ON IPR – ASPECTS OF OPEN INNOVATION CONCEPTS FOR INDUSTRY 4.0

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Abstract: After two decades of decline of the secondary sector, politicians, business leaders and scientists recall the role of the industrial sector as a key driver of research, productivity, and job creation. Consequently, many manufacturing initiatives have been started recently all over the world, driving for re-establishing and regaining an industrial share in the economy. A very promising approach seems to be the fusion of the virtual and the real world leading to concepts of smart production and logistics which has recently been referred to as "Industry 4.0".

While there various legal issues emerging with Industry 4.0 (e.g. protecting corporate/personal data, liability, or trade), research has so far been less focused on its challenges to nowadays' system of IP protection: Industry 4.0 implies a new-scale mass data absorption techniques which are capable to infringe intellectual property rights of various kinds.

The legal dimension of Industry 4.0 itself has been only roughly mapped so far, but a very similar and equally unregulated phenomenon has been already quite some time in practice under the notion of open driven innovation: Here, also the data provided by users in virtual communities in form of comments, feedbacks, recommendations on the web are touching various intellectual property issues and can cause an eventual infringement of protected rights. In this case, the voluntary contributors' interest in a share of the profit generated on base of their innovation has been regulated in detail many decades ago in form of employee's invention law balancing between the user's and the manufacturer's interest by keeping access to these data as free as possible. In the context of Industry 4.0, the related legal transactions go beyond these user-driven innovation concepts, as data is not provided and/or used/processed by the users themselves, but autonomously by the IT systems.

Estonia as a transition economy with a small population coped until now with the Industry 4.0 related challenges well by focusing on innovation, improving the ICT infrastructure and evolving the e-governmental service portfolio. Until now several international studies attest Estonia high rankings and performance in innovation and Industry 4.0 readiness. But the stronger roles of internet and networking in Industry 4.0 spur the trend to extend the source of innovation from company-run research departments towards open and user driven innovation models which is closely linked with the above mentioned IPR issues and utility models. The paper will thus highlight how Estonian companies will deal with these topics and how open innovation concepts for Industry 4.0 can be used by SMEs in order to benefit from the new business opportunities.

Keywords: Industry 4.0, Internet of Things, open innovation, intellectual property rights (IPR), transnational entrepreneurship, countries in transition.

1. Introduction

After two decades of decline, manufacturing and re-industrialization are enjoying a renaissance on the Western agenda because politicians, business leaders and scientists recall the role of the industrial sector as a key driver of research, productivity, and job creation. Industry generates 80% of the EU's private innovations and 75% of its exports, but a closer look reveals that the global share of European manufacturing value added dropped from 36% in 1991 to 25% in 2012 (Veugelers, 2013; Heymann and Vetter; 2013). Currently, EU industry accounts for only about 15% of the total gross value added and so, consequently, a weakening industrial base in the EU is threatening its wealth and future innovation performance (Eurostat, 2015).

Within the last years, many manufacturing initiatives have been started all over the world, driving for re-establishing and regaining a significant industrial share in the economy. A very promising approach seems to be the fusion of the virtual and the real world, i.e. the linkage between internet and manufacturing leading to concepts of smart manufacturing and logistics. Smart manufacturing aims to develop cyber-physical systems (CPS) and dynamic production networks in order to develop flexible and open value chains in the manufacturing of complex mass customization products in a small series up to lot size 1 (Ramsauer, 2013).

In Germany, the most important industrial EU country with an industrial gross value added of about 30%, this approach has been called “Industry 4.0”. Industry 4.0 aims to develop cyber-physical systems and dynamic production networks in order to develop flexible and open value chains in the manufacturing of complex mass customisation products in a small series up to lot size 1. But first studies reveal that beside sophisticated manufacturing expertise, the implementation of Industry 4.0 also require ICT knowledge in cyber security, e-commerce and e-government, the integration of the SME sector, and the implementation of a regulatory framework integrating traditional legal concepts like contracts and liability issues into the virtual sphere.

Comparable initiatives outside Europe are called “Advanced Manufacturing Partnerships” for the USA or “Made in China 2025” for China (Dujin et al., 2014; Kagermann et al., 2013). Meanwhile, since July 2015, there exists an approximation between Germany and China in modern digital industrial technology comprising “Industry 4.0” because the German minister of economics, Sigmar Gabriel, and the Chinese minister for industry and ICT, Miao Wei, signed during a trip to China an agreement about cooperation in the field of “intelligent manufacturing” (Handelsblatt, 2015).

By analysing the objectives of Industry 4.0 it turns out that Industry 4.0 has even higher ambitions beyond the use of cyber-physical systems and dynamic production networks, as it aims targeting energy and resource efficiency, shortening of innovation and time-to-market cycles, as well as a rise in productivity through internet–linked production facilities, i.e. machine-to-machine-communication and interaction (M2M). The use of M2M allows to name, identify and trace products during their whole creation process and their life time, which opens up new perspectives for the entire supply chain including product design and development, operations management and logistics (Bauer et al., 2014; Brettel et al.; 2014). In this sense, Industry 4.0 represents nothing less than the fourth industrial revolution, comprising 3D printing, big data, Internet of Things and Internet of Services, i.e., all of the ingredients needed to facilitate smart manufacturing and logistics processes (Kagermann et al., 2013). Thus, Industry 4.0 shall bring back the competitiveness in the manufacturing and high-tech sectors to Western countries especially to those countries which are equipped with a high innovation level, a sophisticated ICT infrastructure, and highly qualified workforce (Spath et al., 2013).

Unfortunately, smart production is to large degrees so far still a concept, and there are still many open questions concerning standards, technical solutions as well as appropriate business structures and models. Solutions are complex and they can only be attained in cooperation and by knowledge sharing since sophisticated production expertise is not sufficient for the implementation. Industry 4.0 also requires ICT special knowledge in cyber security, e-commerce and e-government, the integration of the SME sector and new business models (Prause, 2015).

Already now, some ideas of Industry 4.0 like 3D printing, production in networks and smart logistics concepts are starting to get partly realized and the existing companies are trying to develop new business models and structures in order to benefit from the business opportunities of the new technology and related innovations.

2. Literature review

In his work about competitive advantage Porter (1998) developed in the context of his value chain theory the importance of specific company activities and he stressed the specific profile of activities as a source for the long-term competitive advantage of a company. These specific company activities which he used as synonyms for business processes comprise also logistics and supply chain processes due to the cross-company character of value chains. Today’s value chains have often evolved over longer periods and tend to be relatively static and the supporting ICT systems exchange information via a variety of interfaces with parts of the value chain but there is no global overview from the perspective of the product that is being manufactured (Brettel et al., 2014).

Industry 4.0 aims to create a horizontal integration through value networks with an end-to-end digital integration of engineering across the entire value chain together with a vertical integration and networked manufacturing systems and as Kagermann et al. (2013) pointed out Industry 4.0 aims also for energy and resource efficiency, increased productivity, shortening of innovation and time-to-market cycles together with a horizontal and vertical integration through value networks and an end-to-end digital integration of engineering across the entire value chain. Internet–linked production facilities and networked manufacturing systems open up a machine-to-machine-communication and interaction, called M2M, which allows to name, identify and trace single products during their whole creation process and later on during their life time, which generates new perspectives for the entire supply chain including product design and development, operations management and logistics (Bauer et al. 2014; Brettel et al. 2014). In this sense, Industry 4.0 represents nothing less than the fourth industrial revolution, comprising 3D printing, big data, Internet of Things and Internet of Services, i.e., all of the ingredients needed to facilitate smart manufacturing and logistics processes (Kagermann et al. 2013). M2M technology of Industry 4.0 together with internet–linked production facilities and networked manufacturing systems allow to identify and to trace single products during their entire life-cycle and even more because in industry 4.0 it becomes possible for products to organise and choose their own way through the production and related logistics processes (Bauer et al. 2014). Thus Industry 4.0 leads to new supply chain paradigms based on complex and intertwined manufacturing networks with changed roles of designers, physical product suppliers, clients and logistics service providers.

Consequently, companies which are active in the context of Industry 4.0 will become able to acquire knowledge from a variety of different sources and actors and combine it with internal and localized knowledge and expertise which is crucial for competitiveness as innovation processes in the interplay between local and complementary global knowledge (Porter, 1998, 2000; Gertler and Levitte, 2005; Boschma and Ter Wal, 2007). User driven innovation in form of online communities can be considered, by following Bartl (2008), as an open innovation approach, which underscores the way of going beyond the corporate boundaries, i.e. an active strategic deployment of environmental clout or external factors of influence to increase its own innovation potential (Faraj et al., 2011). Crucial determinants of such concepts are the shift from the industrial society to the network-based knowledge and communication society. As a result, innovation occurs, and ideas are generated in such a society through the interactive creation of value. Additionally, open innovation encompasses such manifestations as to be open for the knowledge of the other, generation of the knowledge as a joint action as well as the share of the knowledge with the other.

Besides, an important role for the phenomenon open innovations plays the customer. In the course of innovation management, there was generated a new role model of the customer when developing new products or offering new services (Füller, 2006; Füller et al., 2007). In this sense, open innovation emerges also when the customer is involved into the process of generation. Therefore, it is vital to adapt to customer's needs and requirements as well as wishes in the customer goods markets. Furthermore, it is essential to integrate the customer into the entrepreneurship innovation-related activities as a new external knowledge and ideas source (Bartl, 2008: 3-4; Bartl et al., 2012).

Zhao (2005) confirmed that entrepreneurship and innovation are positively related to each other and interact to help an organization to flourish, i.e. entrepreneurship and innovation are complementary, and a combination of the two is vital to organizational success and sustainability. He also pointed out that the organizational culture and the management style are crucial factors affecting the development of entrepreneurial and innovation behavior in organizations.

Originally, user innovators were defined as those individuals who develop new products and services based on their own perceived needs without the assistance and involvement of producers (von Hippel, 1988). In his recent research, von Hippel introduces some measures to quantify the importance of users in the innovation process and suggests that billions of dollars are spent annually by users to improve products and make them better suited to their needs (von Hippel et al., 2011, 2012). With respect to scale, von Hippel's surveys found that millions of users collectively spend billions of dollars every year on developing and modifying consumer products.

Since valuable consumer-related knowledge is widely dispersed recent solutions for the integration of large numbers of consumers into the innovation process is mainly based on information technology (Web 2.0). These online communities contribute to company's profit and related topics like intellectual property right (IPR) and participation of user innovators in their additional generated company profits have recently been a major issue in the field of employee's inventions and non-affiliated private contributors of innovations of any kind.

Most the abundant product-related data provided by users in virtual communities, appearing in form of comments, feedbacks or recommendations, are basically freely accessible on the web, although the "authors" of these innovations generally have various protected intellectual property rights. Unfortunately these IPR issues are often not taken into account by companies making use of the respective data, causing an eventual infringement of IP rights.

3. Method

The research process described in the paper has pursued a manifold research path, whereby diverse research methods have been combined with the respective research approach and research tool. Five techniques were employed in exploring the objectives of the present paper:

- Research types: analytical, qualitative, historical, empirical, practice-based
- Research approach: qualitative
- Research methods: descriptive and qualitative – case studies, semi-structured interviews, expert assessments and observations
- Research scope: different research activities in 2013 and 2014.

The reasons for the selection of the mentioned techniques in the research process are based on the considerations of Creswell (2003) who stated that "if a concept or phenomenon needs to be understood because little research has been done on it, then it merits a qualitative approach", i.e. the authors of this paper used a qualitative approach for the problem solving. However this paper has been developed by also using quantitative data so that the "researcher converges quantitative and qualitative data in order to provide a comprehensive analysis of the research problem".

Consequently the paper has chosen analytical, qualitative, empirical and practice-based way, since during the research process the facts and empirical evidence gathered were appropriately analyzed and subject to a critical assessment. But as already mentioned the core of the research process represents a qualitative research approach which is enriched by secondary data from public sources. Important insight views were given in qualitative expert interviews conducted in Mektory at Tallinn University of Technology and the analysis of case studies of companies operating in the context of Industry 4.0 issues.

5. Leagal aspects of Innovation and IPR

Legally, the development and implementation of Industry 4.0 and its solutions are linked to a variety of open questions (Bräutigam & Klindt, 2015). Industry 4.0 implies mass data absorption techniques which ultimately can infringe a broad range of intellectual property rights. These core techniques enable devices to conclude transactions over tangible assets and digital content and are often referred to under the notion "internet of things". In other words, "industry 4.0" is the "industrial application" of the Internet of Things, describing supply chains and networks of suppliers and manufacturers which are interconnected via internet.

In this context, a new and so far barely researched aspect follows from the fact that the interconnectivity of smart products implies access to various data and their configuration with other devices. Apart from security and data protection issues, these configurations could be protected as intellectual property (as e.g. a patent, utility device, or a trade secret).

As Bräutigam and Klindt (2015) are pointing out the concept of Industry 4.0 together with its new technologies and its connectivity concept raise a variety of new legal questions which are only partly discussed in scientific literature. Already the regulation of open and user-driven innovation which belongs to the field of intellectual property law represents such an issue of ongoing discussions and which will be discussed more deeply in the sequel of this paper.

Generally, an innovator contributes privately and voluntarily to a public good, i.e. to a good or product which is freely available on the market. This model, known as "private-collective innovation" (von Hippel and Krogh, 2003), is applied for instance often in the IT branch to develop and maintain open source software; well-known examples are Linux or Firefox. The model contrasts with the (traditional) private-investment model, where innovation is generated exclusively by the company itself, which – in return – has to amortize its prior investments via granting licenses to users. It therefore is bound to protect the achieved innovations, e.g. via licensable IP rights.

In private-collective innovation, the privately generated innovation is not regarded as an "investment", but rather as a voluntary contribution to a common good, making the innovator waive any copyright and further IP rights as soon as the innovation has been shared with others (Lerner and Tirole, 2002a; 2002b). But not only the individual innovator refrains from his rights, also firms waive their IPRs extensively, realizing that making their technical state-of-the-art freely available to the public generates a much higher return in terms of innovation than the private-investment model (Henkel et al, 2013). Although innovators "invest" considerably time, energy, knowledge and other resources without any expectancy of financial gratification, the private-collective innovation model proved to be very successful in practice (Gächter et al, 2010) and gave grounds to extensive research recently, especially concerning the contributor's intrinsic motivation for their free commitment (Alexy and Reitzig, 2013).

From a legal point of view, there is little demand for a balance of interest to be achieved by instruments of intellectual property law, as the free use of otherwise protected rights form the essence of the "Open Source Scene's spirit": All parties involved in open source innovation are aware that they – expressly or impliedly – waive their respective IP rights, driven by the awareness that they jointly improve a "common good".

But not all user-induced and open innovations contribute to public goods. The innovation beneficiary more and more often happens to be a private and profit-oriented company, making the private user providing innovation not any more to a public good, but to private assets of that company – e.g. sport sailors disclosing improvements they made to sailing equipment on the sailing equipment's company's homepage (see further examples at Baldwin et al., 2006). The value generated by this innovation is not any more freely available on the market, but has to be purchased by each sailor (or other kind of customer) individually. In this situation, the exchange of interest is not as balanced as in the Open Source Scene, and correction measures imposed by law may be required. As these contributions are of immaterial character, these correction measures – in other words forms of legal protection – must be sought among the existing protection schemes intellectual property.

A central instrument aiming at the protection of technical improvement is the patent, either in form of Estonian or international/European patents. A patent is basically the right to exclude competitors from the usage of an invention and is effected only upon registration, which will be granted upon application by national or international/European patent offices if evidence has been provided for following criteria:

- There must be a patentable subject matter (no patents will be granted e.g. on alterations of the human body),
- The invention must be novel – i.e. non-existent so far world-wide –,
- The invention must be non-obvious (in U.S. law) or must involve an inventive step (in European law), and

- The invention must be useful for a concrete purpose.

A granted patent is a strong and effective right, granting the patent-holder a broad range of rights ranging from monetary compensation for past infringements to injunctions against future infringements – although its role in innovation has recently been a controversial issue, as it is sometimes claimed that innovation cannot be harmed more than by the exclusion of others from knowledge (Hall, 2014, p. 26).

In fact, every user-generated innovation communicated via online communities could generally be patented by the user, if the innovation fulfils a number of criteria, comprising novelty, not being obvious and probably useful as well. But still, the ability to patent an invention doesn't grant a comprehensively protected right - neither in Estonia, nor in any other legal system (Tönnies 2013). The company may apply for a patent for an open invention just as well as the user himself – patent law in so far does not directly protect the user's invention from the "exploitation" of the invention by private companies. This situation changes if the private company seeks protection of its legal position from the usage of that improvement against other third persons: If the company is not able to prove the origin of the invention, a thorough research may reveal another person (here: the user) as inventor, who made his invention publically available, depriving the tentative invention from its novelty. This being more or less known to many companies which informed themselves about the basic IP backgrounds of their practices, user-driven invention is often rather reluctantly chosen as a source of innovation.

However, the mere ability to patent an invention does not grant yet a comprehensively protected right – neither in Estonia, nor in any other legal system: The invention itself – even if communicated to the public – is not yet property-like protected and also does not deserve yet protection, as there is no form of intellectual property in mere ideas (Tönnies, 2013). The inventor will have the exclusive right to use his invention (or to, practically just as important, grant a license to third parties for that patent) once the patent has been granted successfully. There is a certain debate about the protection of patent applicants between the time of submission of the application to the patent office and the final grant of the patent – which may take years –, as in this case the applicant has already demonstrated to the public that he requests a comprehensive exclusion right in (hopefully) near future; so far, most legal systems nevertheless would grant a mere compensation to be paid by the infringer to the applicant instead of the full range of patent defence rights mentioned above (for German law: Pahlow, 2008).

Still, returning to the typical situation in which user communicate their inventions online, even this basic step of an application has not been reached yet and is also not endeavoured by users. Before application, there is generally no active right on base of which the inventor may prevent the usage of his patent by others: The sport sailor may, e.g., may not seek a court injunction against the sailing equipment company who produced an improved rope winch modelled after the sailor's descriptions on a social community or the company's website (Lüthje, 2004; Hienerth, 2006; Hyysalo, 2009). Patent law in so far does not directly protect the user's invention from the "exploitation" of the invention by private companies. If the rope winch did not involve an essential inventive step, but merely a minor improvement, many States provide protection for these improvements in forms of the protection as a utility model, which can be seen as a "small patent" (for a list of these States providing this instrument: WIPO, 2014). The procedure to protect a technical improvement in form of a utility model is generally comparable to the patent procedure, but requires less costs, fees and conditions – while respectively the scope of protection will be considerably smaller as well. But again, protection as a utility model will again be only effected after successful grant of the registration as a utility model, and as users generally will not have applied for this kind of protection either, their legal position remains generally defenceless in this context.

In conclusion, a patent generally does not have the right to prevent other persons to make use of his improvement. But the situation changes if the private company seeks protection of its legal position from the usage of that improvement against other third persons: The sailing equipment company may eventually intend to hand in itself a patent for that rope winch development by that sport sailor, based on the descriptions put on the internet by the sport sailor. When the sailing equipment company will hand in a respective application for a patent or a utility model at the competent office, the office will check – among other conditions – the novelty of the invention/improvement. If the company did not disclose itself the origin of the invention, a research by the office may reveal the sport sailor as inventor, who, in this case, also made his invention publically available – depriving it from its novelty. Although details are controversial in national patent law systems (they essentially differ whether they provide a grace period for filing an invention – e.g. U.S. law – or follow a "file first, publish later doctrine – e.g. German law, Klett et al., 2008; p. 4), the lack of novelty will considerably weaken the company's legal position: Depending on the respective legal regime (national or international law, depending on the function of the patent/utility model office), the sport sailor could file a notice of opposition within a special opposition period (e.g. nine months for a European patent, twelve months for an Estonian patent; for background see: Klett et al., 2008 p. 12). But also if no notice of opposition was filed/the office did not find the actual source of the invention and the patent was successfully granted to the company, the company remains endangered that the user will later hand in an action for nullification of the patent, as the conditions for its grant had not been met: If the patent holder was not entitled to hold the patent, the patent will be revoked – e.g. European patents acc. to art. 139 European Patent Convention (for European patents), national patents according to respective national patent acts (in Estonian law acc. to act. 49 par. 1 Patent act).

In other words: If a company endeavours the complete exploitation of a patent or a utility design – and the more useful the invention is, the more probable this endeavour will be –, it has in some way to cooperate with the author of the innovation. Otherwise, it will run the constant risk of a later revocation of the patent – or, although less likely, the application for a respective patent by the inventor itself, which then would exclude the company also from the further usage of the invention in its products.

6. Open and user-driven innovations in the context of Industry 4.0 in Estonia

This is the general status quo in developed countries. Countries in transition – as Estonia – envisage in so far a different situation as many SMEs or start-ups on the one hand do not have funds to maintain own research departments, but fear the second step (the costly and time-intensive application for a patent) just as well. Their interest is basically to make use of open and user-driven innovation without any costs whatsoever – even though this ultimately results in the lack of any legal protection of their products as well.

The developments related to Industry 4.0 are of special relevance for countries with a high performing innovation system, an experienced internet start-up scene and a strongly share in manufacturing like Estonia since these countries have the opportunity to benefit most of Industry 4.0 (Dujin et al., 2014).

Estonia is a relatively small EU member state which regained its independence in 1991, joined the European Union in 2004 and enjoys a young R&D and innovation system which reached a stage of increasing efficiency and capital intensity by science-driven innovation (ERAC, 2012). Moreover, Estonia does quite well in this legally in first sight somehow "vague" field of non-protected innovation. A closer look to the statistics in Estonia shows that despite the fact that Estonian innovation figures are close to EU27 average and the annual growth rates of all kinds of intellectual assets are significantly high (18,9% - 36,6%), the protection of Estonian innovations are still significantly below the EU27 average when it comes to patents or design; only the use of community trademarks are above the average (IUS, 2013). These results reveal a comparatively liberal application of the patent regime which focusses on a quick integration of user innovation in life-cycle supply chains of products by neglecting considerations of IPR aspects with the consequence of only very low patent and license revenues from abroad for Estonian innovations.

The Estonian innovation performance is solid and the country has been able to develop a remarkably robust innovation system over the last two decades, preparing a fertile legal and economic space for high-tech companies like Skype. In 2013 the EU Innovation Union scoreboard positioned Estonia in the middle of all EU member states in the group of innovation followers, slightly below EU27 average, but with about 7% annual growth rates in innovation performance, representing the highest EU value (IUS, 2013). The innovation gap between Estonia and its Baltic neighbours is already remarkably high and Estonia surpassed already a number of Western European EU member countries as e.g. Italy and Spain.

Despite these successes the weaknesses of the Estonian innovation system remains in shortcomings in open, excellent and attractive research systems and economic effects. Especially the low numbers of Estonian patent applications, which are still significantly below the EU average, underline the weakness to capitalize existing innovations. Furthermore, there is a particular need to strengthen the base of skilled professionals in dynamic sectors, for example in ICT and marketing. Also the Estonian performance expressed in GDP per capita and labour productivity is still much weaker than its innovation performance, and Estonia's prosperity level is placed behind all Western European countries as well as the leading Central European economies (IUS, 2013).

Most of Estonian innovation concepts involve more or less the use of open and user-driven innovation, impeding the need for prior investment into research departments. Still, Estonian companies also intend to avoid the eventual risk of such copyright infringements as described above, which could generally easily be archived by simply not applying for any forms of protection (patents utility models etc.). On the other hand, they have to provide a minimum degree of liability for the products produced by them based – among others – on open innovation, which is a demanding task if the products sold are not protected. Some Estonian start-ups which were meeting these challenges remarkably well (Mektory, 2014). An awarded new venture developed 3D printing operating system which allows the use of CAD product data directly for 3D printing which makes rapid prototyping for 3D products extremely quick and efficient. Starting point for the venture were three Estonian students who worked with existing 3D printers and who were part of corresponding user groups. The user groups met in internet fora where advanced clients discussed innovation ideas around 3D printing. The three students participated actively in those fora and quickly found out the weak points of existing 3D printer operating systems and possible business opportunities, i.e. by making use of various useful innovation contributions from their forum colleagues (Shah and Tripsas, 2004).

In this context, of special interest is the consideration of the product life-cycle at the end of the supply chain since this phase of the closed to the client and which gains constantly of importance due to postponement concepts in the context of mass customization (Prause and Thurner, 2014). In this situation the final part of the supply chain ends in the sphere of the client, i.e. the client is directly involved into the finalization phase of the production process at his home – as e.g. in the use of 3D-printing. User-driven innovations in the field of 3D printing are easy to protect if they are linked directly to the 3D printing device or they contribute to services offers around 3D printing which are organized by the inventing users.

Facing these challenges, Estonian companies took into account that innovation becomes more and more complex, fast, interactive, and requires the connection of external and internal knowledge bases (Chesbrough, 2003). Despite the multitude of insights into technology transfer, remarkably little is known about how transfer processes are shaped by the underlying industry and its technical regimes (Breschi et al. 2000; Marsili 2001; Gilsing et al. 2011). Also the need for legal reform respectively adaptation has been identified and implemented in governmental strategies; e.g. the Estonian Research and Development and Innovation Strategy 2014-2020 "Knowledge-based Estonia" states in its recommendations that "the system for the legal protection of intellectual property must be updated so that it could provide even better support to research and development and innovation – taking into account the smallness of the country" (Estonian RDI Strategy 2014).

Based on this knowledge, the three young entrepreneurs formed a start-up company for the development of new software for operating 3D printers based on common CAD program standards by taking under account the innovative ideas from the user groups. The corresponding business model is drafted for 3D printing device manufacturers that are willing to integrate the new software into their products, implying that the software (intellectual assets) becomes part of the final 3D printing device so that a certain license fees for each sold printer will be transferred from the 3D printer manufacturer to the company. These procedures allow safeguarding the developing SME from eventual liability claims initiated by users who have contributed essential innovation into the products provided – and sold – by the SME to the 3D printing device manufacturer, as the original user's contribution is not detectable any more. The company does not have to account future interests eventually articulated by an inventing user, as the company did not file itself for any protection, thus depriving the user from original IP rights. On the other hand, the product sold to the device manufacture is free from any legal defects, as the user contributions themselves were not yet novel or useful enough to be protect worthy; it was essentially the composition of these individual contributions by the company which reached the threshold of patentability. In other words, the product sold by the company can be – if and when demand arises – patented by the device manufacturer without any risk that users may file a notice of opposition against the patent application (which, in a second step, would have made the company liable for providing a "legally defective" good to the manufacturer).

Based on the new operating software, a second 3D printing service company was established, which prints out small batches of 3D printed products for larger companies by realizing a competitive advantage due to shorter 3D printing and product development. It is also more directly related to the new 3D printing operating software, which allows speeding up the life-cycle supply chain process of the 3D printed products based on quick prototyping and optimized product development.

7. Conclusions

Industry 4.0 paves the way to smart production and logistics by developing new technologies which are linked via internet. This new dimension of interconnectivity and large-scale data access implies hitherto unprecedented challenges in legal aspects as well. Until now the related legal issues, especially IPR topics are only partly discussed in scientific literature. While user-driven innovation has partly found parallel legal frameworks in e.g. employee invention law, the internet of things has opened the doors to entirely new contract formation mechanisms – having a direct impact on industry 4.0, the manufacturing component of the internet of things.

As these new contract law concepts for the internet of things still has to be developed, at present entrepreneurs have first of all to be aware of liability issues if they implement industry 4.0 mechanisms. This aspect has especially to be taken into account on economies which eventually will be highly dependent on the chances provided by industry 4.0, especially countries in transition which cannot rely on rich natural resources or an abundant workforce, which is the case mainly for small and medium-size states. Estonia being a representative for a rather small economy in transition realized the potential of open innovation for the development of its domestic economy: Estonia is aware that developments in communication technology have enabled new forms of user integration into innovation processes. Virtual communities, communities of practitioners and living labs are examples of how to integrate the dispersed knowledge of users into strategic decision making. In the field of complex and dynamic socioeconomic technologies in particular, the use of virtual communities is a powerful tool to safeguard user oriented and accepted new technologies.

These considerations especially apply in the case of Industry 4.0 as well as in countries in transition because here the financial means are so low that expensive patenting procedures are not affordable. The existing situation and the described cases in Estonia demonstrated that a product based on open innovation can still generate a considerable turnover, even though no investment had been made into own research departments or patents, and that these business models are also legally water-proof, as the company does nevertheless not have to fear liability issues towards the contract partner to whom the open innovation product is sold.

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