologies can enter the innovation process at any time by various means, such as technology in-licensing or venture investments. Besides going to market by using the firm's own distribution channels, innovation projects

can be commercialized in many other ways as well, such as through spinoff ventures or out-licensing [Chesbrough 2003]. Therefore as such, open innovation applies to all three phases of the innovation process (front end of innovation, idea realization and development, and commercialization). However, open innovation is more than just using external ideas and technologies. It is a change in the way to use, manage, employ, and also generate intellectual property. Open innovation is a holistic approach to innovation management as "systematically encouraging and exploring a wide range of internal and external sources for innovation opportunities, consciously integrating that exploration with firm capabilities and resources, and broadly exploiting those opportunities through multiple channels" [Herzog 2011].

Development of information and communication technology makes it easier to collaborate or jointly innovate, that is why the open innovation becomes increasingly attractive business solution in some industries. It is noteworthy that literature shows different shades of openness in innovation process. An open innovation in literature seems to have two crucial characteristics in that openness is relative and that it is defined by "the willingness to cross the boundary of a firm either to source or diffuse innovation". In other words, there are varying degrees of openness in the definition of open innovation and that as long as the firms are utilizing resources outside the firm, this is viewed as open.[2]

The hereby presented model tries to generalize the processes of knowledge flow in open innovation. There are some interactions between actors taking part in the discussed paradigm that cause knowledge flow and increase of knowledge value. The model can be divided into some parts – "the knowledge cloud", that undoubtedly represents the open knowledge − the most open part of the open innovation process. Knowledge collected in "the knowledge cloud" can be regarded as the commons. It is created not for profit, but it does not exclude it. It contains described in the hereby article sorts of knowledge delivered by public, private (like crowdsourcing) and PPP institutions. Not for profit types of innovative conducts take place when firms want to explore a certain business model or market, or to jointly create knowledge that does not exist. In inbound exchanges, they take what is disclosed or published (public domain knowledge), participate in "open source" type community to jointly create codes or participate in open innovation platforms to unilaterally pose innovation tasks/problems and assignment (i.e. "crowd sourcing") [Lee et al. 2014]. In outbound exchange, open innovation can be practiced by firms freely revealing or disclosing what they know or by their innovation "tasks", contributing back to the community where they took knowledge from or providing a kit for users to participate in the innovation process. Even in this context, modalities of exchange are controlled either through mandatory IP law, or contracts, or norms of the community, or rules of participation (terms of

[2] Terms like crowd-sourcing (to describe firms willingness to replace a contractor or a supplier with community), public or open platform and networked innovation are describing different shades of openness in innovation.

uses, and association). Literature shows numerous examples of new R&D structures within pharmaceutical companies that aim in fostering open innovation dialogue with academia. It is noteworthy that they represent mainly "the knowledge cloud" suppliers with the very basic research needed on the pre-discovery or early discovery stage. There may be mentioned Eli Lilly-PD2 Initiative [https://openinnovation.lilly.com/dd], Merck-Sage Bionetworks [http://sagebase.org/], GSK-caBIG Collaboration, Structural Genomic Consortium and many others [Roy et al. 2011].

The firm zone that consists of "marketable" and "unmarketable innovations" represents openness that could be called "collaborative". The knowledge produced herein is definitely more a club good than a public one, which means that it cannot be regarded as the commons. Transfer of knowledge is a contract between a company and a contractor. Different forms of collaboration have been established in order to launch a new drug. The best known are those between pharmaceutical (or biotechnology) companies, and public research institutions like universities and others (for example NIH in the United States). Those contracts cost a lot and are far from being fully open. Thus it is noteworthy that they definitely constitute either "for profit" open innovation process or "for profit" co-creation process (see Table 1).

Table 1. Modalities of open innovation

	INBOUND	OUTBOUND
For Profit Transaction/ Exploitation	Acquire/Buy/Contract In/ License In	Sell/License Out/Contract Out
For Profit Co-Creation/Access	Cross License & Barter, Pool	
Not for Profit Co-creation/ Exploration	Take (formal&informal)/ "Open Source"/Crowd Sourcing/User Sourcing	Disclose (formal&informal)/ Contribute&Publish/User Participating Kit

Source: [Lee et al. 2014].

When companies practice open innovation "for profit" the innovative exchanges are likely to be a transaction to exploit the innovation. In inbound exchanges, this means that firms either buy or license in the innovative knowledge from actors outside the firms. Often in these exchanges, innovative knowledge is clearly defined as IP or related to the use of the clearly defined IP, in case if know-how or related heuristic knowledge is necessary. In outbound exchanges, this means that firms either sell or license out the IPs that they hold. As the core of knowledge it will be defined as IP, and transaction or exchanging these types of knowledge will be relatively clearer. In these types of exchanges, IP indeed provides certainty as it will provide information on pre-contractual liabilities and minimize transaction costs [Merges 1996]. As such, firms practice the use of open innovation for profit, when there are clearer rules over the ownership over the core knowledge either in the form of IP or through other private ordering means (contracts) or community norms. Commercial software firms using

open sources, for example, engage in open innovation when they know the act of code writing will entitle them to the control over the codes they write, through copyright claims. Their open source licensing allows them to explore the outcome of the result and failure of attribution would invalidate the licenses.

Opening the innovation process in the biotechnological or pharmaceutical industry and using common knowledge resources does not imply free medications and not-for profit activity of these companies. The knowledge flow presented in the hereby article provides benefits to all participants – creating both "the knowledge cloud" and the innovations. There are numerous examples of profitable collaboration between "actors" of open innovation paradigm

On the example of biotechnological and pharmaceutical industries, which are so inseparably connected, the open innovation process and the free flow of knowledge show that the innovations (drugs) are not free and they cost a lot. As presented examples of multilateral cooperation depict, opening of the innovation process pays to each of its participants. Academia, state's institutes and biotechnological or pharmaceutical companies – all these entities benefit from the process of opening the drug development scheme. It is noteworthy that opposite to the software market and open source initiative, pharmaceutical industry output needs IP protection even in the open model business.

The reason for this situation lies in the base of innovation: software as an innovation is based on symbols, and bits of information and drugs on the living matter. Symbols, as already mentioned, are far from scarcity. Opposite to the living matter, open innovation process outcome in the pharmaceutical industry differs from the innovations in software. In the matter of IP protection, some copy left licensing is used. The copy left license means no profits for an author, no fee for a user, but also – no viruses for users (what is an issue of great importance when the "code" is open). In the pharmaceutical industry opening the innovation process, because of high cost of product development, is still connected to IP protection, which is a typical feature of products based on the living matter.

5. Conclusions

As described in the hereby article the open innovation idea presented on pharmaceutical industry's example contains all features of openness. It is an open source in the preliminary phase. Later, as "the knowledge cloud" it is constructed of both open source and open innovation, which is the collaborative form of it.

The production cycle is different with respect to the open innovation usage. The uncertainty of the innovation is often limited by the usage of less "open" dimensions of open innovation like contracting and collaborative innovation. Therefore the required outcome is innovation. However, it must be remembered, that "the knowledge cloud" is powered by information knowledge from every part of innovation funnel.

"The knowledge cloud" is in its assumptions similar to the open source idea that is widely used in software industry, and first of all constitutes the most general,

accessible and open form of knowledge, understood as the commons. Different sources empowering the cloud have one common feature – they understand knowledge as the commons. With the innovation development, during the open innovation process, the idea of openness is gradually replaced by "closed" contracts between interested parties. Openness of the process is on this stage understood more like the possibility of using the knowledge from outer sources, or as the possibility of selling the IPRs than creating or using the widely available knowledge. The increasing development of the product or more and more close profit perspective seems to limit (or even close) the possibility of creating and using the widely available knowledge. However, there are still exceptions when pharmaceutical companies place own unfinished projects and buy the license for innovation. One can say that there comes the re-supply of "the knowledge cloud" that constitutes the commons.

It is noteworthy that knowledge that creates "the knowledge cloud" is the main resource of innovation process, and the lack of access fee lowers open innovation costs.

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