

*“A thousand blooming flowers
through innovation matchmaking
between the research institutions and
firms”*

**Barriers and Potential for Collaborative Networked Matchmaking
Research Innovation**

MSc in Innovation and Entrepreneurship

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match innovation

Abstract

The academic literature has a widespread agreement that knowledge, learning and innovation are the key to economic development and competitiveness for firms, regions and nations. Innovation in present business environment might be seen as a powerful way of securing competitive advantage as the factor of a firm's strategy for survival. Due to complexity of innovations characteristics, change of business environment and uncertainty it is very difficult to make a recipe for "the best practice scenario". Therefore some understanding of collaborative activities between the businesses and universities and their potentially powerful interactions for innovation should be understood better.

The 21st century brought the idea of knowledge sharing and open innovation that might prevail and / or overtake closed and costly research and development process. Overall, such platform for the research and development can increase the interactions between businesses and the universities with more economically suitable and renewable breakthrough innovations. For such scenario the idea of open, networked and matched innovation is necessary.

Networking can be understood as the most important policy for any organization focused on the process of innovation. The management of innovation through matchmaking and knowledge sharing is very complex and thus requires more effort. The purpose of this M.Sc. thesis is to investigate how innovation might be made, managed and sustained through different set of interactions between universities and businesses through networking and matchmaking with understanding the obstacles formed with the businesses – universities links and interactions.

This M.Sc. thesis describes a literature review of existing knowledge on regional, national and global level of innovation activities within networking and matchmaking platform suggestions. It also describes the results obtained through pilot and the main study done within the university scientists and interviews performed with R&D responsible persons in start-up firm, SME and large company. The empirical study was performed to understand what the obstacles are for interactions between the university scientists and businesses and what would be the acceptable innovation tools and platform for networked matchmaking innovation policy governed by university's technology transfer office. In this thesis script the empirical studies (qualitative and quantitative) are described, the results are executed, explained and discussed. Finally, some suggestions on the best-practices for matchmaking innovation process were given and conclusions were drawn.

This scientific M.Sc. thesis work is not conducted with an aim to reveal what are the reasons for low collaboration between the university members and businesses but to find what can be the optimal performances that can expose best practices for both innovation actors through the innovation that will be focused on the research matchmaking activities.

This study is only exploratory and all the conclusions made by author are solely suggestive.

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1. Introduction

Professor Ferdinando Alexandar Porche mentioned in 1972 that if someone analyzes the function of an object, its form often becomes obvious. These functions are often brought by the integration of various ideas and hence the innovation elaboration. Considering that the research, development and innovation are among the most important prerequisites for economic success the ancient Chinese proverb "the person who says it cannot be done should not interrupt the person who is doing it" is justified.

The innovation process is one of the most requiring processes and there is the point where innovation should be understood as a distribution process where integration of certain components such as the ideas, skills and knowledge is possible from several resources. Crucial factors for fertility of "garden of innovation", and its utilization can be understood within the "fertilizers" used to make the fertile ground, namely, a private and public research, human capital, governmental regulations, public and semi-public institutions and natural resources (Niosi, 2002). By understanding the chemistry between mentioned fertilizers a perfect innovation match between them would be possible and hence a thousand blooming innovative flowers can enrich economical garden on local, regional, national and global level.

The innovation is a product of the social relationship that develops over time along culturally close collaborative partners within certain set of rules or norms. Regulations and models of innovation can set the behavioral roles between the innovation partners and bring some expectations for novelty. In short, they bring the realization of a new idea.

Universities and other public or private research organizations are the essences for innovation and knowledge creation, while companies defined as entrepreneurial, small and medium size (SME) or large are the essences for innovation utilization and commercialization. Leveraging the links between these actors and making them to understand each other's cultures and needs (technology or service) and thereafter finding the solutions for these current needs by setting up the theoretical model would create and transform all the knowledge to perfect collaborative and business match. To be able to match existing information set from both sides (universities – firms) without becoming impossibly complex and thereby losing its main point a serious literature review on local, regional and national interactions within the area of open innovation, links and networks

between previously mentioned players as well as matching their wishes and needs is a MUST.

Belussi et al. (2010) have clarified that innovation is a geographically bounded broad system, whose context can be expanded from local to global level. This expansion can be slow or fast, depending to interactions between the important players. Innovation systems geographically can be divided as interaction between the knowledgeable or skillful individuals within the small town, region, country, or global – international (Niosi, 2002). Some experts argue that this 21st century will be a century of regionalization where regions will bring up their regional economies more effectively in terms of systematical promotion of innovation activities (Chung, 2002). That's why bridging the innovation between two sets of innovation systems, public or private, is very important. This bridge can be easily constructed by understanding different cultural behavior, fair distribution of intellectual property rights (IPR), extensive linking, networking and matchmaking the novel ideas within the open innovation process of technology transfers and commercialization.

Vast quantity of scientific literature is showing that in the last three decades the growth of technology transfers has dramatically increased globally and hence the innovation itself. As many researchers have agreed, this increase can be directly attributed to "Bayh-Dole Act" that allowed universities to license their IPRs and retain subsequent royalties and thus finance the fundamental research (Golob, 2006). This act has provided the possibility of open innovation on regional, national and global level where the universities and scientists can directly economically benefit from their skills, knowledge and fundamental or applied research results.

The tendency of this M.Sc. thesis was to identify how collaboration between researchers and companies are initiated, what are the main barriers for initiation and what are the problems involved in carrying out collaboration with companies as well as how that collaboration can be improved. The ultimate aim is to come up with new measures, methods and tools by which the involved universities can improve its collaboration with businesses.

This M.Sc. thesis work is structured as follows:

In the first section it will be theoretically reflected on general innovation policy and its dynamics as well as its influence on economical development on the regional, national and global level. The section after will provide some details about links in the innovation policy between universities, other research institutions and firms (businesses). Also,

bottlenecks within these links, wishes, needs and motive for interactions will be presented. Thereafter will be clarified what is the networked innovation policy and how it can increase the speed of innovation and enhance the economical gain, followed by innovation matchmaking and suggestion for its tools. Subsequently, in section after the propositions will be developed by focusing on the gaps in literature related to university – industry interactions and building-up the proposition for the research questions. Thereafter the research methodology will be explained together with the analysis of the data by quantitative and qualitative methodology related to the perspective and opinions of university's scientists and industrial research and development (R&D) representatives. Future collaboration perspectives in matchmaking the scientific research from the university and R&D needs from industry will be suggested by planned and detailed large scale investigation. In the end of this section some suggestions and ideas related to matchmaking tools and platforms that might be used between university scientists and businesses will be given.

This M.Sc. thesis work will bring some underdeveloped knowledge contribution and hopefully motivate some serious scientific research.

2. Innovation policy & economical development (regional, national and global)

Innovation policy and the research within this field can be followed down to 1987 where **Freeman (1987)** has explained the technology policy and economic performance in Japan. Created policies are strongly incorporated into the macro-institutions defined as industry, universities and government which are linked to engage in systemic interaction created by need for the knowledge, development of local, regional or national economy and competitiveness through innovation demand and larger scientific involvement in industrial production. These systematic interactions can be explained as dynamic capabilities of networking the knowledge through institutional resources on various levels. If all mentioned macro-institutions understand each other well the industry and government will be prepared to sponsor knowledge-based growth by funding more research. This will be assumable stimulus for closer interactions among the institutional private and public partners, or way subsidize the innovative infrastructure and stimulate academic entrepreneurship. This can be seen very well on the basis of networking partners listed by **Cooke (2005)** such as universities, research laboratories, research associations, industry associations, training agencies, technology transfer organizations, specialist consultancies,

government development, technology and innovation advisory agency programme funding, and private investors. The same author has explained that in the early stage of innovation the combination of scientific and commercialization expertise might exploit the innovative ideas by matching scientific output to market potential where some IPR transactions or arranged collaborative investments can create serious economical benefits for these players and the regions they perform in. As concluded by [Cooke \(2005\)](#) the open science through specialization and diversification can bring the high potential for any innovation from regional to global reach. With today's global information technology a regional, national and global innovation systems can be interrelated easily and hence collaboration increased between two or more players within the public knowledge and needs of businesses. Yet, the initiation of such collaboration is complex and mutual understanding of actors involved might be the good way to go. The explanation for previously mentioned is compiled from different literature and presented in section number 3 of this thesis. To grasp better the interactions possibilities between potential collaborators the geographically pre-defined, governmentally and organizationally supported arrangement of innovative networks should be understood.

2.1 Regional innovation system

The regional innovation was excellently defined by [Cooke \(2001\)](#) as a geographically defined and administratively supported arrangement of innovative networks and institutions that interact on a regular basis with the innovative output and commercialization from regional firms. [Tödtling and Trippl \(2005\)](#) have explained so as in the end of 20th and the beginning of 21st century a growing interest in regional innovation systems has materialized the idea that national and international, technological and sectoral factors are essential. Among them the regional dimension is the most important.

Knowledge transfer into successful innovation in addition to intensive contacts based on trust and understanding is best assisted by geographical proximity ([Tödtling and Trippl, 2005](#)).

Regional innovation system was described by [Cooke et al. \(1997\)](#) as a mosaic within a single national system of innovation. Further, the same author explains that this mosaic is formed of elements that are linked by specific relationship and interactions. These organizational elements can be divided as: public actors (universities, research institutions, skills-development agencies, technology-transfer agencies, science parks and incubators, public funding entities, patent offices, etc.) and private actors (firms, venture capital

organizations, banks, consultants, legal consultants, etc.). The intensity of these interactions (weak, intense, regular or irregular) can shape the ideas to a novelty creation, better explained as the innovation. The innovation systems might include the integration of innovation-driven elements such as: focus on high-tech, knowledge based / science based industries, building up the research excellence, attraction of local / global companies and if the outputs would be successful, the stimulation of commercialization to local, regional, national and international companies would be the end-scenario. **Tödting and Trippl (2005)** have clarified that specific strengths and weaknesses of regions in terms of their industries, knowledge institutions, innovation potential and problems are not sufficiently taken into account and that the “best practice” innovation policy approach does not exist. That’s why the same authors have analyzed different regions with respect to their prerequisite for innovation, networking and innovation barriers. The overall results brought by serious research on this topic were explained as the lack of interaction and networking between private and public institutions, and hence the low willpower for sponsoring university-business collaborative research. This problem might be related to non-understanding the organizational culture, policy and habits of potential collaborator. **Cooke (2005)** has made it clear that in optimized environment the regional innovation systems is good enough to quest the new knowledge formation, testing it and reflecting it upon the practical application. Such approach is designed to enhance the capabilities of knowledge dissemination and commercialization of innovation in that region. It was found by **Belussi et al. (2010)** that the regional research networks and knowledge sources distributed within the innovation networks can influence significantly the firms’ innovative performance. The greatness of relations in knowledge-based economies was explained by **Della Mothe and Mallory (2003)** where they have empirically clarified that “microcosmos can enable macrocosmos to function better”. **Edquist (2004)** pointed out that the innovation process should be seen in all its glory as the interactive and intensive process where communication and collaboration between different actors, both within companies and other organizations such as universities, innovation centers, educational institutions, financing institutions, standard setting bodies, industry associations and government agencies should exist. **Tödting and Trippl (2005)** have elaborated the graphical structure of regional social, economical and cultural innovation settings (figure 1). The most influential elements of regional innovation systems according to **Tödting and Trippl (2005)** are public research and educational institutions (universities, institutes), technology mediating organizations (technology transfer offices, innovation centers). Those authors

have stated that in the ideal case, there are intensive interactive relationships within and between these elements that make possible a continuous flow of knowledge, resources and human capital exchange. They have also found that there are also several types of problems and failures within the regional system of innovation such as the lack of respect between organizations and institutions and a lack of relations within and between these elements.

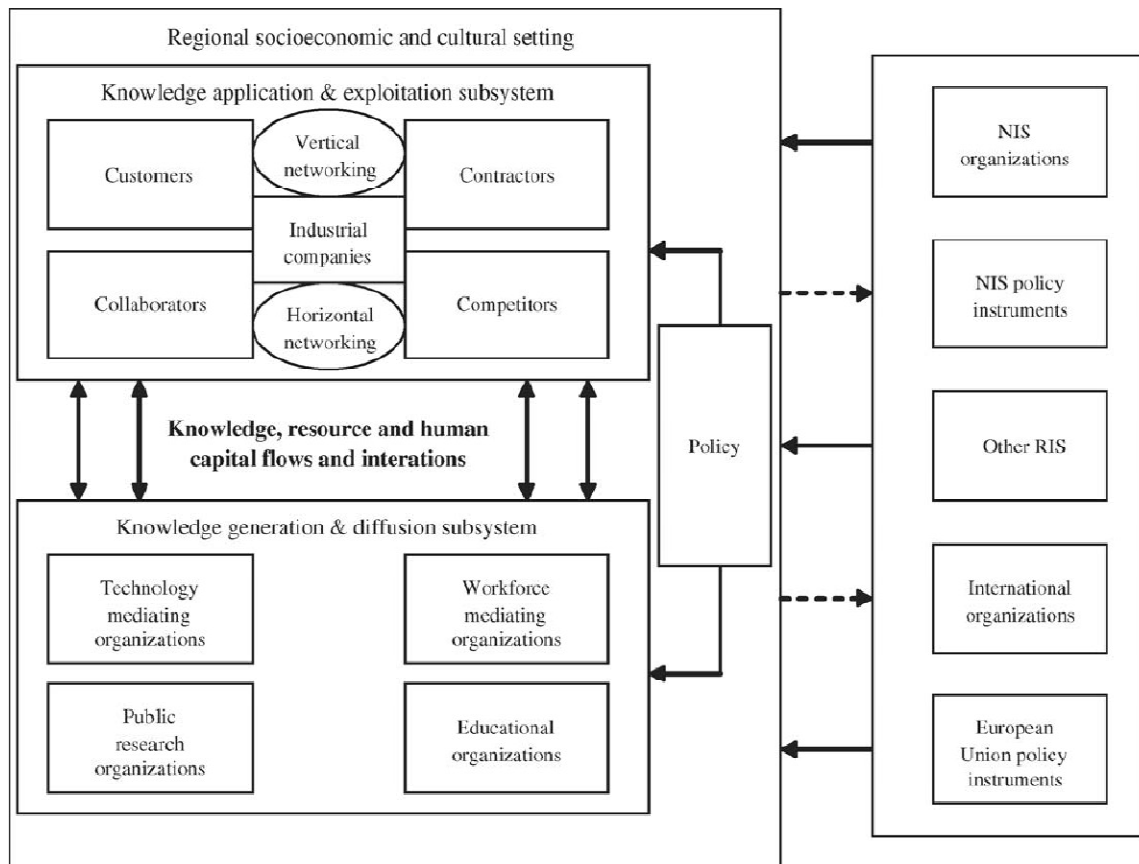


Figure 1. Main structure of regional innovation systems (RIS). *Source: Tödttling and Trippel (2005)*

Tödttling and Trippel (2005) have explained problem dimensions through different types of the regions as knowledge generation problem and diffusion at the university and research organizations as well as problems in knowledge transfer or even problems related to network characteristics.

2.2 National innovation systems

Previously was explained that regional innovation system is a piece of the mosaic within a larger picture such as the national innovation systems. This system can be easily explained

through interrelated institutional actors that create, spread and exploit innovations. The scientific literature suggests that these institutions are directly related by demanding, exploring and using the technological innovations. Namely they are: firm's R&D departments, national universities and other public research institutes (Chung, 2002). These actors are very important for generating innovations and strengthening / maintaining national competitiveness. Within those systems of innovation a very complex generation and diffusion of technological innovation is happening through constant interrelationship between the key institutions. Smooth relationship between previously mentioned actors will form the effective national setting where motivation for information flow between the actors in order to generate and appropriate innovation effectively might be very easy task. Unfortunately, this is not the case. The reasons for such claim are various. One of many reasons might be addressed to different corporate culture and understanding the innovation upon these cultures. The public innovation producers (research institutes and academia) and industry are developing and performing the R&D activities that should be found into the "collective innovation box" where the mutual understanding between those producers will enhance the collaborative opportunities and hence increase the economical benefit to entire nation. This will collectivity give an opportunity to regional governments to coordinate the R&D activities by the needs of regional policy instruments, visions and perspectives for the national future as well as present needs of various markets or industrial actors. Chung (2002) has proposed that innovation actors should collaborate very closely with each other. This collaboration might be based on strong level of trust where national and regional governments should promote and activate the trust and interaction between innovation actors. The same author concluded that the concept of this innovation system might be very helpful for the enhancement of regional and industrial competitiveness by activating interaction and flow of qualitative information among major innovation actors in a region and/or certain sector. Except the regional governments, the knowledge supplying actors (universities, industry and public research institutions) are also directly responsible for regional generation, diffusion, and appropriation of technological innovation and interrelationship between those factors (Chung, 2002).

Golob (2006) have noted that scientists argue that the university plays a leading role for bringing businesses and national governments together to support economic development. Others emphasize that the universities have a sole role of providing talents, knowledge and innovation. In general, all observed evidence regarding universities impact on national and regional economy is inconclusive. Subjectively, the most vital to understand is the

importance of universities for creation of fundamental knowledge that might attract the industry that is creeping for various technological solutions. In this kind of environment the potential for collaborative activities might be formed on collaborative applied research which would be based on scientific fundamental approach.

2.2.1 Norwegian innovation system and its generation of the knowledge

Scientifically non supported argument but rather subjective opinion of the author of this M.Sc. thesis is that innovation actors, especially public research institutes, are unevenly distributed among Scandinavian KASK region (figure 2), which potentially can lead to weak interactions between previously suggested innovation actors. This is the reason why the role of governments is solely to increase the R&D and innovation activities through different platforms by using the various matchmaking tools and social R&D online networks between the regional and national research institutions/universities and firms so that closeness and cultural understanding between them will be enhanced.

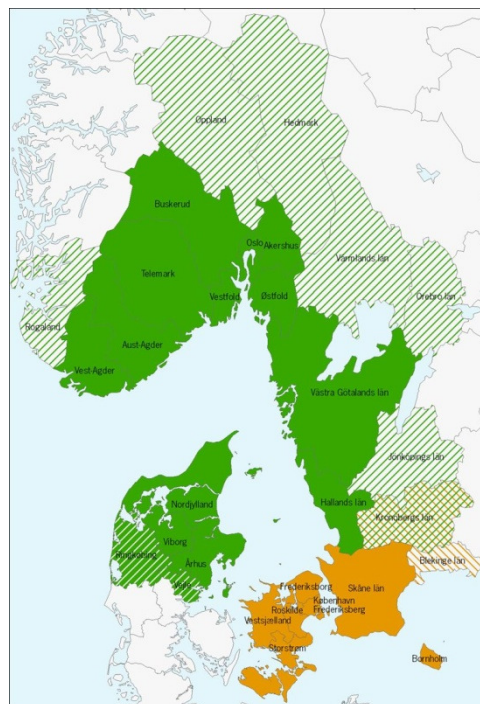


Figure 2. Map of Kask region

Fagerberg et al. (2009) have focused on the creation of new technologies arrived from Norway. They have stated that these technologies ignore their exploitation risks and are overlooking the essential cross-national differences in the transformation of newly developed knowledge into economic growth. Also, these authors have argued that Norway combines high growth in productivity and income with very low levels of investment in R&D. The reason for that might be explained in Norwegian well established position in the

niche of oil industry Engen (2009), fishery and other opportunities created by Norway's geography and terrain for mining and production of hydroelectric power, which provided the basis for the nation's electrometallurgical (Moen, 2009) and chemical industries. Overall, smart national and international investments followed by the innovative national incentive approach have all established a high growth in productivity. In order to explain the word "smart" the citation from Fagerberg et al. (2009) is necessary:

"A national system of innovation consists of firms in many different sectors operating within a common (national) knowledge infrastructure and a common institutional and political framework. The sectoral composition of a given national economy therefore influences the operation and structure of its national innovation system, even as the national innovation system affects the performance of its constituent sectoral systems. Hence, the relationship between sectoral and national innovation systems is a co-evolutionary one, in which sectoral characteristics (and the needs of firms in these sectors) influence the development of the knowledge infrastructure, institutions and policies at the national level, while these factors influence the subsequent evolution of the national economy, including its sectoral composition".

As everywhere else, the Norwegian innovation system is a set of interrelated institutions (industrial firms, universities, or government agencies) where they produce, diffuse and adapt new technical knowledge. As Niosi (2002) have explained, the links between these institutions consists of knowledge flows, financial and human capital flows as well as set of managerial, commercial and regulatory activities. Unexplored or incomplete indicators of Norwegian system of innovation such as the innovation effectiveness of the university rated by scientific publication production, IPRs in possession, knowledge flow, technology transfers toward the national or international industry as well as the micro-macroeconomic ratios should provide the information of supply and demand of the innovational activities. Norway and Denmark are having institutions that are diffusion-oriented and quite different from other EU mission-oriented ones (Niosi, 2002). That might explain the economical progression of those two countries and in particular the KASK region. However, the improvement of university-industry interactions and enhance of their collaborations should be examined by the "root-cause" exploratory study partially presented in further text of this thesis.

Norway is one of the Nordic countries without important high-tech firms on the international scale and without the research institute or the university ranked among the

most important ones within the globe. Yet, these characteristics related to economy increase (Appendix A, figure 3) are rarely associated with strong national innovative performance (Appendix A, figure 4), especially in knowledge-intensive industries.

Norwegian R&D investments as a percentage of national GDP is among first thirteen EU economies where the government and industry financed projects are equalized (Appendix A, figure 5). The Norwegian economy was boosted with these smart R&D performances. Such policy has brought Norway at the second place among the most innovative countries for almost one decade (Appendix A, figure 4) even though the Norwegian position for R&D investments is not on the EU-top (Appendix A, figure 5) but still the significant funds are used on national level for R&D activities (Appendix A, figure 5a; tables A and B).

Norwegian regional innovative approach is known from the middle of 20th century where firms have utilized “localized search” in problem-solving, seeking technical knowledge from other firms, research institutes, public sources and academia. Only when the search for solutions from external sources was unsuccessful these firms were investing in in-house R&D (Fagerberg et al., 2009). This kind of strategy is still very important for Norwegian economy and business development and that is well documented by Fagerberg et al. (2009).

Study about the Nordic SMEs within the 13 various Nordic regions (Oslo, Stockholm, Helsinki, Gothenburg, Malmö/Lund, Aalborg, Stavanger, Linköping, Jyväskylä, Horten, Jaeren, Salling and Icelandic regions) was performed by Asheim et al. (2003) in order to explore the existence of similarities and differences between regional clusters of SMEs. In their research, in a Nordic cluster context, initiatives on social networking arrangements have proven to be especially successful for boosting and securing social capital and trust. SMEs that used the analytical knowledge support and innovate through science-driven public R&D institutions tend to collaborate more with global partners in search for new and unique knowledge while SMEs that draw on a synthetic knowledge base (innovation by application or novel combination of existing knowledge) and innovate through engineering-based user–producer learning tend to collaborate more with regional partners. What however Asheim et al. (2003) did not explain is what the advantageous system among these two was. Neither Fagerberg et al. (2009) nor Asheim et al. (2003) perform the research on interactions between previously mentioned innovation players nor were their positive or negative outputs were examined in order to provide full information about

the potential platforms or tools that will enhance the regional collaboration and hence increase the regional innovative performance.

Doloreux and Parto (2005) have proven that these innovative regional performances are improved when firms are interacting with various knowledge contribution support organizations within their region in order to plan the strategies and performance by creating important and basic stimuli for promoting innovation activities. The importance of regional innovation scale in stimulating the innovation capability and competitiveness of firms within north European regions was explained by **Asheim et al. (2003)**. **Maskell and Malmberg (year unknown)** have explained how firm-specific competencies and learning processes can lead to regional competitive advantages if they are based on localized capabilities such as specialized resources, skills, institutions and share of common social and cultural values.

In order to make regions to develop competitiveness, some localized capabilities such as institutional and governmental assistance, built-in educational and research structures as well as knowledge share should exist.

Generally speaking, any regional innovation system around the globe should be understood as a set of interacting public and private interests, where institutions and organizations function according to organizational and institutional arrangements and relationships **Doloreux (2003)**. With these arrangements, contribution to the generation, utilization and/or dissemination of knowledge on regional, national or international scale is feasible. This can produce tremendous effect that will encourage other firms and/or research institutions within the same region to develop certain forms of assets or human capital in order to develop the region or reinforce regional innovative capabilities and overall, competitiveness (**Gertler, 2003**).

By understanding all previously mentioned a regional innovation system can be easily considered as an evolutionary process with integrated social activities. From the aspect of this M.Sc. thesis a regional innovation system is characterized by set of cooperative innovation activities between firms and knowledge creating and dispersing organizations. These organizations can be defined as the universities, R&D institutes and technology transfer agencies. Within such developed frameworks all focus will be put on improving the capabilities and performances in regional knowledge based institutions (universities) and regional business environment (firms). The importance to promote interactions between public-private innovation actors (that are having a good reason to interact) and finding their optimal needs for creating certain innovative solutions should be, most of all,

turned towards universities or R&D institutes, start-ups as much as SMEs and large firms (Cooke, 2001). Stimulating the innovation and hence competitiveness of firms from particular region can have tremendous impact on global economy as well (Porter, 1998). This postulate can be explained in the simplest way by mentioning the name of Frederic Terman (Stanford's dean, 1940-1950) that has encouraged scientists and graduates to start their own businesses such as Hewlett-Packard and other high-tech firms from the "Silicon Valley" (Sharpe, 1991). Distinctive competences built and maintained by regions and certain firms within the region should be considered as a form of regional / firm's assets developed from norms, needs, values, social relationship as well as from interactions within a geographical, scientific or niche-business community. These interactions might help regional firms to overcome market failures or reduce market costs in dens business environments by supporting stable and shared idea exchange by the regional innovation actors.

Structural elements of regional innovation systems and the interactions among them are explored by Cooke et al. (1998). They have proposed that regional innovation system is embedded in an institutional structure in which firms and other organizations are systematically engaged in interactive naturally matched learning. However, they didn't explain what constitutes the innovation structure of actors' interactions and what kind of inter-relations or events bind them together in order to collaborate and as a consequence innovate. The author of this M.Sc. thesis has found only one publication related to boundaries in the regional innovation system (Belussi et al., 2010). They have explored in details how regional firms can overcome organizational boundaries, through the use of external sources of innovation (public research institutions and universities) and the regional boundaries, through long distance research collaborations.

The lack of sufficient literature related to interactions between the mentioned actors in regional innovation systems and more closely between the universities and businesses brought the idea on EU basis to look upon these issues within the universities and firms in certain European regions by initiating the Interreg IV project, where KASK:vie is only a part of it with focus on Scandinavian region (Denmark and Norway).

2.3 Global innovation systems

Cooke (2005) has suggested that the extension of the dynamic knowledge capabilities analysis into the regional sphere underlines the globalization of accomplished regional innovation systems composed of specialist firms and research institutes, as a key asset in

the formation of global knowledge networks. Global innovation systems are mostly occupied by large firms that take part of a regionally rooted system of research and production that can engage in late globalization (Cooke and Morgan, 1998; Cooke et al., 2000) after the optimal moment.

3. Links and network in the innovation policy between universities and firms

Links between the universities and companies are research and development (R&D) targeted policies designed to stimulate cooperation in R&D activities between those collaborators for the purpose of innovation. The ability to develop linkages between the university and businesses (UBL) and match the research results with present needs might be the key criterion by which to judge the success of innovation. These links can be important to foster the social and economical capital needed to facilitate company's growth and innovation network formation. Considering that a large share of scientific results takes place at universities and other research institutions, the border between them and businesses has recently come into focus of scholars. The extensive literature related to this topic was covered by some researchers in various scientific publications. Siegel et al. (2004) have produced the empirical evidence toward a model of the effective transfer of scientific knowledge from university to businesses. Etzkowitz (1998) has recognized the effect based on the "processes of thought" of the new UBL formation such as the perception, culture, language, reasoning and emotion. Siegel et al. (2003) have developed the methods for improving the effectiveness of university-industry collaboration. Goldfarb and Henrekson (2003) have reviewed the policies towards commercialization of university's intellectual property. Shane (2001) has identified dimensions of universities-businesses collaboration through industry-sponsored contract research, consultancies, technology licensing and technology development and commercialization. Arvanitis et al. (2008) have examined what university scientists think about collaboration with businesses. Debackere and Veugelers (2005) have focused more towards the role of technology transfer organizations in improving the UBLs while Giuliani and Arza (2008) have debated about the driving forces that are forming the UBLs. Campos (2010) reviewed the influence of long-term patterns on formalization of UBL and Bresci and Catalini (2010) have traced the links between science and technology. Park and Leydesdorff (2010) have examined longitudinal development in networks of university–industry–government relations. Link

and Scott (2007) have proven the theory that UBL is stronger if SMEs and start-ups are collocated at the university research parks.

All these peer-reviewed findings should be systemized and as such used as a recipe for successful innovation through collaboration between the university and businesses.

3.1 Firms motivation to interact with the universities, bottlenecks, differences between smaller and larger firms and firm characteristics leading to collaboration

3.1.1 Motivation for firm’s interaction with the university

Etzkowitz (1998) has explained the effect of the links formed between the university and businesses. Old fashioned way of seeing the links between the university and industry is as a source of human capital, generation of future employees and as a source of knowledge that might be useful to the businesses.

Now-days a motivation for collaboration is very simple. Siegel et al. (2003) have given a systemized explanation for this (table 1).

Table 1. Collaborators and collaboration activities and motives between them. Source: Siegel et al. (2003)

Actor	Actions	1st motive	2nd motive	Perspective
University scientist	Discovery of new knowledge	Recognition within the scientific community (publications and grants)	Financial gain and a desire to secure additional research funding (lab equipment and graduate students)	Scientific
Businesses	Commercialize new technology	Financial gain	Maintain control of proprietary Technologies	Organic/ Entrepreneurial

Collaboration between universities, other research institutions and firms and their collaborative performances was found to be rewarding for all the actors involved in the relationship within the regional, and consequently, national system of innovation (Carlsson, 1994). Such collaborations contribute in several ways, for example to address innovation success and failures and help the government and collaborative players grasping the social returns of the research investments (Martin and Scott, 2000; Siegel and Zervos, 2002; Golob, 2006).

3.1.2 Bottlenecks

Collaborative links between the university and businesses was justified very well by the ability to innovate (Laursen and Salter, 2006). However, these collaborative activities are not always as smooth as someone would have expected. Martin and Scott (2000) have given the rationales why firms invest less in research collaboration with universities. That's why many governmental organizations are trying to find the possibilities to encourage such collaboration by the financially supported research projects where the outputs would be related to publishing the scientific results and commercializing those results in certain industrial areas. Nevertheless, governmental bodies would benefit more if filtered information about the firms such as, the size, sector, R&D-intensity, innovation search profiles, etc, would possibly be linked to collaboration with certain university and the research group within it. Research results provided by Harrysson et al. (2007) have contributed the science by understanding better university-industry collaboration. Broström (2008) has argued that studies related to this topic have not been systematically considered. Systematization of scientific data related to full variety of UBLs in the innovation studies literature should be collected, elaborated and modeled with multifactorial data analysis approach. One of those important factors that shouldn't be overlooked is the geography and the cultural differences. In general, conditions that involve deviations from standard academic norms and / or managerial policies in the firms shouldn't be ignored neither.

Regional, national and international competitions have brought the incredibly fast technological evolution and with it the increasing need for complex and precise development of the technology within short period of product cycles. In such competitive business jungle the intensive R&D understands that it is not workable to invest in vast, expansive and extensive research solely within the company. These findings can be attributed to Gerybadze and Reger (1999). Businesses within the regions, thus the entire globe, have realized that more collaboration with external research players is the essence to reduce the research costs and minimize the risks of investments in innovation (Hagedoorn et al. 2000; Chesbrough, 2003). However, Chesbrough's (2003) arguments do not deal sufficiently with the science based innovation processes that are commonly supported through collaborative links between universities, governments and firms.

Harrysson et al. (2007) have suggested possible mechanisms and links which firms can use in order to benefit from collaboration with universities. Respectively those are: opportunities to leverage research spending, recruit young talents from the university, opportunities to collaborate around complementary knowledge bases and accessing

advanced equipment that cannot be found in-house. Those findings were complementary to findings provided by Lee (2000) such as leveraging the access to new research, development of new products and maintaining a relationship with the university. Holmén et al. (2007) have proposed the question that can be very important to realize the power of this reasons and hence link creations. The questioned theory is: “under what circumstances does collaboration enable a firm to reach a point in state identified by the firm’s need and when collaboration serves the purpose of creating new or exploring already identified innovative opportunities.” Some proposed theories suggest that the firms use the universities for leveraging the problem solve in important areas of firms core businesses and as a means to build competencies in areas different from the core competence of the firm. This is mainly the case with large firms where generation of technological opportunities through learning is leveraged (Broström, 2008).

The same author has suggested four distinct categories of rationales for collaboration with universities on R&D. These are:

1. Collaboration outcomes for product and process development,
2. Access to academic networks,
3. Human capital management, and
4. Direct business opportunities

Firms are taking care of collaborative network levels with the integration of R&D process that brings the R&D objectives based on resource complementary, risk reduction and pool of the resources. From the other side the universities and individuals within it are creating the R&D process by linking them with the businesses where the value creation and long range planning, knowledge creating, creativity expression as well as investigation are the objectives. For the universities all this might be preferably related to fundamental science.

The research results provided by the university’s scientists might not be so important for entrepreneurial companies (EC). Certainly, the universities that are localized close to the ECs are more than welcomed to ECs because of their proximity and potential collaborative activity. This strong tendency of ECs to collaborate with university scientist is based most of the time on consultancy (Shane, 2002). He has explained that ECs are less likely to engage in contract research or participate in research consortia than large companies. The author also has added that consulting agreements with ECs require more intense enrolment of the university when compared to the large firms. Scholars have explained that conflict of interest exists more within this kind of collaborative activity rather than with the large firms. Anyhow, this is not happening often because consulting agreements between the

university scientist and EC are the end result of personal ties between mentioned actors (Tornatzky et al., 1999). Here, the university scientists hope to use the collaborative activities within the personal ties in order to transfer out the technology from the university. The technology licensing-in of university's IPR by EC may depend on mechanisms that are depended on complementary financing and IPR distribution or equity. Shane (2002) has explained that these interactions are more dependent on the university technology transfer office (UTTO), while that is not the case with the large firms where the financing in the R&D and IPR licenses is annually budgeted. The university however prefers contract research with the established firms because that generates larger research and teaching benefits, but still, that might not be a case for ECs based on biotechnological sciences (Lee, 1999). Shane (2002) has concluded that a mediating body (suggested as UTTO) should be a filter that generates information about the faculty or the research group members and their research work that might fit to the needs of the ECs, SMEs and large firms and follows-up the differences across the stage of the technology development. In that way the ECs and UTTO will be surer whether the interaction of two collaborative players is productive enough to the ECs and if the UTTO should invest the resources in a relation not well designed (matched) for two-sided interests.

3.1.3 Differences between smaller and larger firms

Etzkowitz (1998) has recognized that smaller firms based on low level technologies with little or no R&D capacity will be very informal through engaging in the collaborations based on consultancy to test materials or troubleshoot a specific problem. And this type of collaborative activity can be named by an "old form of UBL", while the "new form of UBL" can be seen as the multiplication of resources through the faculty's members that actively participate in project formation of product or technology development. These links and collaborations can function very well when the university's members are inserted into both, the university goals (publishing/education) and industrial research goals (R&D and commercialization). Scientific advances related to biotechnology, nano-particles, material science, etc., can be easily developed as a source of profit. Only, these sciences are not the only ones that can be commercialized. For example the linguistic as a science was based on fundamental science solely but recently it has become important part of global sciences which are tightly connected to computer software industry (e.g. google translate or other dictionaries). Very good comparison was delivered by Etzkowitz (1998) where a scientist

was thinking 30 years ago as “I never realized I had a trade” while 10 years after this has shifted towards, “I can do good science and make money.”

3.1.4 Firm characteristics influence the collaboration with the universities

A study done by [Mohnen & Hoareau \(2002\)](#) has gathered patterns of firms, reporting which firm characteristics (size, sector, R&D-intensity, innovation search profiles) are typically associated with university cooperation. Businesses normally pursue forward to the collaboration with the university by relating the R&D process to business advancing and revenues. As recognized by many scholars, this process is found to be complex but with the great long-term economic potential for both sides. [Broström \(2008\)](#) has argued that in some companies reported results were turned towards available research as typical innovations (novel or improved products or processes). Although it can be argued that such R&D outputs require some form of simple transformation to fit to market conditions. Previously mentioned author has described that the other cooperation projects, even though illustrated as successful and important, cannot be linked to the introduction of “innovations”. They are rather tools that bring the expectations of the R&D actors on the longer-term effects of the R&D efforts and as a driving motivation for the investment in collaborative R&D engagement. [Broström \(2008\)](#) has also found that some collaboration can be motivated by a hope that such R&D process can create new innovation opportunities for the firm. Firm members that understand better the university policies shape the collaboration motivated by the “will to work on a problem or a technological opportunity” that was identified and defined by the firm. [Cohen et al. \(2002\)](#) have identified similar difference between “ideas for project” and “project completion”.

Yet, some collaborative efforts are motivated by ambitions to expand the R&D, while others are motivated by ambitions to reach an identified point in R&D action ([Loasby, 1999](#)).

3.1.5 Grounds for firm-university interaction

If there is a direct link between interaction outcomes and invented / improved products or processes and the firms seeks to develop a defined opportunity for invention the only rationale for such linking would be the problem solving. On the other side if the direct link between interaction outcomes and invented / improved product or processes does not exists and the firm does not seek to develop a defined opportunity for innovation their rationale for collaboration might be based only on orientation, learning and broadening perspectives

that might bring the idea for any future innovation. Firms also might rationale collaboration with the university by commercialization of academic research if there is a direct link with their previous collaboration and innovative outcome, even though the firm did not seek to develop a defined opportunity for innovation. Otherwise, if they seek to develop a defined opportunity for innovation and if the link between the university and businesses interactions does not exist, the firm will most probably justify collaboration with the university through the opportunity for supportive research. Now, the question is what marketing strategy the universities and UTTOs should use in order to make the companies interested in the university's research results that might be commercialized. Also, how the universities should use their networks to brief the companies on university's research so that companies will be willing to broaden the perspectives that potentially might bring some collaboration. On this subject, it was concluded by [Broström \(2008\)](#) that the firm considers in the beginning seeking only the orientation rather than innovation process. This was outlined as an important form of dynamic capabilities. Also, the problem solving was considered by this author as an important reason to engage in the collaboration with the university.

For the businesses it is very important to increase the dynamic capability ([Zaheer and Bell, 2005](#)) by accessing and maintaining the successful academic network where the access to information would be easier and potential collaboration straightforward. If network within the academic environment is maintained, potentially any problem can be solved because the colleagues at the university with special expertise might be unofficially engaged and hence problem easy solved. Usually this kind of dynamics is important during the product and / or process development. Some scholars argue that creating and maintaining university – businesses networks could lead to knowledge leaking and thus diminish the returns on R&D investment efforts. That's why some companies are avoiding creation of such networks.

Collaborations with universities can be motivated in any further ways that might not be directly related to the content of the planed collaboration. [Zaheer and Bell \(2005\)](#) have explained that some firms with constant needs for expert's skills might contact the academics outside the collaborating group with hope that this may help the firm to identify important sources of expertise within the academia network. Also, the same authors have explained that around the academic projects, the discussion with competitors (other university's collaborators) can be held on "neutral grounds" and new potential customers can be identified among the firms with similar interests participating in the consortium. It

should not be overlooked that the grip on human capital is very important also. Collaboration with the universities can be rationale by recruiting qualified personnel and to secure the availability of scientific collaborators. If the R&D actors within the firm interact with university departments, firm might also be able to increase its attractiveness as employer for skilled professionals. [Zaheer and Bell \(2005\)](#) have furthermore explained that by supporting research groups that are active in scientific areas of certain interest to the firms, firms can influence the university with promoting the activities of importance for the firm. Here the firm might be able to facilitate the recruitment of young professionals with new knowledge in vital scientific fields that are included within firm's agenda. Usually, access to academic networks is not solely considered as a key driver. Yet, some academic sources have argued that for most collaboration projects access to academic networks is an important side effect for co-motivation ([unknown reference](#)).

Findings by [Pavitt \(2001\)](#) have emphasized that the work of universities only rarely translates into new products or services, where the university research is considered "ready to use" for collaborating firms. This was confirmed by [Zaheer and Bell \(2005\)](#) where they have brought the empirical evidence that the collaboration outcomes for product and process development are majorly based on orientation and learning as well as problem solving.

Businesses that understand the importance of collaboration with the university usually supports the research groups that are active in particular scientific areas which are interesting to the firms. In such collaboration firms can directly influence the university agenda, as for example to promote activities of importance for the firm or even create the graduate programs related to their particular area of business, where the firms can increase the availability of competent graduates that can be recruited. For some businesses the researchers and universities might be an important customer groups (laboratory equipment, new drugs, new computer software or method). [Lee \(2000\)](#) has presented the reasons that firms are using in order to find partnership with universities. He has found that the most important reasons for collaboration are found to be the access to new research, development of new products and maintaining a relationship with the university. [Santoro and Chakrabarti \(2002\)](#) find that smaller firms use universities mainly to solve problems in their respective businesses. Large businesses primarily use cooperation with universities as a means to build competencies in areas different from the core competence of the firm that can generate some income in the future.

Now, after all previously mentioned scientific findings some questions might be raised. These can be addressed as: “to what extent it should be the general focus on measurement of particular collaboration links that bring significant commercial results”, and “how much to focus on evaluating the value of possibility for UBLs without considering how to overcome biases between them first, and what is the main reason for such biased collaboration”.

The “root cause” quantitative analysis should be performed on the regional and global scale within the large companies and SMEs.

3.2 University’s motivation to interact with businesses, obstacles for interaction and types of disciplines that influences this interaction

3.2.1 Motives for interaction

Links between industry and academy are important factors for the transfer of scientific and technological know-how into valuable economic activity. [Debackere and Veugelers \(2005\)](#) have explained what should be done at the universities to cultivate an effective commercialization of the academic science based results. They have considered that perspective of knowledge distribution power of an innovation system is integrated into the links between industry and science. They have also argued that use of scientific knowledge relates positively to creating and maintaining industry-science relations that can positively affect the innovation performance. Universities in general prefer to do licenses to large companies because the difficulty for commercialization is lower and because the big companies will most probably bring the product or service to society ([McCooe, 2002](#)). For such interactions the university technology transfer offices (UTTO) play the most important role. [Debackere and Veugelers \(2005\)](#) have given detailed explanation on how important the university technology transfer offices are for creating and maintaining industry-science links. The formation of such offices at the university is helpful to secure a sufficient developing relation with industry. In this sense these UTTOs can be a good buffer against possible conflicts of interest between the commercialization and the research and teaching activities. As such the formation of UTTO’s incentives to locate at the university the profitable inventions might justify the invention offering to the firms that have incomplete information on the quality of university’s inventions. The UTTOs are interacting between the IPRs regime and the market for complementary assets that are required to commercialize new technologies. The role of UTTOs can be simply explained as a “matchmaker” that evaluates the scientific knowledge supply and its transfer

capacities at the university. The UTTOs are aware that the formation of quality links with industry can be solely based on the scientific excellence in research because the attractiveness for industrial partners is based on the competence at universities both in short-term oriented R&D and in long-term oriented strategic research. Basically, the main competitive advantage of universities is based on their competence in generating new findings and / or new approaches to problem solving. The UTTO should be an initiator of the research group or the team structure builder that allows exploiting the complementary between basic and applied research and thus becomes a strong player in the market of knowledge (Debackere and Veugelers, 2005). For getting to this point the UTTOs should have a formal mission of evaluating the research group or researchers individually. The same authors have argued that these tools bring more success in the long term links and collaboration with the industry. Also, increased portfolio of financing by the government for long term fundamental research combined with industrial financing should be possible. High influence on low UBLs in EU is the small size of understaffed UTTOs that suppose to stimulate UBLs effectively (Polt, 2001). According to this author a successful UTTO should focus on:

- Combining basic and applied research within research teams,
- Regularly audit the research strategy of the group in order to cope with changes in economy and society,
- The direct transfer between researchers and industry (avoiding many intermediaries),
- Day to day proximity to the researchers,
- Reward systems for sufficiently attractive and successfully transferred activities, etc.

All this mentioned can be used as a tool that configures the values, norms and attitudes of academic researcher towards combining the curiosity driven research and active quest for market relevant opportunities originated from his / her scientific research. Such tools can bring direct incentive for the researchers to actively manage and organically grow their portfolio of explorative and exploitative research actions (Debackere and Veugelers, 2005). Faculty members might be motivated to collaborate with the industry because of financial gain or desire to secure additional funding for laboratory equipment and graduate students (Siegel, 2003). However, motivation might defer between EU and USA where in the USA they focus more on creating economic incentives for universities to commercialize their research that will allow them to experiment. In the EU countries motives are the attempts made by governments to create mechanisms that facilitate commercialization (Goldfarb and Henrekson, 2003).

The commercialization of university research results, according to [Jensen and Thursby \(2001\)](#) require the continuing enrolment of inventors from the university. According to them about 48% of the ideas are in concept stage, 29% as prototypes and only 8% is feasible to manufacture.

[Arvanitis et al. \(2008\)](#) have done an extensive research on what the university scientists think about collaboration with the businesses. The interactions between businesses and university can directly influence the applied science and thus regional and national economics. The intensity of these interactions can directly contribute to high innovation performance.

3.2.2 Obstacles for interaction

[Tijssen \(2004\)](#) has concluded in his research that companies have narrowed the focus towards strategic and applied research with shorter time perspective that positively influences on links between the university scientists and businesses. [Thursby et al. \(2007\)](#) have argued that the research for licensing is more motivated for generating the new knowledge than for financial aspects of it. They have shown that generating the knowledge through the applied research and generating the opportunity to earn license income may not change a scientific research agenda of the scientist. [Arvanitis et al. \(2008\)](#) have mentioned that [Hellman \(2005\)](#) has developed a theory of the search and matching process between scientists and firms. At the core of the model is the problem that scientists rarely know how their research results might be used for the industrial applications. On the other side, firms are often unaware what scientific discoveries might help their needs. They have suggested a solution for this problem as a “science to market gap bridging” tool. This tool might be addressed to the patents that university owns. Suggestion was based on the idea that this gap can be bridged when scientists and firms engage in a process of search and with communication which can influence their mutual bonds in future relationship. The role for designing the suggested tool was given to UTTOs because they are more efficient of using their network with industrial players that UTTO has already built-up ([Arvanitis et al., 2008](#)). The UTTO has to be a motivation builder where “push and pull” factors will be used in order to engage the university scientists in commercialization activities ([Hellman, 2005](#)).

Of course, the UTTO might need to be aware of the type of scientific fields operated at the university, the size of the research group and the profile of its members as well as the existence of a strategic orientation towards research ([Schartinger et al., 2001](#)). The UTTO

might serve as the medium where collaboration of the research groups or university's scientists with businesses can be channeled. Arvanitis et al. (2008) have reviewed the existing literature and have identified a few factors and channels that can influence engagement of university scientists towards the applied research and commercialization.

The identified factors respectively are:

- Access to industrial knowledge,
- Access to additional resources,
- Institutional or organizational motives,
- Pursuing higher research efficiency – cost and time savings, and
- Access to specialized technology.

The identified motives that positively influence the liking the UBL are:

- Type of scientific field, engineering and natural sciences showing a stronger inclination to UBL than other disciplines such as mathematics or physics,
- Existence of Technology Transfer Offices and their network, and
- Extent of external funds

As the last mentioned, authors have also identified a series of obstacles that could be grouped in six categories:

- Deficiencies of the firms,
- Different interests and attitudes to research,
- Lack of confidence to business world and risk of damaging scientific reputation,
- Endangering scientific independence and neglect of basic research,
- Lack of human resources for UBL, and
- Allocation of university funds (basic research, teaching or applied research).

One of many obstacles that the authors have discovered empirically was related to difficulties to get informed about R&D activities in industry. Scientists do not know what the research topics and necessities in industry R&D are. They have also concluded that the level of teaching obligations doesn't influence negatively on UBL formation and thereafter collaboration and thus teaching obligations should not be the barrier for good collaboration between the university and businesses. Negative effect was however connected to reduction of the fundamental research activities. Also, obstacles might be found in the institute's research focus that might not be attractive enough for industry. From the other

side industrial research questions might be insufficiently interesting for institute. A few more obstacles were identified from university's perspective as: no possibility of commercialization of research results and difficulties to find an appropriate industrial partner. Arvanitis et al. (2008) have also identified motives for expected benefits such as: instant access to business sector knowledge and access to additional resources relevant for research activities (short-term objective). Important motive for creating the UBL might be the educational activities and consulting. Long term goals are reflecting institutional policy towards the extension of university's mission based on promoting regional development, improving the image of technological creations based on science. Those motives might be the most important for UBLs. Very important empirical evidence brought by Arvanitis et al. (2008) is that the activities of UTTOs are oriented very much towards educational activities and informal contacts which are not linking the research, consulting and infrastructure-related activities enough. Their findings explain that informal contacts, educational activities and consulting are more usual in engineering than other scientific fields, while institutes of economics and management are majorly involved in consulting activities. In their research Arvanitis et al. (2008) have empirically concluded that the UBL formation related to access of industrial knowledge and practical experience and possibilities for application and commercialization are relevant only for patenting. Very important activities that might activate potential UBLs can be defined through teaching, informal informational contacts, educational activities, consulting and joint use of technical infrastructure.

Same authors also have discovered a very important barrier to be bridged in order to get involved in university – business collaborations. These are complexes of different interests and attitudes, fears to lose scientific independence or neglect basic research and scientific publication activities. These are primarily cultural differences between university and business that can be traced within different goals practiced by the university and businesses. Also, deficiency in knowledge of the problems and interests of each other was defined as the barrier also. If the last mentioned can be overcome fast, potentially the starting point for a policy involvement would be based on targeting the UBLs (bringing universities and business nearer).

In order to support these policies formed around the interactions between the university and business some reasoning can be addressed towards better understanding of the demands or needs for public co-funding. These co-funds should be based on the industrial-problem-solve research with active integration of principles based on fundamental science.

Important consideration for this subject was set by Siegel et al. (2003). They have formed the questions as: “to what extent are demands on co-funding compliant with the standard norms and quality criteria of academic research?” Considering that such policy represents the clash between industrial and academic norms, there is a great importance for such question to be answered. Siegel et al. (2003) have reported all previously mentioned as a leading barrier to interaction. Ziman (2000) has put the point that research should be judged solely by scientific criteria and no other interests than scientific should guide the research. Benner and Sandström (2000) have explained that forming a public co-funding is meant to internalize the interests of science based sectors. Lee (1998) argued that this might create the situation where academics may hesitate to enter such collaborations anyway. Sandström and Benner (2000) have explained that research funding leveraged by industry and linked to the university is very important as a prerequisite for being able to engage in research “fit-in” to previously mentioned categories. The same authors have described that problem existence related to engaging in this research in order to take the opportunities and thus produce results through collaboration with the universities is derived mostly from businesses. Most of the time the businesses fail to comply or shape their policies towards the important norms for scientists. One of the most important norms might be a freedom of research. Complaint with high demands on generalized results and novelty of research was reported by Sandström and Benner (2000). They have explained that conditions for public co-funding of scientific research and thus interaction between the university and businesses might be more efficient if businesses will influence the problem formulation less and if high demands on generalized results and novelty of research would exist. Authors have explained that decrease of such criticism might be related to university’s better understanding of direct business opportunities and problem solving. The businesses should also understand better need for supportive research.

For some businesses the interaction with universities is a way to increase firm’s ability to convert market opportunities from academically based sources into resolving technical or organizational problems. Once the collaboration is formed and the research is ongoing the most unique competence wanted from businesses and received from the academia is the commitment to problem solving (Sandström and Benner, 2000).

3.2.3 Influence of the types of disciplines on interaction dynamics

Academy researchers who are motivated to interact with industry on fundamental or applied basis do it so through different forms. These norms can be addressed to the research income increase and/or satisfaction to see the research results applied to the industrial needs. Studies done by **D'Este and Patel (2005)** have shown that there is a positive relationship between quality of university research and likelihood of interaction with industry. The same authors have concluded that the variety of interactions between the businesses and the university was based on two important factors: formal contracts between university and industry researchers and informal networks (meetings and conferences). Activities included in the formal collaboration between the university and businesses are described as industry-sponsored meetings and conferences, consultancy and contract research, training the postgraduate students in the firms or training company employees at the university. **D'Este and Patel (2005)** have explained that more than 56% of university researchers are engaged in consultancy or contract research. They have concluded that joint research and training are of moderate importance. The rest of their conclusion is presented in table 2.

In addition to presented results the authors have explained that patenting activity is not itself an interaction with industry but it can be described as “an indication of the commitment of university researchers towards commercialization”. The geographical location seems according to the authors not to influence the interactions between the university researcher and businesses and that research income at the university's department increases the collaboration activities with businesses. All these valuable information are creating a part of the puzzle that explains how the interaction between the university scientists and industry begins.

All previously mentioned tools or systems might bring knowledge dissemination on all geographical innovation levels where the initiation of collaborative activities might be identified as the “innovation system”. Within such system many actors in the geographical proximity can make a benefit out of it. These systems might be formed around the knowledge producers (universities and laboratories), knowledge users (businesses), knowledge regulators (food and drug inspection agencies or intellectual property agencies), knowledge diffusers (infrastructure of the information highways) and knowledge funders (governmental granting agencies) (**De la Mothe, 2003**).

Table 2. Enrolment of university researchers in different interaction types according to scientific discipline (% engaged in an activity at least once in 12 months)

<i>Discipline</i>	Meetings & Conferences	Consult. & Contract research	Joint Research	Training
Chemical Eng.	85.5	75.4	59	56.5
Chemistry	67.4	58.9	46.8	45.2
Civil Eng.	81.4	74.4	47.7	44.2
Computer sci.	59.9	42.0	42.6	31.5
Electrical & Electronic eng.	81.4	69.8	54.7	53.5
General eng.	79.3	71.6	55.3	52.6
Mathematics	24.1	20.4	12.0	15.3
Mechanic. Aero & Manuf. Eng.	86.0	81.0	62.9	62.0
Metallurgy & Materials	89.9	82.6	61.8	64.7
Physics	46.7	37.4	35.9	31.8

The authors have marked that significant difference (Chi-square, $p < 0.01$) exist across all the disciplines and within each interaction type

Once such system gets into the function the linkages within it and financial or human flow between governmental or private financing organization, businesses and universities can be much easier (Niosi, 2002).

3.3 Boundaries between businesses and universities and mechanisms for their reduction

Siegel et al. (2003) have presented reasons why the boundaries exist between firms and universities and they have generated methods for decreasing these boundaries.

Goldfarb (2001) has provided the empirical evidence that detection of practical and commercial goals within the academically based goals is not so likely to happen. That is why businesses have difficulties in building the relation with the academics. Coordination of academic research direction sponsored and coordinated solely by industry provides very weak incentives among the university scientists to effectively communicate research results (Monteverde and Teece, 1982). Goldfarb and Henrekson (2003) have proposed that such mechanism should be noticed beforehand and complemented for example by consultancy or as the best-case scenario some of the research associates from the university will take the active role as the company's employees. In the case that knowledge or scientific results as the expected outcome are very difficult to understand the equity compensation to the university or lead scientist might be very valuable and it can boost the academic incentives (Jensen and Thursby, 2001). Nevertheless, the UTTO might provide

few options that will decrease the boundaries between the university and business in the case that commercialization of the technology is feasible. These options might be exclusive or non-exclusive licenses, transfer agreement, royalties, equity, complementary consulting or sponsored research arrangements. The last two mentioned are never part of the licensing agreements (Goldfarb and Henrekson, 2003), because the university does not have the power to enforce such arrangements. Several scholars have emphasized that personal contacts of university scientists with the industry are very important for overcoming the boundaries. However, these contacts are mainly with the large industrial players that prefer most of the time to keep these contacts and relation informal in nature where university scientists or the research groups can successfully transfer their ideas through the consulting arrangements (Goldfarb and Henrekson, 2003). Anand and Galetovic (2000) have argued that weaknesses of the large firms are the lack of a system that will offer strong incentives to the university scientists. Anyhow, incentives that are good enough and come from both potentially-collaborating sides (industry and university) can overcome the boundaries with the multi-formed collaboration. Those can be based on short research project with M.Sc. degrees, consulting activities, doctoral studies hosted in industrial labs, salaries of scientists included into the project paid by industry or as the most advanced the research group jointly runs the project with the industry (Goldfarb and Henrekson, 2003).

4. Networked innovation

Shortage of energy supplies, quality food, health and safety and many other demands from the society are connected to rapid behavioral change of users that requests the breakthrough innovation. For meeting such rapidly changed demands some serious networking for finding the solution is required. In order to develop a product, service or technology that will satisfy the need of certain population the collaboration between many different industrial partners, research groups or the universities is an important condition for developing valuable social innovations. Sharing the knowledge with collaborating partners can integrate a new set of knowledge and rules much faster. There are several publications related to this issue where understanding of sharing, integration and creation of knowledge within multidisciplinary teams establishes a new set of rules, processes, partnerships and alliances, design of technology and monitoring systems that all creates possibility for cultural transformation (Boghani et al, year unknown; Bergema et al., 2010; Breschi and Catalini, 2010; Park and Leydesdorff, 2010). Up to now there is a lack of

knowledge about this process in networked innovation teams. Particular lack of knowledge can be addressed between the research organizations and businesses. Normally, the presence of institutional innovation networks includes the regional institutions connected to each other. Similar actors are connected beyond this, from the other regions, national systems and globally located knowledge network. This integration might create the gradual knowledge build-up and thus breakthrough innovation. Also, the formation of policy instruments might be formed in order to motorize the promotion of the innovation networks among businesses by using the scientific system approach developed by universities or other research institutions. These policy instruments might encourage the local university–industry partnerships. Tödting and Trippel (2005) have explained such innovation process as a system of interconnected institutions that are creating, storing and transferring the knowledge and skills which define new technologies. Knowledge networks are the dynamic capabilities that might transform industrial organization (Cooke, 2005) where regional innovation actors will rely on networks of project contracts. However, those contracts might have relatively short duration (Cooke et al., 2004). A typical cross border network partnership on regional level can be addressed to central EU region of France, Germany and Switzerland called the Bio-Valley. Such networked innovation can be described as promoter of collaboration between companies involved in the biotechnological and biomedical sectors and the scientific institutions (Cooke, 2005). This is good example on how the networked innovation and matchmaking process between many different innovation actors (universities and businesses) functions very well. In such environment the stimulus for new creative opportunities and establishment of new businesses in collaboration with universities is expected. Bio-Valley innovation network is based on close collaboration between companies, research institutions, economic development agencies, trade associations and financial providers that brings the economical development to entire region.

Networked innovation might be explained as the open innovation. Boghani et al. (year unknown) have mentioned that many companies are aware of innovation networking, but only about up to 30% are experimenting with it, and only 5% have mastered the practice out of it. This might be explained by lack of understanding the complex barriers within such systems. Boghani et al. (year unknown) have described those barriers as:

1. There are many different external sources that could be tied-up to a network. A process that identifies what sources can be tapped and for what technologies is necessary to engage for both, businesses as well as the universities,

2. Experts and external organizations for creating the innovation network must be identified, managed and upgraded in order to obtain a commercial value from it,

3. Process to obtain, screen, filter and absorb new ideas from the network is an important part of such innovation system, and

4. Screening and inviting the organizations which are able to take responsibility according to their competence and accountability for doing so.

Important factors in selecting sources for specific technology are defined in previously mentioned work as levels of internal capability within the company and the maturity level of the technology, businesses or the research groups. Figure 6 describes the options available for forming an external networks and hence the creation of innovation. Industry and governments are having the most important role in technological capability with low maturity level. Universities and regional innovation centers are good opportunity for firms with low level of internal technological capability. The authors have explained that a firm that already has a high level of internal technology capability and joins the some type of consortia might be a good way to expand the network. For firms with low level of internal technology capability, the options may include university connections or individual experts. In this way a global expanding of R&D activities is possible where such networking might provide, among all other things, the “eyes and ears” in places where new developments in the technology of interest have taken or might be taking place. The idea of networked innovation is having focus on identification of new technology trends that will secure development of the technology and its capabilities through collaborative R&D. Universities on regional or global level can and should participate in such networks because considerable number of ongoing projects or patented and published information might transfer the tacit knowledge to the networking partners and commercialize the research results. **Boghani et al. (year unknown)** have highlighted several important steps that need to be taken to successfully implement networked innovation. These are:

- Diagnostic to determine how networked innovation will be received and what will be the barrier for implementation,
- Management process must be established in order to handle the flow of ideas and technologies that are arriving from the network,
- Successful establishment of partnership and alliances through the important factors of strategic clarity, partnership design and complexity, culture, communication and leadership (figure 7).

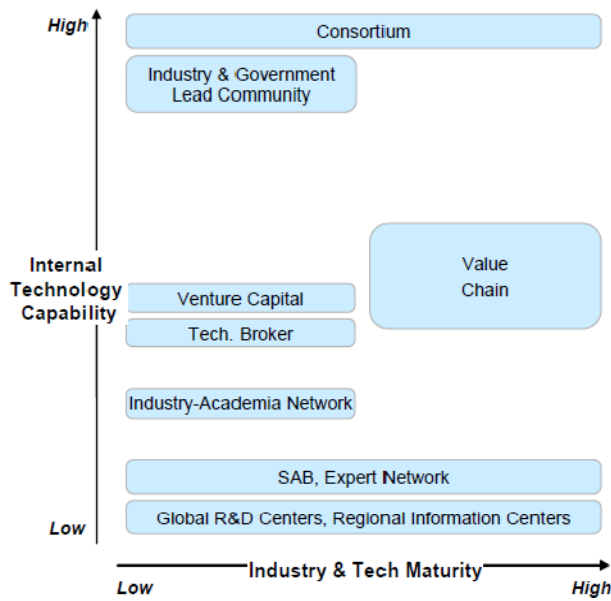


Figure 6. Options available for forming an external network (source: [Boghani et al., year unknown](#))

Strategic Clarity	<ul style="list-style-type: none"> • Establish partnership primarily to create and enhance enterprise value through innovation • Be sure about what you want to create, and the value you expect to realize from the partnership as early as possible • Ensure that there is complete alignment between the partners and senior management
Partnership Design / Complexity	<ul style="list-style-type: none"> • Choose the most appropriate and simplest model for the partnership • Weigh the respective benefits of complicated valuation of assets and negotiation of the value of services provide vs. expeditious completion of the transaction with enhanced working relationships • Ensure both senior managements have provided input and are enthusiastically behind the structure chosen • Pay attention to decision rights and partnership relations
Culture and Communication	<ul style="list-style-type: none"> • Manage effects of cultural mismatch, a key impediment to all collaborations • Manage internal tensions generated by the formation of partnership or alliance...they have the impact of slowing down the process • Weigh organizational variables in order to determine the best approach for the desired synergies
Management and leadership	<ul style="list-style-type: none"> • Have patience...experience teaches us that successful partnerships are managed through distinct stages and typically take between 3 and 18 months before "steady state" is achieved depending on complexity and maturity of topic • Focus on only a few, high leverage initiatives with the most impact on the objectives of the partnering organisations • Establish clear accountability and leadership for and within the partnership from a very early stage • Be clear on milestones and behaviours expected throughout the partnership • Assign "Change Leaders"...they are necessary to spearhead the acceleration of results

Figure 7. Factors for forming the successful partnerships in networked innovation (source: [Boghani et al., year unknown](#)).

One of the important steps for such successfully implemented networked innovation can be addressed also to establishment of technological intelligence and monitoring systems (figure 8). As the last step for implementing the networked innovation where the

universities and businesses are joined is related to managing cultural transformation between them. Building the cultural atmosphere is an important phase where researchers are allowed to confidently open up the research results without the fear of losing any benefit. [Bergema et al. \(2010\)](#) have discovered factors that might influence collaboration in networked innovation systems based on multidisciplinary approach. In this work they have described the importance of lack of experience, communication, demand for quality, availability of information, coordination of duties, novelty of the task, group climate and time pressure as factors that directly influences collaboration between the networked teams.

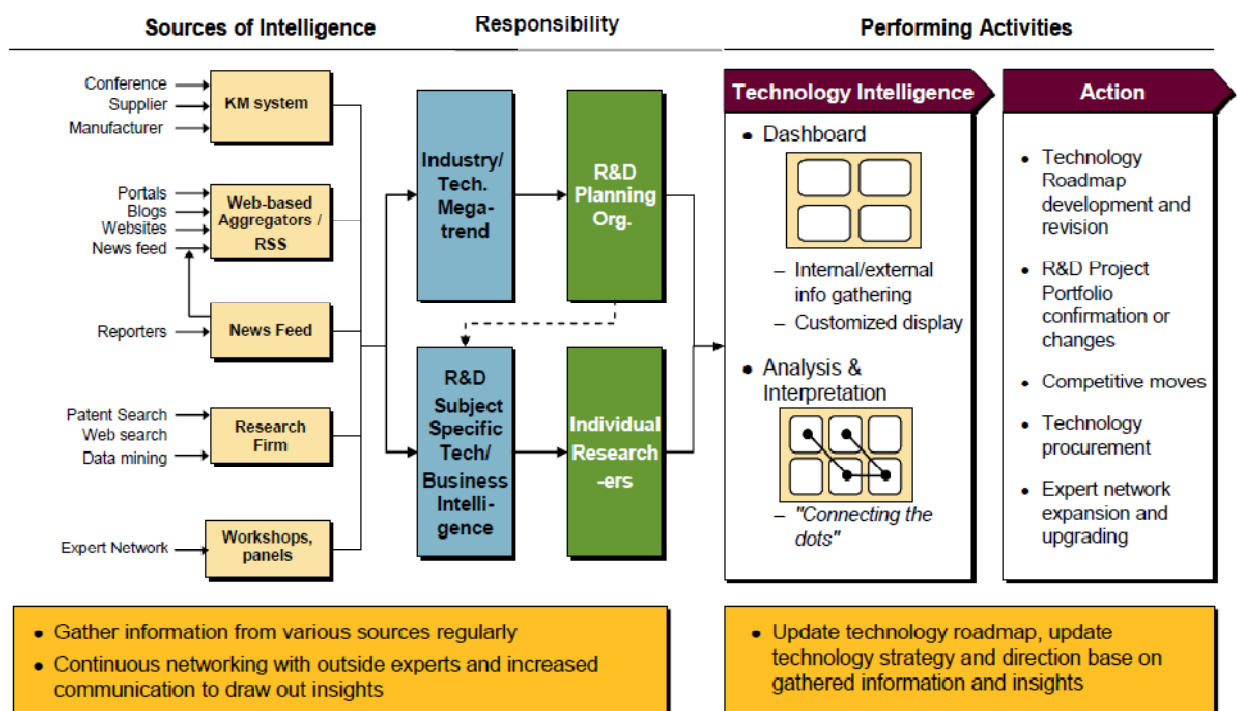


Figure 8. A system of technology intelligence and monitoring within networked innovation system (source: [Boghani et al., year unknown](#)).

Some personal characteristics as the variation in routines or styles in which people organize their thinking and action as well as the negotiation skills can all influence knowledge integration within the networked innovation ([Bergema et al., 2010](#)). The same authors have explained through the reviewed literature that the organizational aspects also have an impact on sharing and integration of knowledge. The characteristics of this subject matter are: the organizational culture, company-university hierarchies, organizational routines within the system of networked innovation, bureaucracy, the organization of

resources, allocation of tasks and responsibilities as well as the environmental circumstances. Basically, all actors enrolled in this system can be expected to have flexibility in following their own institutional logic in the case of university and to be driven by market forces in the case of businesses. **Park and Leydesdorff (2010)** have described a long-term erosion of university–industry co-authorship in Japan despite of government programs directed to stimulate their long-term collaborations. That might be explained by the lack of incentives to enter in or build the innovation network.

In their qualitative research **Bergema et al. (2010)** have found that their respondent (founder of an innovation agency) thinks that a big and a small company or three big and two small companies will not work within the networked innovation. This was explained by the fact that such relation is very different and they all need to be big or all need to be small. Otherwise the cultures are too different to match and thus the innovation process slower. Only, if the universities, research institutions or any other governmental matchmaking medium is present within the network, these cultural differences might be bridged and symbiosis network boosted. For such bridging, the social capital, described as communication, trust, and conflict, plays an important role in the health of collaborative partnerships among university research centers, businesses and other strategic institutions (**Park and Leydesdorff, 2010**). Building trust is a slow process, which happens through co-operative projects and proximity. **Narula (2001)** states that a new alliance is more likely to be successful if trust has been created in a previous alliance or collaboration.

The industrial symbiosis network is the newly formed innovation system that represents a collection of long-term, symbiotic relationships between and among regional actors and involves physical exchanges of knowledge, human or technical resources that might provide the competitive benefits (**Mirata and Emtairah, 2005**). This kind of networks can create an innovation framework as an initial step in the formation of a network of actors. Creating a social network of individuals, organizations and businesses that will focus on common problems and search together for solutions related to their respective business environment is necessary. Within such networks based on a forum for individuals, research groups or corporations all actors would be able to explore solutions in the context of mutually shared interests. In this way they would be able to overcome the barrier of access to resources required for reaching relevant information that can be beyond the reach if they would try to seek relevant information individually. A good example given by **Mirata and Emtairah (2005)** is the founding of Swedish Business Development Agency (NUTEK), which involves private companies and public organizations. The number and nature of

collaboration possibilities depend on the complementarities in regional needs, capacities and capabilities. Such complementarities can easily increase with the enlarged network and hence the diversity of organizations that will participate within the regional networked innovation system also.

In general terms, such way of working for innovation is very novel and the real empirical rounded knowledge doesn't really exist. Therefore, there is a need to search for identification and implementation of various transformations connected to requirements of a more suitable innovation through regional networks where the universities, research organizations and businesses will all head-on toward one goal, a joint development.

5. Innovation matchmaking (tools and platforms)

Innovation matchmaking can be explained according to the topic of this M.Sc. thesis-script as a system where possibility for finding the academic and industrial competences or products is likely to happen. This system should be able to provide a complete overview over the needs, research topics, publications and patents that have derived from a matchmaking network member. A matchmaking system might be a promoter of certain region and the innovation capabilities within this region where all members (companies, academic laboratories, research groups, university departments or individual scientists) would be equality represented. The matchmaking platform with all its tools can act as a networking platform. Those platforms might bring likeminded people from academic research groups, large companies, SMEs and start-ups together. While being a member of such network an opportunity for supportive services such as consultancies or venture capital might be possible to gather through governmental institutions or similar actors. In this way, the support and stimulus for the exchange of business experiences and ideas between its members can be the reality. In order to create stable incentives within such matchmaking platform necessity for targeted events, informal networking, continuously generated information and training session is vast. The time might be an important factor in growing the right culture for effective technology or knowledge transfer. This will give the sufficient freedom to academic researchers to engage and operate whenever the transfer of technology / knowledge is possible.

Matched-pairs sample related to industrial R&D was pioneered by **Westhead and Batstone (1998)** with descriptive analysis of factors that attracted firms to each other. Matchmaking in this context is an approach based on emerging information and integration of

technologies where potential providers and demanders of information send messages describing their capabilities and needs. [Feldman and Audretsch \(1999\)](#) have stated that matchmaking the innovation is stimulated by the presence of complementary industries sharing a common knowledge base. This type of innovation system can reduce the commercialization time of university's research results and patents through UTTO ([Markman et al., 2005](#)) and thus decrease the R&D funds usage in business corporations. However, an obstacle in this process might be that businesses may be unwilling to reveal their problems of the technology they are using, or for example the bottlenecks they experience. This is a barrier that will bring difficulty for matchmaking process. Two future collaborators (university scientists or UTTO and businesses) have to get to know each other through simple collaborative acts as consultation or similar. In this matchmaking process the university inventors should actively participate and take the initiative to link the UTTO with companies that would need the technology or the research results and hence more likely a serious future collaboration might take place [Markman et al. \(2005\)](#). UTTOs non-effectively played role within this system was mentioned by [Niosi \(2002\)](#) where he has stated that such innovation agents do not maximize, but only satisfy the process of innovation. Usually this performance is below any optimal level of efficiency and it brings very low commercialization outputs. In order to overcome this obstacle the emphasis should be set on analyzing the historical data of the research, publication and patenting performance at the university by specific research group or scientist and present cumulative needs of different businesses in the region or geographically proximate to the university. Otherwise, simply relying upon theoretical perspective of UTTOs may not yield outcomes that are attractive for businesses. The extraction of impulse responses corresponding to the variables of innovation interest from the side of businesses might bring the overall matchmaking strategy and positive innovation outputs for the university and businesses. [Kano \(1999\)](#) has described the UBLs and matching the scientific results with needs from businesses and its commercialization. He has also described that science-based industry is seeking for sources of innovation through research conducted by research universities and other public scientific organizations. Their wish consequently is to secure relationship with relevant academic institutions. Firms that outsource research and development, and patent to protect innovation and to signal competencies show higher levels of collaboration with the universities ([Fontana et al. 2006](#)). The same authors have stated that usually larger firms and start-ups have a higher probability of benefiting from academic research. Those are the firms whose R&D needs should be screened by UTTO

and links with such firms should be created. Kano (1999) has stated that a mismatch in such links is not rare and that matching process might be very complex. In order to overcome this complexity the understanding the management policy in the firms is vital. Some firms (monochronic) prefer to complete one matchmaking task at a time while other firms (polychronic) might be more flexible and matchmaking process can be multitasked with “no previous problem integration activities” but solely different innovation processes (Benabou, 1999). Mismatches between innovation phase and management mode occur often during the evaluation phase. Kano (1999, pg. 373) has defined the activity that can work as a medium to link the individual creation phase and the development phase (commercialization) through matchmaker. The function of this person is described as “proposal and evaluator of R&D strategy” where securing the R&D assets (money, people, material, IPR) and cultivation of these assets is the main focus. Kano (1999) has explained that the most critical period for within the matching-the-innovation process between universities and businesses is the mid-phase of innovation and therefore should be seriously considered by the matchmaker, in this case a UTTO. According to Kano (1999) the UTTOs, as the coordinators of the innovation assets, are also the mediators of few functional elements:

1. Structuring and understanding the R&D management scheme in targeted firms and establishing a mechanisms for resource innovation or research investing,
2. Planning the innovation strategy for converting the fundamental research from the university to applied research by comprehending the needs from businesses and translate it, if necessary, to firm’s representatives.
3. Networking is the essence that involves lots of channels created in the beginning of realizing the R&D needs in order to find an individual creative researcher / research group at the university that can be incorporated into the scheme of firms enhanced R&D activity and hence increase the possibility for innovation. Research network is important to be developed in the evaluation phase.
4. Securing the innovation assets (human capital, R&D, research material, research space, IPRs, etc..)
5. The content of the university’s research results should be evaluated according to the R&D strategy formed in the firm and it should be compared to the other available technological option. The entire evaluation process should be within the matchmaker

because he/she is the one that understands and links it to the research innovation process at the university and R&D strategies in the firms.

6. Following up the rights and contacts where the university's and firm's benefits will be a win-win situation.

Unfortunately there is only one governmental body in Norway that has taken seriously the benefits and opportunities formed on the matchmaking system. The organization in question is the "Innovation Norway". They have introduced their "Business Matchmaking Program" in 1997 with the overall goal to establish sustainable and profitable business ventures between Norwegian and South African companies. This is achieved through the development of business partnerships which foster transfer of technology and the exchange of business skills. The most common form of partnerships they use involves: joint ventures, outsourcing, license production, long term project co-operation and market collaboration and development. In the first year of the matchmaking program operation approximately 287 Norwegian companies have participated. Such vast initial interest has resulted in 107 matches in various business sectors that include oil and gas, information and communication technology as well as the energy and trade. However this matchmaking system didn't include the universities from both countries. According to all previous literature reviewed it can be concluded that a non-inclusion of the research institutions was the mistake that has influenced on innovative non-performance in both countries and cannot be observed or calculated at the present and neither will in the future. Basic values that participants in such system should bring have been discovered by the "Innovation Norway" and it includes the necessary resources required for international collaboration, such as: adequate technical competence and management capacity / skills, adequate financial resources to fulfill the project and establish the partnership. The participants should have a long-term objective with the intention of being active partners prepared to take the necessary risk in the project. This implies a certain size of the company in terms of turnover, adequate equity capital and long term finances. The companies that should be accepted in this project should have already been in operation for more than 3 years and that company's board of directors has approved such participation. This system can be possible to apply between the research institutions and regional (Scandinavian) businesses where regional universities and their TTOs would have a major role in managing such system. Potential expansion on other regions, continent or global level is achievable. Further text is the suggestion for the potential tools and platforms and the dynamics of such system.

5.1 The matchmaking model for firms and universities governed by UTTO

Such model that would be governed by regional UTTO should be made on the basis of several stages.

- I. In the beginning should be the *identification phase* that UTTOs should take account of. Most likely the UTTO would outsource this phase to experienced business and/or technology consultants. The experienced consultants will approach to known companies whose businesses are relevant for the sciences the university and the research groups are related to. In order to take any further step the company should be approved for participation by screening a preliminary profile that outlines what kind of innovation research partners would be ideal for their innovative advancing.
- II. Innovation *research-partner-search phase* should be performed at the university where the TTO operates in. Potential research groups, lead scientists or entire departments who are interested in the innovative research opportunity have to complete a research profile as the scientific publications within the same or similar topic required by the industry, the new research ideas and innovative approach that matches innovation needs of the screened companies. Companies that are requiring innovation will evaluate the given profile from the research group, lead scientist or university's department.
- III. In *contact phase* the UTTO consults with the companies throughout the search process and once there is the research group and / or a lead scientist that fits the innovation requirements with patent and peer reviewed publication portfolio the UTTO should start building the arrangements for companies to meet the research groups or scientists. This can be done through custom made seminars, symposiums and even innovation speed-dating.
- IV. The *collaboration phase* might include ready-to-use step system for feasibility studies in order to assess the possibility of the innovation project development and further steps up to the signing the agreement.
- V. *Finish phase* should offer few potential innovation matches and will be presented to the company.
- VI. The *IPRs phase* should include the contracting agents or patent offices.

The additional scenario for presented innovation model is presented in Appendix B, figure 9.

5.2 Online matchmaking portal

The possibility for creating the matchmaking offers within the online data-base systems with can be provided by the particular queries where the incoming offers or requirements will be matched regarding a specific innovation request. The online data-based system (Appendix B, figure 10) would define a framework in which a ranking of certain keywords can be generated in order to acquire an optimal decision for a desired innovation need. The system will connect certain UTTO, research group or scientist to company with the innovation need. This ranking procedure within the online innovation portal framework can be very complex when multidimensional or multiattribute research innovation portfolios and requests meet. This might be a challenge that can confuse users and thus the necessity for constant employment of data miners is vital.

Viet (2003) have explained the systematization of data for matchmaking electronically based negotiations that can be easily adjusted to innovation purposes (Appendix B, figure 11).

In “intention phase” the innovation offer validation is the process that will check the offer or request as well as completeness and the compliance with certain rules. The agreement phase can be more complex and it should have particular characteristics. Innovation offer and request matching should be set in order to find pairs of the ideas and requests which are set in layers and where potential innovation matching part for a research transfer exists. That is why the identification of all ideas and innovation offers which match a given request is necessary. The matching phase might include a scoring procedure in order to identify the best matching offer for certain request. In the matchmaking framework, in this phase, a ranking of all offers with respect of the current request should be computed and returned as a ranked list to the centered requesting firm. In the “agreement phase” the offer and request allocation task related to the other matching part for a possible innovation and knowledge transaction are determined using the information from the matching and scoring phase of innovation needs and offers.

In the next phase the system selects, offers and requests certain value ranges or options. The final configuration has to be determined in this phase as an option validation. Offer and request acceptance is the final task which serves the acceptance of the terms and

conditions and further contacts in innovation collaboration as well as letter of intention between those two future collaborators.

This would be an explanation of online, generic and multidimensional matchmaking mechanism which can be developed in order to cover the scoring and matching phase between the UTTO, the research group and industrial partner in innovation need and hence speed up the system of innovation and R&D in the industries.

6. Research question and the research methodology

6.1 Research question (assumptions and propositions)

According to previously reviewed literature, the pattern of assumptions can create the assumptions and propositions such as:

Assumption 1

The production of scientific papers based solely on fundamental science is not the only ground base that scientists are using for evaluating the interaction with the businesses. University scientists are willing to cultivate an effective commercialization of the academic science based results within the applied science also. So far, UMB's scientists theoretically are satisfied with the collaboration and in the last three years no difficulties have encountered within the collaboration with the industry.

They did not encounter any collaboration difficulties related to differences in management, communication, traveling, lack of complementary funding, contractual and IPR issues.

Assumption 2

University scientists do reflect that important outcome from collaborating with the industry can be addressed to the access to complementary knowledge, access to wider scientific activity, additional funding, insight information on industrial culture and mechanisms as well as the importance of establishing the new partnership for future collaboration. Also, joint publications, higher international visibility, gaining the prestige, and increasing awareness of problems that industry tries to solve. Furthermore, university scientists think that becoming a part of the professional network and getting the feedback about the technological viability for scientific research is important collaborative outcome as well.

Assumption 3

Difficulties to get informed about R&D activities in industry and lack of understanding by the industry what the universities can offer (absorptive capacity) as well as the lack of incentives for university researchers and differences in expectation from both sides on

what might come out of the collaboration are the main bottlenecks for university – business collaboration.

Assumption 4

Tools for adjusting to better collaboration and its importance among the university scientists can be observed among: shaping a fundamental scientific research according to industrial needs, forming the win-win situation with the industrial partner for future collaboration as well as high number of connected industrial and scientific partners. Tools for improved collaboration according to scientific personnel is to find the ongoing research and competences at the university that fits to industrial needs which can be done through the matchmaker. Also, the promotion of the scientific research and representation of the academic research groups, labs or companies are tools that shouldn't be overlooked.

Proposition 1

Scandinavian R&D managers think that overcoming the biases between the universities and the firms can be done with a tools and platforms for innovation matchmaking, where highly developed and overall understood matchmaking tools will encourage informal relationship as well as expand the social networks between those two players. Such platforms will increase collaboration and hence create a circle of trust and amplify innovation possibilities where designing of a flexible technology and IPRs transfers would be feasible.

Proposition 2

Usage of platform for innovation matchmaking, thus collaboration increase between the university and businesses would be justified more in large firms and start-ups than SMEs. By using such platform (possibly the online portal) an easier network creation between businesses and universities would be feasible and hence motivation for firms to interact with the universities greater.

Proposition 3

Firms might rationale collaboration with the university by commercialization of academic research if there is a direct link with innovative research groups within the university. The R&D manager in large firm, SME and start-up firm would rather communicate about the innovation and product development directly with the scientists and the UTTO would be avoided.

Proposition 4

Better contractual issues, organizing the B.Sc., M.Sc. and Ph.D. research related to applied science in favor to industrial needs, seminars together with the matchmaking tools and

platforms can all improve the collaboration activities between the university and businesses.

Proposition 5

University scientists and business R&D professionals think that the matchmaking tools through a matchmaking online portal is important to have. University scientists see any form of the “matchmaking platform” valuable for connecting the university scientists with businesses within the motivating research area. Here the interested members can contact each other or share the ideas about the problem solving and organize meetings related to technology and / or service innovation for scientists and innovation professionals.

6.2 Research methodology

6.2.1 Quantitative research

This thesis applies quantitative and qualitative research methodologies. In particular, it presents some descriptive analyses used for networking and innovation through matchmaking as well as collaborative activities with businesses.

Partially, in order to understand better some of the previously mentioned propositions and assumptions a quantitative pilot research was performed by usage of short (54 questions) survey (appendix 1) with the university scientists at the Norwegian University of Life Science (UMB). Large response rate (50%) on the pilot survey was received from 16 university scientist, 8 males, 8 females, 8 senior scientists and 8 junior scientists. All of them have given the complete answer that was used for further analysis. The number of surveyed scientists was low but relatively enough to construct more targeted questionnaire for larger scale. A pilot research was prepared by using the online tools “docs.google.com” and distributed through the UMB’s e-mailing system to targeted respondents. The main quantitative research was performed on a large scale by using more complex questionnaire prepared in “questback.com” (appendix 2). The questionnaire prepared in Qustback was constructed by Likert seven point bipolar scaling method in order to measure either positive or negative response to a statement. Also, the possibility for university scientists to answer more in detail as the “comment” or “explain in short” was left so that answers from Likert seven point scale would be easier to explain by this thin layer of qualitative approach. This large survey questionnaire was sent to 400 employees chosen according the random sampling without replacement at the UMB (PhD researchers, post doctoral researchers, the assistant and full professors as well as the senior scientist). All the respondents were chosen entirely by chance, such that each UMB’s scientific worker had

the same probability of being chosen at any stage during the sampling process. Also, each subset of certain group (department) had the same probability of being chosen for the sample as any other subset of certain group. This method is explained in detail by Yates et al. (2008). The distribution of these groups was equalized as close as possible. The percentage of males and females was set on 49.4% and 50.6%, respectively.

The selection of university researchers to be surveyed was conducted as it follows. In order to increase the likelihood of the final list being representative for the overall population of researchers, the range of scientific fields was constrained to all the departments within the UMB. The 8 scientific fields included in this large scale study were:

Management of natural resources (INA), Bioforsk (The Norwegian Centre for Bioenergy Research), Animal and Aquacultural Sciences (IHA), Centre of Integrative Genetics (CiGene), Landscape architecture (Landskap), Institute for Mathematical and Technical sciences (IMT), Institute for Chemical and Biotechnological studies (IKBM) as well as the Business school (HS).

Only two independent variables were set for this qualitative research. Those were: gender and seniority. Seniority was defined by the official academic title (PhD researcher, post doctoral researcher, assistant professor, associate professor, full professor and senior scientist). All other variables were dependent and defined as the event studied and expected to change whenever the independent variable is altered. The statistical analysis on data obtained from pilot study was done by Minitab V.15 software and basic statistics such as the Mann-Whitney U statistical test. The statistical analysis performed on data obtained from the main quantitative research was performed with the same statistical software by engaging the Mann-Whitney U test to compare the influence of responds between the independent variables and their influence on the dependent once.

6.2.2 Qualitative research

The qualitative research was done with the R&D responsible employees from the industry. They were asked to participate in semi-structured research interviews, lasting between 45 and 60 minutes. A list of the interview questions used for qualitative research for each interviewee from the industry is presented in Appendix 3. Note that each person (3 in total) from the specific group (one start-up's technical manager in charge of R&D, one SME's R&D director and one large company's senior researcher) was asked to describe company's approach to networked innovation and organisation for managing technological collaborations and innovation projects. Also, they were asked to remark the advantages and

main problems in innovation collaboration with past external collaborators as well as the possibility to participate the networked matchmaking-online-platform and hence create the informal relationship and social networks related to innovation possibilities. All comments from the interviews were categorized in few areas:

- the nature of collaboration,
- network and relationships,
- main objectives and the most relevant benefits,
- barriers and proposed improvements to UBLs and collaborations between the university and businesses.

Both, qualitative and quantitative research carried out by the questionnaire or direct interview have given the opportunity to use the primary data collected at the levels of influence on UBLs, networks and collaboration in general by the seniority, gender and length of employment. Also, the possibility for university scientists to rate some benefits on Likert scale from 1 to 7 has made an overview over the collaborative situation at UMB as well as shown how likely is that certain collaboration will be extended, expanded or reduced in size. Likert seven point bipolar scaling method was used for measuring either positive or negative response to a statement. Furthermore, survey results can always suffer from a low level of in-depth information on the context and situation which restricts the understanding of interaction rationales. Findings from survey studies are complemented by qualitative studies on university-industry cooperation from the business's point of view. Since the universities are quite different in their organization, operations and purpose from businesses, the culture and management style of businesses and universities are often of a different nature. Therefore in a section from the questionnaire: "Difficulties during collaboration with businesses / industry and what can be done to solve them" the types of and reasons for difficulties that scientists have encountered while working with companies was revealed. Also, the emphasis was put on what can be done to solve them.

The structured results from this research are presented in chapter 7.

7.0 Data collection and data analysis

7.1 Pilot study with the university scientists

Since the research sample in pilot project was very small, all the results from this research can be presented as exploratory data analysis only, rather than attempt of any rigorous confirmatory statistical analysis.

This pilot quantitative study was performed at the Norwegian University of Life Sciences (UMB) with distribution represented by 50% of senior and 50% junior scientists. Distribution related to gender was 50% female and 50% male scientist. In this study the average working experience at the university for junior scientists included into survey was 7,5 years, while working experience for senior scientists was in average 23,7 years. The average working experience for the male scientists was 15,7 years and for female scientists 15,4.

Overall, the investigation done by using the statistical tools (MiniTab, v.15) and statistical test of Mann-Whitney U analysis for examining patterns among presented variables did not yield significantly different results for all suggested assumptions. The reported results should be considered as preliminary finding only. The Mann-Whitney U test statistical analysis was used in order to observe if there are any differences between the groups represented by gender or seniority. The non-significant p values (>0.1) are giving an insight of similar opinion within the gender or seniority groups on the given question. Significantly different answers provided in appendix C, tables 2, 3 and 4 with the p values smaller than 0.1 cannot be taken as general opinion of all the surveyed groups but as uniformed judgment within the respected group.

Teaching and the research time distributed in year 2010 and the time the university scientists have spent on the projects related to collaboration with the industrial partners are presented in appendix C, table 1. From all the respondents about 25% have worked on the fundamental science basis, 68,75% applied science basis and only 6,25% on the other basis (non-defined).

Research produced with different financial resources has given different outputs (appendix C, table 1a). About 50% of surveyed scientists have worked more than 50% of their time on applied science basis. Even though the number of respondents in this pilot research was very low it was enough to see that patent application was not dependent on the financing resource (appendix C, table 1a). Yet, the number of respondents that have collaborated with the industry and being financed by it was highest. Nevertheless, the table 1a in appendix C presents that patenting is not the largest outcome from such collaboration. The pattern of a highest number of patents obtained at UMB can be assumed that comes from public financial sources.

Appendix C, table 2, explains the assumption 1 from chapter 6 and it provides general information on satisfaction within the university scientists related to their collaboration with businesses. Also, presented results in appendix C, table 2 show the percentage of the respondents who identified a particular item as an output recognized like "satisfied" with the collaboration with the industry and "no difficulties have occurred" during the collaboration with the industry. The Mann-Whitney U analysis has shown that within the group of gender (female and male scientists) and seniority (senior and junior scientists) there was no different opinion ($p>0.1$) and thus it can be assumed that surveyed scientists are satisfied with the collaboration with the industry. That can be also seen in consistent percentage (75%) of positive responses and mean-value scores from Likert seven point scale. In the same table high p values are also answering the question related to collaborative difficulties. However, it seems that the female scientists are not as satisfied as the male scientist with the collaboration with the industry. The reasoning for such different opinion might be related to the "lack of complementary funding" that comes from the industry.

In appendix C, tables 3 and 4, more logical pattern of the general opinion within the surveyed groups is presented. A major percentage of the answers provided in appendix C, table 3 are more uniformed except the opinion given by male senior scientists for insight information on industrial culture and mechanisms ($p=0.09$), where they do not see its extreme importance as the collaboration outcome. However, the male scientists do not see the importance of establishing new partnership for future collaboration as females. They think that this collaboration output is not as important as others. Also, females do not share their positive opinion with the male scientists about positive outcome from collaboration with industry through higher international visibility. Senior male scientists do not have a uniform opinion about the increase of the awareness of problems that industry tries to solve. About 75% think that it can be considered as "important" and the rest as "not that important". There is significant difference in the opinion related to importance of becoming a part of the professional network for both studied groups. Non-consistent opinion was found within the group of senior scientists where males do not believe strongly that important collaboration outcome can be the feedback about the technological viability for scientific research.

In appendix C, table 4, all scientists agree that shaping the fundamental scientific research according to industrial needs can be an important tool for adaptation to better

collaboration. The Mann-Whitney U statistical analysis have shown that there is a large difference between the seniority related to importance of number of industrial and scientific partners that are connected. Particular importance for such tool can be seen among female junior scientists. Male senior scientist are having view that the promotion of the research at the university cannot help gaining economic strength of the Scandinavian region, neither that it can be helped by the tool developed on the idea of representation of the academic research groups, labs or companies. A benefit of the innovation matchmaking platform can be seen only by junior scientists and females. Benefit from a matchmaker to connect the scientists with business needs within the particular research area was seen by junior female and male scientists as well as senior female scientist. The senior male scientist do not find very attractive to have the university as a matchmaker. For administrating such innovation matchmaking platform was suggested both, a regional university and the matchmaking company. More consistent positive answer was turned towards the matchmaking company existence. The mean values of the importance score for all the questions subjected to the respondents are presented in appendix C, tables 2, 3 and 4.

7.2 Main quantitative research with the university scientists

High non-response rate (97 %) among the university scientists at the UMB could have an influence on the estimated research stricture. Although the sample size was big enough to allow rigorous assumption analysis, all the results from the main quantitative study are presented only as tentative indications of whether the observed rationales are important drivers of interaction, or mainly irrelevant or very unusual. When the respondents have given their suggestions and explanation in the form of a “free answer”, these results were presented qualitatively. Since the structure of a respondents was without precise uniformity (50-50 %), the surveyed groups based on gender will be avoided and presented by “seniority only criterion”. Also, considering that some surveyed scientist did not answer on all the survey questions these answers will be presented as tabular values of number of respondents and the average value of their group answer. Between these two groups of scientists a Mann-Whitney U test statistics was used in order to understand whether the seniority is or is not the judgment factor related to collaborative activities with the businesses. However, the non-parametric Mann-Whitney U test statistic between the surveyed groups was performed on data where the number of responses allows it. The results obtained from this study are divided into few sections such as: the rating of

relevancy of obtained collaboration-outputs, collaborative activities from 2007 until the end of 2010 grouped by seniority, the importance of particular collaborative activities with the industry funded by different sources, the importance of particular collaborative activities with the industry funded by different sources (public, private or the mixture of these two), the difficulties encountered during the collaborative activities with the industry and overall satisfaction with collaborating with the industry. After bringing-up the gathered data the results related to the importance of using particular tools for improving the collaboration with the industry was recognized and / or evaluated by scientists.

The average working experience of senior scientists at the university that have responded on the main survey was longer than six years whereas for junior scientists that was between 2 and 4 years. Both groups of scientists (senior and junior) have evaluated the importance for collaboration-outputs that can be obtained from collaborating with the industry (table 5). Even the number of responses wasn't very high the statistical analysis based on Mann-Whitney U test analysis was performed. Representatives from both groups have seen that access to complementary knowledge and research results is an important output while collaborating with the industrial partners. However, the junior scientists cannot see this as a very important output but rather they have a neutral opinion about it. Also, the junior representatives have evaluated additional funding for the research and insight into industrial culture as an important output, while senior scientists saw this as neutral. Such results were expected because the senior scientists have had a contact with the industry, or utterly explained, some experience from before (previous collaborations) and hence the neutral opinion related to insight into industrial culture.

Collaborative activities of surveyed scientists and its dynamics with the industry are presented in table 6. Most of the working time was spent on the research activities which were financed with public funds. Most of the research projects were initiated by scientists, someone from the university department or the university in general. None of the research project was recognized as "initiated by UMB's TTO". Senior scientists have been performing teaching and the consultancies more than junior scientists, which was expected.

Table 5. The importance rating for collaborating outputs with the industry (Important 1, Not relevant 7)

	<i>number of responders</i>		<i>respond: mean value</i>		<i>*p value</i>
	Junior sci.	Senior sci.	Junior sci.	Senior sci.	
Number of surveyed scientists	N=6	N=6	N=6	N=6	
Access to complementary knowledge	4	5	4	3	0,74
Access to research results	4	5	4	3	0,86
Additional funding for research	5	5	3	3	0,74
Insight into industrial culture	5	4	3	4	0,68

Note: The number of respondents who identified a particular item as an output recognized as "important" with the collaboration with the industry and the group's mean value of the importance.

**p* values are presented as the results of a Mann-Whitney test statistics performed between the groups of junior and senior scientists. If values in last column are lower than $p < 0.1$ it is accepted as statistically significantly different for Mann-Whitney U test statistics.

Table 6. Number of collaborative activities from 2007 until 2010 grouped by seniority

<i>Number of collaboration activities (2007-2010)</i>	<i>Seniority</i>	
	Junior	Senior
Funding source:		
Public funds	4	21
Total hours spent on collaboration sponsored by public fund	8400	1512,5
Funds from collaborating company	1	5
Total hours spent on collaboration sponsored by company	120	500
Public and company's funds	1	2
Total hours spent on collaboration sponsored by public and company	-	350
Contract research funds	-	6
Total hours spent on bases of contracted research	-	600
Number of consultancies	1	3
Total hours spent on consultancies	10	300
Total hours spent on teaching engagements for companies	80	271
Project initiated by scientist	1	1
Project initiated by someone from UMB	1	3
Project initiated by someone from my department	-	1
Project initiated by UMB's TTO	-	-
Project initiated by the unit outside the university	-	1
Project initiated by industry as a continuation of previous projects	1	2
Total number of scientific publications	-	1 to 5

The importance of particular collaborative activities that scientists are performing by using the different funding sources with the industry is presented in table 7.

Table 7. The importance of particular collaborative activities with the industry funded by different sources (Important 1; Not relevant 7)

	number of the respondents		mean value		* <i>p</i> value
	Junior sci.	Senior sci.	Junior sci.	Senior sci.	
	N=6	N=6	N=6	N=6	
Number of surveyed scientists					
Collaborative research - financed with public funding	5	4	4	4	0,79
Collaborative research - financed from industry	5	4	4	4	0,44
Collaborative research - financed from both public and industrial funding	5	4	4	4	0,80
Contact research	5	5	4	4	0,87
Consultancy	5	4	4	4	0,71
Teaching engagements	4	5	5	3	0,17

Note: The number of respondents who identified a particular item as an collaborative activity with the industry recognized as "important" and the group's mean value of the importance

**p* values are presented as the results of a Mann-Whitney test statistics performed between the groups of junior and senior scientists.

If values in last column are lower than $p < 0.1$ it is accepted as statistically significantly different for Mann-Whitney U test statistics.

Considering the low response rate on the survey and the results obtained in table 7, it cannot be concluded that both groups of scientists are having a neutral opinion related to the importance of particular collaborative activities with the industry funded by different sources even though the p values are showing so. Importance related to teaching engagements as the collaborative activity with the industry was recognized by senior scientists while junior scientists didn't see it as the important activity. Nevertheless, the p value for this particular collaborative engagement didn't show to be significantly different between two surveyed groups of scientists.

Due to lack of sufficient data-set a Mann-Whitney U test was not performed on data related to difficulties encountered during the collaborative activities with the industry and overall satisfaction with such collaboration (table 8). Taking into account the data from table 8, it can be assumed that senior scientists are not satisfied with the collaborative activities performed with the industrial partners. Communication, the lack of funding, the contractual difficulties linked to confidentiality and rights of using the research results and IPRs were encountered during the period from 2007 until the end of 2010. Also, it was recognized by senior scientists that the contractual arrangements make it very difficult to patent the research results.

The usage of particular tools for improving the collaboration with the industry was identified by the author of this study. The surveyed groups (senior and junior scientists) have evaluated every tool and the differences between those two surveyed groups. The p values presented in table 9 gives an estimation that can be correlated to the pilot research where the senior scientists cannot see clear benefit of having the matchmaker that can connect the research groups or scientists with the industrial R&D needs within the particular scientific area of the research performed at the university. Junior scientists showed to be more interested in such tools.

Table 8. The difficulties encountered during the collaborative activities with the industry and overall satisfaction with collaborating with the industry

(1 Very difficult; 7 Not difficult); (1 Very satisfied, 7 Not satisfied at all)

	number of the respondents		respond: mean value	
	Junior sci.	Senior sci.	Junior sci.	Senior sci.
	N=6	N=6	N=6	N=6
Communication	1	5	3	5
Lack of funding	1	4	4	6
Contractual difficulties linked to confidentiality	1	3	4	6
Contractual difficulties linked to the rights of using the research results and IPR	1	4	4	4
Contractual arrangements make it difficult to patent the research results	2	3	2	5
Lack of willingness on the part of business to pay the real cost for the research	1	3	7	2
Industry was preoccupied with the financial reward	1	3	4	4
Time devoted to research contract negotiation	1	3	4	4
Overall satisfaction of the collaboration in the last 3 years	1	4	3	3

Note: Presented results are the total number of respondents and the mean value of the response

Due to lack of sufficient data-set a Mann-Whitney test was not performed

Table 9. The importance of using particular tools for improving the collaboration with the industry

	number of the respondents		respond: mean value		* <i>p</i> value
	Junior sci. N=6	Senior sci. N=6	Junior sci. N=6	Senior sci. N=6	
<i>Tools for improving the collaboration with the industry</i>					
<i>Respons: 1 Very important; 7 Not important</i>					
The university invites companies in order to promote Ph.D.; M.Sc. or B.Sc. students that can collaborate with firms	5	5	2	1	0,19
University invites companies to present firm's particular problem. Students that are interested in solving the problem would be invited to internship program with the firm	5	5	3	1	0,15
Seminars where businesses and academy will meet and discuss certain problems or topics related to industrial needs (speed meeting)	4	5	3	1	0,19
Would you and your research group benefit from a matchmaker that can connect you with the industrial R&D needs within your area of research?	4	6	3	4	0,28
How would you rate the importance of matchmaking tool (platform)	5	6	2	4	0,19

Note: The total number of respondents and the mean value of the response

**p* values are presented as the results of a Mann-Whitney test statistics performed between the groups of junior and senior scientists.

If values in last column are lower than $p < 0.1$ it is accepted as statistically significantly different for Mann-Whitney U test statistics.

Both of the surveyed groups have given very positive opinion for using the tools that can be formed upon certain scenarios as:

- The university invites companies in order to promote Ph.D.; M.Sc. or B.Sc. students that can collaborate with firms,
- University invites companies to present firm's particular problem. Students that are interested in solving the problem would be invited to internship program with the firm,
- Seminars where businesses and academy will meet and discuss certain problems or topics related to industrial needs (speed meeting).

The results obtained from questions where the answers couldn't be presented in the tabular arrangement are explained qualitatively in further text.

Comments related to collaboration with the industry and the difficulties encountered were seen by the few junior scientists as slow, "Too many hours used and not so many results obtained". However, the senior scientists are more concerned on shortage of funding where the uncertain future of the project can be observed by lack of the financial assets.

Lack of understanding by the industrial representatives on what universities can offer is recognized by both, junior and senior scientists. One of the surveyed junior scientists has explained that "Industry wants to have total control of the research and they cannot see that they are slowing the research down". Yet, senior scientists see that the importance for absorptive capacity is very high. Lack of the ability of firms to recognize the value of new information, assimilate it, and apply it to commercial ends is evident and hence the importance of positioned research ethics as empirical ownership, transparency and publicity is important to be maintained at the UMB, preferably UMB's TTO. As one of the senior scientists has commented, "With enough funding we could establish several clustered research groups by means of better contacts with companies where better understanding of their needs will be obvious. It should be also considered what can be used from the UMB's IPR bookshelf". The senior scientist have seen the solution in marketing of the basic research knowledge obtained by the ongoing projects or better funding and exchange of R&D representatives. The exchange can be done within the personnel from the company's R&D group or persons important for the networking evaluation in the companies. Some scientists have pointed out that companies should show some willingness to accept the 'wrong' (unexpected) research results. Also, earlier involvement of the R&D representatives with the collaborative research group would create better absorptive

capacity. Usage of the B.Sc., M.Sc. or Ph.D. students should be done in a better way in this context.

Lack of incentives for university researchers (teaching and publishing comes first) was not recognized among the surveyed scientists. The senior scientists think that teaching is undervalued. In the case that lack of incentives exists, a better overall funding should be available and thereafter a focus should be given on the teamwork research.

As suggested by one of the senior scientists, the differences in expectation from both sides on what might come out of the collaboration can be overtaken by early planning, direct and constant communication with the scientists as well as the company's R&D team. Also, as a good scenario for such matter can be taken as proposed by one of the senior scientists: "Make better plans for the cooperation, be clear about expectations and have well defined research milestones"

When the time pressure is in question, a junior scientist has explained that industry is trying to get a lot of outcome for few money and few research hours. As a suggestion from another senior scientist in order to avoid such "time pressure" problem the research funds should be secure and the time limit extended. Also, it was suggested that long term cooperation is important so that companies can see the real situation related to the R&D research.

Differences in culture between the university and the businesses can be explained as short as "making money versus making science". The university junior scientist has commented that scientists as well as the research groups or the university central administration (UTTO) should control the pattern of the collaborative research projects, not the businesses. As a suggestion that can help overcoming such problems related to mentioned cultural differences, the acceptance of each other's differences and finding a project of common interest should be focus.

Difficulties related to collaboration between the R&D groups and the university research groups and the projects defined as planning, management, reporting, follow-up are mostly coated with the thick layer of confidentiality. As one of the senior scientists has explained, "For some companies every single small detail of the research process as well as some scientifically non-important research result is so important. That only shows that some of

the R&D representatives are not really aware of its importance but they only follow the book of local rules”.

All of the scientists have agreed that collaboration with industry can be improved through better use of students. Some of the suggestions are related to better organizing of M.Sc. or B.Sc. theses where the topic will be focused on solving the problem encountered by the industry. Also, the student projects related to the industrial needs and individual custom made courses should be organized for teaching the industrial personnel.

Dealing with contractual issues should be improved or as explained by one of the senior scientists, “with the help of early involvement, long term contracts and communication between two professionals interested in the same research topics from both sides”, the university and companies.

7.3 Qualitative research with Norwegian industrial R&D representatives

The interview guidance was prepared exclusively for this research (appendix 3) where three R&D representatives were interviewed from businesses related to the life sciences and connected to similar R&D subjects performed at the UMB. One representative was from the start-up firm, one from medium size and one from the large Norwegian firm. They were all asked categorized questions in few different systemized areas. In order to access the degree of firm’s research strategies, the firm’s R&D representatives were asked to describe the company’s approach to networked innovation, company’s organization for managing technological collaborations and open innovation projects, advantages and main problems in innovation collaboration and possibility for participating the networked matchmaking-online-platform. All these questions were expanded by grouped sub-questions. The answers given during the interviews were sorted in three different categories:

- Company’s approach to networked innovation,
- Company’s organization for managing technological collaborations,
- Advantages and main problems in innovation collaboration and likelihood for participation in the networked matchmaking-online-platform.

For better explanation purposes the tabular data explanation was avoided and instead direct answers as well as the interviewee’s detailed explanations are given. In the text below the

outputs from the interviews are presented as from start-up firm, medium size company and large company, respectively.

7.3.1 Start-up firm

The R&D manager from the start-up firm “Krill Sea group AS” is tightly related to university scientists with the contracted collaboration of 5 years. The company has less than 30 employees and is oriented to discoveries of novel raw ingredients for feed used in intensive fish farming.

7.3.1.1 Company’s approach to networked innovation

The R&D manager of Krill Sea group has shown particular interest in networked innovation, particularly with the university where obtaining the patent, commercialize it and keep the dominant position on the market is the must. The company also has collaboration with some patent owners (senior scientists) in the USA. It was shown that networked innovation is the essential tool for this start-up firm through public co-funding. As the R&D representative has explained:

“We recognize clearly that opportunities to leverage R&D budgets through public co-funding of collaborative research helped us to reduce risks and cost of R&D. Therefore I can say that network innovation and such R&D approach can be considered as a rationale in itself.”

Reasons recognized for cooperation with universities on R&D projects are related solely on few simple things defined by this start-up firm as:

1. Collaboration outcomes for product and process (technology) development,
2. Access to academic networks for future collaboration,
3. Human capital management and knowledge grasp,
4. Direct business opportunities within the network that scientists can cover with their personal contacts

Contribution evaluation from different innovation partners is performed each year on the meeting with this special agenda. On such meetings they (steering comity, CEO, R&D and owners) discuss if designated targets are met and defining the progress. When needed, the extraordinary meeting is also arranged more or less every 4th-5th month.

The ongoing innovation processes are related to production technology and product development, value added product development, obtaining the IPR and process technology tuning. The main objectives and most relevant benefits obtained from the collaboration

with the UMB is genuinely designed product produced by unique technology. As the R&D representative has mentioned:

“We are using already known technology but yet, designed and combined in specific way that holds our benefit turned to market dominancy”

7.3.1.2 Company’s organization for managing technological collaborations and open innovation projects,

Since this was the first collaboration a company has ever had with the university, managing technical collaboration is done through binding contracts where the company finance the research and where the results are openly presented through scientific papers and a few PhD degrees. The R&D representative has shown that the company has benefited a lot through this collaboration:

“We were engaged into the collaboration with the UMB’s centre of excellence to find out how the nutritional properties of salmon fish feed would increase of using the krill meal (original product) and stick water (by-product). It ended up by collaborating with several researchers from different departments at the UMB that our most important product is stick water and krill oil and the by-product (still with the largest quantity) actually became the krill meal, or our original main product.”

The uniqueness of the techniques and tools used for monitoring networked collaboration process is based on simple procedure and contacting within the GMP, ISO 9001 and confirmation from the external accredited and certified labs. Also their tool is based on contracts and targeted performance results comparison.

7.3.1.3 Advantages and main problems in innovation collaboration and possibility for participation in the networked matchmaking-online-platform

So far the problems within mentioned collaboration with the university for innovation were not encountered often. Failure in the potential collaboration activities with the UMB was encountered few times because of external factors. That is solely based on the impossible application of grasped knowledge from scientific papers. Also, if Krill Sea group AS collaborates with the external partners (companies), the partners usually don’t want to share IPR with the public institutions. During the interview the R&D representative has shown interest in participation in the networked platform based on the online form:

“We might start thinking about such networked innovation approach when we establish all our products on the market and when the new product development will become must. I am saying that because we might need to expand our research to other branch of science, as for example nutraceuticals and integration of our raw material in it. So far we have all

necessary contacts at the Norwegian academia that can help us out, but new networking tools are more than welcomed.”

Yet, it appears that the formation of social networks is essential for business this start-up is dealing with.

“A social network as the Linked-in helps me a lot to gather some contacts which would be difficult to obtain if this kind of network would not have existed.”

The company’s employees are able to have a contact with the UMB’s collaborator whenever it would be necessary. In general, the communication networking and controlling the collaboration activities is smoothly done through meetings and presentations as well as using the e-mails and telephone conversations. The key individuals for the R&D representative of this start-up company networks are senior scientists from UMB, a project leader, CEO, chairman and entire steering comity. Almost 50% of total working time is spent on this networking activity.

The fastest and easiest way to get the things done while working in start-ups, explained by the R&D representative, is to get the information and thereafter contracts directly through proven experts not the university administration office. The justification for such judgment is:

“University lacks the mentality of making a deal in the fastest possible way. This is the 21st century and the things must be done fast and thus there is no space for administrative inflexibility through TTOs.”

The R&D representative can see that that a platform for innovation matchmaking between the firms, universities and other research institution should exist. Positive value of such platform would be the transparency and efficiency to find the appropriate research partner for targeted research.

The company has no problem of sharing the information publicly through scientific publications. Also they are willing to share fairly all the IPRs achieved by collaborations that will be formed and/or based on previously mentioned network:

“All this would actually help us more for marketing purposes and also as the product documentation development”.

7.3.2 Medium size company

The interviewee is the R&D responsible in a medium sized company with more than 200 employees and its main business is related to food processing and meat technology.

7.3.2.1 Company's approach to networked innovation

The representative of the R&D for medium sized company involved in meat processing has described that innovation development projects are ongoing constantly, unfortunately, not with the university. However if there would be any new strategy and opportunity to collaborate with such external actors the university would be most likely the top priority since the innovation dynamics are locally changing towards the openness. On the question to describe such decision the R&D representative has answered:

“Yes, the university would be our priority since we do not have all the required equipment and experience to run the research that will be related to new product development. Only thing is that I've heard from some other industrial collaborative partners that it might be very difficult to get the project done as planned, with all those small details the university scientists can think of. I understand that for them the perfectionism is important for publishing purposes but for our company the product should be on the market as it was planned (not before and certainly not after it was planned). We don't care that much about the complex statistics, we need only a simple proof that product is very good for consumer's health and digestion, the rest will be taken by marketing department.”

The interviewed R&D representative has explained that they have already had the collaboration with the non-university research institute but they didn't feel good about that collaboration because it ended up, according to interviewee, that *“they were too stiff and not that creative as we have expected them to be”*, since the company paid to the research institute for R&D services a significant price. This medium sized company has tried to collaborate with big companies but they never seemed interested in collaborating with a medium sized company even though they do not share the same market directly.

Also, important information related to evaluation of the contribution given by the different partners was described as *“contribution was the new product and mutual patent application”* and *“we try to gain information about the new technologies that would relate our own area of business”*.

On the question, what are the main objectives and the most relevant benefits expected from external sources of knowledge and technology, the R&D representative from the medium sized firm has answered:

“Some sort of protected rights that will help us stay without headache if someone would copy what we have invested in. What is the point of paying for the R&D which cost really a

lot and tomorrow you would need to engage lawyers and pay even more. Patents, copy rights and other similar tools are important.”

7.3.2.2 Company’s organization for managing technological collaborations and open innovation projects

R&D contracts were recognized as the most appropriate organizational form used for the collaborations with external partners. However, no especially pre defined tools for managing and monitoring collaborations and networked innovation projects are known for this company. As explained, there are a few sets of different collaborative contract scenarios produced by one of the company’s departments and everything out-of-the contract is considered as out-of collaborative settings and goals.

7.3.2.3 Advantages and main problems in innovation collaboration and possibility for participation in the networked matchmaking-online-platform

The main benefits recognized with past external collaborators was with the private company and it was related to protected the new design for their old product or as it was described: *“We have to stay new and fresh even if changing only the package!”*

The main reasons determining not collaborating with the universities was:

“We were not attracted to the university because I know from others stories that the university scientist are only ready to collaborate if they publish the results. We don’t want that, we want to have it all in our drawers for some time (3-5) years.”

It seems that participation in some sort of matchmaking platform would facilitate inter-organizational interactions for this medium sized company. That can be seen from the answer:

“I guess that if we would be able to get in touch with someone who has brilliant ideas that we are willing to pay for and have the long collaboration and mutual benefit would be only positive for our R&D process.”

This R&D representative uses about 20% of his working time on networking. Key individuals he networks with in order to start the innovation process are only the company’s director and board of directors that are also project leaders. Communication involved in such networking is based on questions, answers, suggestions and comments. During this 45-60 minutes interview the interviewee has mentioned few times the importance of potential collaboration with the regional university because:

“They know our company, they know our products and they most probably consume it. So, they can understand our R&D needs more likely before any other outsider. If we would collaborate with the university we would most likely need to allow them to publish and I don’t know how that would be accepted at the board of directors.”

In the case of collaboration with the university the medium size company that the interviewee work as the R&D responsible would prefer to communicate directly to university scientists rather than university TTO or any other office because as the interviewee has answered:

“I can go straight to the point and they can give me a feedback immediately, maybe even over the phone and hence my problem will be solved faster.”

Regarding the matchmaking the innovation by using some modern tools of present days through the online-matchmaking-platform the interviewee has explained that if such tool will match the innovation (research) activities within different companies, universities and other research institutions that could help a lot:

“If we can pin point someone (scientist) through such platform and thereafter contact, meet, agree and start the collaboration it would be great. Only thing is that I cannot believe that it would work as easy as that. I have feeling that scientists are too proud to be networked in such way where they would need to be in the same box with companies.”

The last question in this interview has concluded the positive sense regarding the R&D matchmaking in order to encourage informal relationship and social networks where the innovation possibilities, flexible technology transfer and fair IPR would be encouraged.

7.3.3 Large company

The R&D representative of this largest Norwegian producer of daily fresh products has been interviewed for about an hour. The company has around 5700 employees. Many different known projects with the UMB are formed more as the traditional collaboration with this particular university.

7.3.3.1 Company’s approach to networked innovation

The company wants to be engaged in collaboration with a broad range of partners. Presently they have projects with different business industries than their own. Also, collaboration with the universities and independent research organizations is part of strategy. The company chooses their collaborating partners from their competences, skills and fields of expertise. Examples of collaborating partners that they are collaborating with are: UMB/Matalliansen, Yara, University in Stavanger (UiS), University in Oslo (UiO),

Valio, Landteknikk, etc. The company evaluates the contribution given by the different partners in defined and structured manner where contribution and ownership to results is clearly defined in contracts prior to project start. The interviewee has explained further:

“During the project period the evaluation is performed in reports and presentation within the company and collaborating partner.”

Innovation processes in which the company have collaborated with external partners in the last three years is mostly related to new knowledge and new process (technology) lines. The new product development is normally the result of collaboration in the company. The interviewee was not able to identify collaborators in specific collaboration cases. The most relevant benefits expected from external sources of knowledge and technology defined for this large company is always a more effective production and higher economic income. The interviewee has added:

“Our research department holds a wide range of knowledge, and our collaboration is chosen to fill in the gaps between our areas of expertise.”

7.3.3.2 Company’s organization for managing technological collaborations and open innovation projects

The interviewee has encountered problems of describing the company’s organisation for managing technological collaborations and open innovation projects because there are many different models they are using and their usage is highly dependable on collaborators business nature. Techniques and tools for managing and monitoring collaborations and networked innovation projects are related directly to the department employed for that reason:

“We have lawyers in our company to read all incoming contracts and to develop contracts to company’s benefit. There is also one person in the R&D department whose only task is to guide collaboration and contracts between partners.”

7.3.3.3 Advantages and main problems in innovation collaboration and possibility for participation in the networked matchmaking-online-platform

In the experience of the interviewee the main reasons determining the failure of technological collaborations might be wide ranged but they seldom experience that delivery of technique, equipment or expertise is a source for failure.

She further adds:

“Our products need a market, and if the market fails, the project is a failure. Economy and reduced costs can also be miscalculated before the project ends, thus the project can be based on false premises, and as such a potential failure.”

Obtained answer on the question related to matchmaking-online-platform is as follows:

“It is very difficult to come out from our traditional networking methods, but certainly I would consider using it if it would become a standard for such usage.”

The key individuals that the interviewee networks with in order to start the innovation process are colleagues, boss, already established network within the area of innovation, or the team (project) leader. Most of communication performed within such networking is by direct discussion on the meetings, presentations, conferences, e-mails or telephone calls.

For such large company the communication with the university was found to be crucial for success. As explained:

“Without the university the company certainly wouldn’t be able to have so many different products and use so many different technologies.”

Also, when asked about the preference in communication with the university, the interviewee has put emphasis in direct communication with scientists, because *“the essential information and observations can be lost when communicating through an office of “non-experts”.*

The networking platform is the essence for innovation and hence benefit and the R&D department of this company is aware of it.

“I believe in a network platform – where all participates can meet (e.g. in facebook) and discuss ideas, possibilities and solutions. Such open dialogue would be a break-through! Yes, we would be happy to participate!”

Overall, findings within the scope of this thesis script indicate that R&D representatives in the firms use significant amount of time on networking. Networked innovation is important for all three of company types. The clear message that comes from all of the R&D representatives is that the regional university is or can be an important participant for company’s R&D activities. The main objectives and the most relevant benefits expected from external sources of knowledge and technology are related to collaboration activities where guaranteed and protected IPR share will allow both of collaborators to benefit from. Also, avoidance of miscalculated project-tales before the project ends where the project will not be based on false premises and condemned to failure is important to consider.

For most of the R&D representatives the key individuals that they network with in order to initiate the innovation process are colleagues, and some sort of established networks within the area of innovation through personal and direct contacts by the communication which is performed within such networks formed by direct discussion on the meetings, presentations, conferences, e-mails or telephone calls. It is clear that if the match-making-online portal would have existed, most probably it would have been used for the R&D purposes in all three company types.

7.4 Other results

In this section of chapter 7 it was meant to give any detail or additional information related to the scope of this M.Sc. script. In informal conversation with one of the university's TTO representatives at one of the Norwegian universities and the information related to licensing and preferences for licensing deals is turned rather to the large firms and start-ups that will license in the research findings. Reasoning for that was due to easier commercialization. That information is however opposite from Golob (2006) where the decision is illustrated by citation that sometimes large companies do not want to license the university's IPR but rather wait for start-ups or SMEs to prove the technology and than if it works they will buy it.

8.0 Discussion and suggestions

The first proposed assumption that production of fundamental scientific knowledge is not the only ground-base that scientists are using for evaluating the interaction with the businesses. This is justified by findings provided by the pilot study with the university scientists in this thesis. The results based on the high percentage (>50%) of surveyed scientists in this small sample that has performed the research activities on the applied science basis are not in correspondence with Tödting and Trppl (2005) findings. Also, it seems that university scientists are satisfied with the collaboration with the industrial partners even though it is not at the highest level. However difficulties encountered during the collaboration with the industry are unavoidable. Reason for that must be the lack of cultural similarities related to managerial activities and lack of financial assets as well as the lack of relations between these public and private collaboration elements. These results can correlate to findings by Tödting and Trippel (2005). The highest problem that might come out from such lack of relation can be the knowledge transfer reduction from the universities to the firms. This might create even wider bias related to culture and network characteristics. The innovation actors should collaborate very closely with each other on the basis of strong level of trust. At this juncture the national and regional governments should promote and activate the trust and interaction between innovation actors through UTTOs. These offices should enhance and activate the interaction and flow of qualitative information among major innovation actors in a region and within the research area interesting for both, businesses and scientists by the scenarios mentioned in the previous chapters.

As previously assumed, bottlenecks in information flow around the R&D activities in industry and lack of understanding by the industry what the universities can offer as well as the lack of incentives for university researchers can be accepted as proposed in chapter 6. That is why UTTO or any other matchmaker should bridge these biases by the information flow through previously suggested speed meetings, particular thematic events and frequent human capital flow. The university scientists and business R&D representatives in this M.Sc. study all agree that human capital flow should be frequent between those players. The frequency of the mentioned flow might overcome the cultural biases and hence increase the knowledge flows, financial capital flows as well as improve the managerial and regulatory activities. This general opinion is in agreement with Niosi (2002).

All these particular tools should be made and adjusted by the innovation matchmaker where the adjustments to better collaboration can be done by proposing the “shaping of a fundamental scientific research according to industrial needs”. Also, the promotion of the scientific research and representation of the academic research groups within the matchmaking platforms towards the companies shouldn't be ignored. This suggestion can be justified by the fact provided from the qualitative results from chapter 7 where the R&D representatives are using many working hours on innovation networking. With such tools and platforms the industrial R&D employees will spend less time on networking for innovation and have the same or even better effect of the R&D performances.

Usage of platform for innovation matchmaking, thus collaboration increase between the university and businesses is justified more in large firms and start-ups than SMEs. This was assumed by understanding the results presented by [Broström \(2008\)](#) where the technological opportunities through learning and bridging the knowledge biases in the large firms is greater than any other size of business. Those type of companies are the targets that UTTO shouldn't avoid. By using such platform (possibly the online portal or university spin-off firm) an easier network creation between businesses and universities would be feasible and hence motivation for firms to interact with the universities greater.

Important setting for better contractual issues and understanding each other can be provided, as suggested by one of the scientists in the main quantitative research, by organizing the B.Sc., M.Sc. and Ph.D. research related to applied science in favor to industrial needs. Successful dynamics of such mechanisms are also concluded by [Harryson et al. \(2007\)](#). Such research basis can together with the thematic seminars and the matchmaking tools and platforms improve the collaboration activities between the university and businesses. This would be the environment where the interested members can contact each other or share the ideas about the problem solving. Also, members can organize meetings related to specific R&D needs between themselves and without the mediator that might influence the failure of the information flow.

Networking tools are the essentials for the R&D process and without them the science build-up and low willpower for sponsoring university-business collaborative research might be possible. Being the part of professional network and technological viability from businesses was not seen as the direct output from the collaboration with the industry. Therefore the university should focus more on such essentials as the starting points for the initiation of R&D through creating the social network in order to find the technological research capability.

In this particular M.Sc. study the overall results brought the indication that lack of interaction of university scientists with the businesses is mostly connected to junior and female scientist. Therefore the focal point of UTTO's should be rotated around such population. This focus should be especially turned to female scientists, because they clearly see the importance of networking for establishing new partnership for future collaboration that might bring higher international visibility and create more R&D projects.

A benefit of the innovation matchmaking platform can be seen by the surveyed scientists. Benefits from a matchmaker can be seen as a mediator between the scientists and companies with particular R&D needs and within the particular research areas. This research area should be attractive to university scientists and related to their research skills. Considering that surveyed scientists see the matchmaker more likely as the matchmaking company, the existence of university's spin-off or governmental regional matchmaking office should be introduced. Start-up, SME, large companies as well as the university scientists have all found the online-matchmaking-platform as the important tool for initiating the collaboration through making a match between the industrial R&D needs and the research skills. Such platform should be also based on the various networking events such as the conferences or speed meetings where the informal relationship will be encourage and R&D social networks expanded. Such platform might increase collaboration and hence create a circle of trust and amplify innovation possibilities where designing of a flexible technology and reasonable IPRs transfers would be feasible. Justification for such conclusion can be based on the idea developed by [Asheim et al. \(2003\)](#) where the initiatives on social networking arrangements have proven to be especially successful for boosting and securing social capital and trust.

The results from qualitative research done with industrial R&D representatives from the large firm as well as the start-up firm shows that they would rather communicate about the innovation and product development directly with the scientists and hence the UTTO would be avoided. The SME has no developed cooperation with the university but the intention exists. That defers from findings explained by [Link and Scot \(2007\)](#).

The UTTO as a mediator should design the essential and central role in increasing the awareness of problems that industry tries to solve. The UTTO should be a filter that generates information about the faculty or the research group members and their research work that might fit to the needs of businesses. Also, the UTTO should follow-up the differences across the stage of the technology development within the match-made collaborations. This conclusion is based on the fact that all surveyed scientists agree that shaping the fundamental

scientific research according to industrial needs can be an important tool for adaptation and better collaboration with the industry. For successful R&D matchmaking the UTTO should be aware of the type of scientific fields operated at the university, the size of the research group and the profile of its members as well as the existence of a strategic orientation towards particular research.

The most central mediating role of the UTTO as explained by [Shane \(2002\)](#) also initiates the question on marketing strategy the universities and UTTOs should use in order to make the companies interested in the university's research results or collaborative performance. As proposed by [Broström \(2008\)](#) and in correlation to the qualitative study performed for this M.Sc. thesis, the firms considers in the beginning seeking only the orientation rather than innovation process. That is what should be offered as a starting point by the UTTO. The results obtained from the qualitative study are in agreement with [Lee \(2000\)](#) who has presented the reasons that firms are using in order to find partnership with universities as the access to new research, development of new products and maintaining a relationship with the university and university's network.

The evidence provided by this M.Sc. thesis suggests that there is considerable potential for enhancing the regional effectiveness of collaborative activities between the businesses and the universities by creating the matchmaking platform and online matchmaking portal. In such system the mutual cultural gaps between those two innovation players might be bridged, the flow of information and human capital amplified and hence collaboration frequencies increased.

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Appendix 1

Questionnaire for pilot study with scientists from the Norwegian University of
Life Sciences (UMB)

EU project KASK:vie

With this questionnaire we want to know how university scientists are satisfied with collaboration with the industry. Entire questionnaire has 54 questions and it will not take more than 15 minutes.

Thank you for your help in advance!

* Required

1. Year of birth *

2. Gender *

Female

3. What is your title *

Please choose only one title

- Ph.D. Researcher
- Postdoctoral Researcher
- Assistant Professor
- Associate Professor
- Full Professor
- Senior Scientist
- Other

4. How long you have been employed by the university? *

Please write the total number of years

5. How much working experience overall do you have (including industry and other experience) *

Choose from the list

1-3 years

6. Did you obtain a PhD? *

Choose from the list

Yes

7. If you have a PhD degree when did you obtain it?

Indicate the year

8. What is the university you currently belong to? *

Please write the univeristy's name

9. What is the department / centre you currently belong to? *

Please write the name of the department or centre

10. What is the research group you currently belong to? *

Please write the name of the research group

11. Indicate how your time was divided related to the following activities during 2010

Mark how many percent (%)

	20 %	40 %	60 %	80 %	100 %
Research	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Teaching	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Consulting the industrial partner	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (administration, etc...)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

12. What percentage of your research was dedicated to research financed by industry? *

Mark how many percent (%)

13. Have you ever been involved in any collaboration with the industry over the past 3 years? *

Example: research, consulting, administration, teaching, etc. If this question is answered with NO, please go to question 25 otherwise continue with question 14.

Yes

14. What type of collaboration did you engage in with industry? *

Example: research, consulting, administration, teaching, etc.

Collaboration for Applied Science

15. What percentage of your research was dedicated to research financed by industry?

20 % 40 % 60 % 80 % 100 %

%

16. Was this time invested in..

	20 %	40 %	60 %	80 %	100 %
Collaboration on basis of Applied Science	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Collaboration on basis of Fundamental Science	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

17. How was this collaboration financed?

Check few if needed

- Industry
- Scientific / Research partners
- Research Council
- Public sources
- Other

18. Who has initiated this collaboration?

- Industry
- University department / Your research group
- Other

19. How satisfied were you with this collaboration?

1 - Not satisfied; 7 - Very satisfied

1 2 3 4 5 6 7

Not at all Very much

20. What was the main field of collaboration?

- Biotechnology (Food, Feed, Nutrition, Health, Plants, Genetics, etc...)
- Other (Mathematics, Statistics, Engineering, Design, etc...)

21. How many scientific papers has your research group produced within this collaboration?

- 1 - 5

- 6 - 10
- I don't know

22. How many PhDs have been defended based upon this collaboration

- 1-3
- 4-6
- More than 6
- I don't know

23. Has your research group filed any patent within this collaboration?

Choose from a list

Yes

24. Please indicate what the largest outcome of the collaboration was



25. The difficulties during the collaboration - DIFFERENCES IN MANAGEMENT / CULTURE

1 2 3 4 5 6 7

Very difficult Not difficult

26. The difficulties during the collaboration - COMMUNICATION

1 2 3 4 5 6 7

Very difficult Not difficult

27. The difficulties during the collaboration - TRAVEL

1 2 3 4 5 6 7

Very difficult Not difficult

28. The difficulties during the collaboration - LACK OF COMPLEMENTARY FUNDING

1 2 3 4 5 6 7

Very difficult Not difficult

29. The difficulties during the collaboration - CONTRACTUAL ISSUES

1 2 3 4 5 6 7

Very difficult Not difficult

30. The difficulties during the collaboration - INTELLECTUAL PROPERTY RIGHTS

1 2 3 4 5 6 7

Very difficult Not difficult

31. How can you enhance the collaboration with the industry *

Choose one option

- First contact with CEO and than R&D manager – (Top-Down)
- First contact with R&D manager and than CEO – (Bottom-Up)

32. How important do you rate the following outcomes of collaboration with industry in general - ACCESS TO COMPLEMENTARY KNOWLEDGE *

1 2 3 4 5 6 7

Important Not relevant

33. How important do you rate the following outcomes of collaboration with industry in general - ACCESS TO WIDER SCIENTIFIC ACTIVITY *

1 2 3 4 5 6 7

Important Not relevant

34. How important do you rate the following outcomes of collaboration with industry in general - ADDITIONAL FUNDING *

1 2 3 4 5 6 7

Important Not relevant

35. How important do you rate the following outcomes of collaboration with industry in general - INSIGHT INFORMATION ON INDUSTRIAL CULTURE AND MECHANISM *

1 2 3 4 5 6 7

Important Not relevant

36. How important do you rate the following outcomes of collaboration with industry in general - ESTABLISHING NEW PARTNERSHIP FOR FUTURE COLLABORATIONS *

1 2 3 4 5 6 7

Important Not relevant

37. How important do you rate the following outcomes of collaboration with industry in general - JOINT PUBLICATIONS *

1 2 3 4 5 6 7

Important Not relevant

38. How important do you rate the following outcomes of collaboration with industry in general - HIGHER INTERNATIONAL VISIBILITY *

1 2 3 4 5 6 7

Important Not relevant

39. How important do you rate the following outcomes of collaboration with industry in general - GAINING A PRESTIGE *

1 2 3 4 5 6 7

Important Not relevant

40. What do you think about the importance to be engaged in collaboration with the industry in order to - INCREASE THE AWARENESS OF PROBLEMS THAT INDUSTRY TRIES TO SOLVE *

1 2 3 4 5 6 7

Very Important Not Important

41. What do you think about the importance to be engaged in collaboration with the industry in order to - BECOME A PART OF THE PROFESSIONAL NETWORK *

1 2 3 4 5 6 7

Very Important Not Important

42. What do you think about the importance to be engaged in collaboration with the industry in order to - GET FEEDBACK FROM INDUSTRY ABOUT THE TECHNOLOGICAL VIABILITY FOR SCIENTIFIC RESEARCH *

1 2 3 4 5 6 7

Very Important Not Important

43. Would you collaborate with industry on applied science basis? *

- Yes
- No
- Maybe

44. Would you shape your fundamental scientific research according to industrial needs? *

1 2 3 4 5 6 7

Very likely Not at all

45. Would you try to find any win-win situation with the industrial partner for future collaboration? *

1 2 3 4 5 6 7

Very likely Not at all

46. Would you benefit from a matchmaker to connect you or your research group with the industrial R&D needs within your area of research? *

1 2 3 4 5 6 7

Very likely Not at all

47. Are you currently using a type of matchmaking platform or tool? IF YES WHICH? *

The unique matchmaking tool can be a platform where the opportunities for research projects are presented by industrial parties, and where scientific parties poste information on their scientific expertise and interests.

48. Would you benefit from an online research Scandinavian Matchmaking Platform (SMP) for potential future collaboration? *

1 2 3 4 5 6 7

Very likely Not at all

49. How important would you rate the features of such a system - NUMBER OF INDUSTRIAL AND SCIENTIFIC PARTNERS THAT ARE CONNECTED *

1 2 3 4 5 6 7

Very important Not important

50. How important would you rate the features of such a system - FINDING OF ACADEMIC and/or INDUSTRIAL NEED and/or COMPETENCES *

1 2 3 4 5 6 7

Very important Not important

51. How important would you rate the features of such a system - PROMOTION OF THE RESEARCH and/or ECONOMIC STRENGTH OF THE SCANDINAVIAN REGION *

1 2 3 4 5 6 7

Very important Not important

52. How important would you rate the features of such a system - REPRESENTATION OF THE ACADEMIC RESEARCH GROUPS OR LABS and /or COMPANIES *

1 2 3 4 5 6 7

Very important Not important

53. Please suggest a host for the SMP? Can it be a Regional University? *

1 2 3 4 5 6 7

Very likely Not at all

54. Please suggest a host for the SMP? Can it be a Private Matchmaking Company? *

1 2 3 4 5 6 7

Very likely Not at all

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Appendix 2

Questionnaire for the main study with scientists from the Norwegian University
of Life Sciences (UMB)

Test Quest**Questionnaire Regarding Business Cooperation****Institutional background:**

The Norwegian University of Life Sciences (UMB), the University of Oslo (UiO) and the University of Aalborg (AAU) is currently involved in an EU project (Interreg VI A Kattegat-Skagerrak) with the title: **Knowledge sharing, entrepreneurship and innovation**. <http://www.kaskvie.eu/om-projektet.aspx>. The present questionnaire is part of a master degree under this project at the University of Oslo at the Centre for Entrepreneurship.

About the questionnaire:

Associate professor Mirjam Knockaert at Gent University is the main supervisor with Professor Truls Erikson at the Centre for Entrepreneurship as co-supervisor. The student is Dejan Miladinovic.

The main purpose of the master degree is to identify main barriers for collaboration between the university and companies and how collaboration can be improved. The ultimate aim is to come up with new measures, methods and tools in which the involved universities can improve its collaboration with businesses.

The findings from this questionnaire will be published as part of my master degree thesis. **If you have any question related to this questionnaire please contact the author dmilad@umb.no** If you send me a mail I will notify you when the thesis will be available.

Your identity will be hidden
Read about [hidden identity](#). (Opens in a new window)

With this set of questions we would like to know to what extent seniority, age, gender and length of employment might influence the tendency for collaboration with businesses.

Year of birth**Gender**

- Female
 Male

What title describes you?

- Phd researcher
 Post doctoral researcher
 Assistant professor
 Associate professor
 Full professor
 Senior scientist

Other title, describe

Other working experience at the university

- 1 to 3 years
- 4 to 6 years
- More than 6 years

Benefits from collaborating with businesses

The benefits from collaborating with businesses can be many sided and multifaceted. In the next set of questions we would like to know how you would rate various kinds of benefits from collaboration with companies.

How would you rate the listed benefits

Businesses might sit on complementary knowledge that might be useful to one's own research or teaching.

Access to complementary knowledge

	1	2	3	4	5	6	7
Important=1, Not relevant= 7	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Some companies engage in research. Collaboration might provide access to research results that can prove beneficial to one's own research.

Access to research results

	1	2	3	4	5	6	7
Important=1, Not relevant= 7	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Collaboration with companies might bring in additional research funding.

Additional funding for research

	1	2	3	4	5	6	7
Important=1, Not relevant= 7	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Collaboration with companies might provide insight into how businesses operate and work. This can be valuable for developing collaboration with businesses.

Insight into industrial culture

	1	2	3	4	5	6	7
Important=1, Not relevant= 7	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

What benefits: _____

What other benefits can you have and how do you rate these?

	1	2	3	4	5	6	7
Important=1, Not relevant= 7	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

What benefits: _____

What other benefits can you have and how do you rate these?

	1	2	3	4	5	6	7
Important=1, Not relevant= 7	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

What benefits: _____

What other benefits can you have and how do you rate these?

	1	2	3	4	5	6	7
Important=1, Not relevant= 7	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Collaborative projects. These questions are directed at identifying the types of projects you as a researcher engage in, the extent of involvement, who initiated the projects and specific benefits connected to the specific types of projects.

Have you been involved in any of the listed types of collaborative projects with companies in the past 3 years? If so, how many total working hours per project per year?

With public funding

Number of collaborative projects last three years?

Total working hours per project per year (approx)?

Funding from the collaborating company

Number of collaborative projects last three years?

Total working hours per project per year (approx)?

Both public and company funding

Number of collaborative projects last three years?

Total working hours per project per year (approx)?

Contract research

Number of collaborative projects last three years?

Total working hours per project per year (approx)?

Consultancies for companies

Number of consultancies in the last three years?

Total working hours per project per year?

Teaching engagements with businesses

Number of hours per year?

Other types of projects

Explain what type:

Number of projects?

Total working hours per year per project?

Please indicate who initiated the project, and specify the number of projects of each type:

Initiated by myself:

Initiated by someone else at the university

Initiated by my department

Initiated by university business liaison office

Initiated by other unit within the university

Initiated by unit outside the university

Initiated by the collaborative company

Initiated as a continuation of previous projects

How many scientific papers in total have you produced within these collaboration activities with businesses?

- 0
 - 1-5
 - 6-10
 - > 10
 - I do not know
-

Please evaluate main benefits of the collaboration:

Collaborative research - financed with public funding

1 2 3 4 5 6 7
Important=1, Not relevant=7

Possible comments:**Collaborative research - financed from industry**

1 2 3 4 5 6 7
Important=1, Not relevant=7

Possible comments:**Collaborative research - financed from both public and industrial funding**

1 2 3 4 5 6 7
Important=1, Not relevant=7

Possible comments:**Contract research**

1 2 3 4 5 6 7
Important=1, Not relevant=7

Possible comments:**Consultancies**

1 2 3 4 5 6 7
Important=1, Not relevant=7

Possible comments:

Teaching engagements

1 2 3 4 5 6 7
Important=1, Not relevant=7

Possible comments:

Other types of collaboration

1 2 3 4 5 6 7
Important=1, Not relevant=7

Possible comments:

Difficulties during collaboration with businesses / industry and what can be done to solve them

Universities are quite different in their organization, operations and purpose from businesses. The culture and management style of businesses and universities are for instance often of a different nature. In this section we would like to know the types of difficulties you have encountered while working with companies and the reason for these difficulties.

What were the main difficulties you encountered? You might answer several questions.

Lack of understanding in industry / businesses on what universities can offer?

Explain in short:

What can be done?

Lack of absorptive capacity in the company (ability of firms to recognize the value of new information, assimilate it, and apply it to commercial ends)

Explain in short:

What can be done?

Lack of incentives for university researchers (teaching and publishing comes first)

Explain in short:

What can be done?

Differences in expectation from both sides on what might come out of the collaboration

Explain in short:

What can be done?

Time pressure (other priorities first)

Explain in short:

What can be done?

Differences in culture between the university and the company (making money versus making science)

Explain in short:

What can be done?

Difficulties related to collaboration and the project (planning, management, reporting, follow-up)

Explain in short:

What can be done?

Other types of difficulties

Explain in short:

What can be done?

Communication styles and standards might differ between the university and the company with respect to response time and frequency of communication, keeping the other party informed at all times.

If you have experienced difficulties due to communication please rate how difficult this communication was

1 2 3 4 5 6 7
1 = Very difficult, 7 = Not difficult

What can be done? Explain:

If you have experienced difficulties due to lack funding what was the extent of the difficulty?

1 2 3 4 5 6 7
1 = Very difficult, 7 = Not difficult

What can be done? Explain:

Researchers and companies might disagree on various contractual issues. Please indicate the nature of these difficulties and their extent.

Did you experience difficulties due to contractual issues? Please indicate the nature of these difficulties and its range?

Contractual difficulties linked to confidentiality

1 2 3 4 5 6 7
1 = Very difficult, 7 = Not difficult

What can be done? Explain:

Contractual difficulties linked to rights to research results and intellectual property issues

1 2 3 4 5 6 7
1 = Very difficult, 7 = Not difficult

What can be done? Explain:

Contractual arrangements make it difficult to patent the research results

1 2 3 4 5 6 7

1= Very difficult, 7 = Not difficult

What can be done? Explain:

Lack of willingness on the part of business to pay the real cost for the research

1 2 3 4 5 6 7

1= Very difficult, 2 = Not difficult

What can be done? Explain:

Industry / businesses were preoccupied with the financial reward

1 2 3 4 5 6 7

1= Very difficult, 7 = Not difficult

What can be done? Explain:

Time devoted to research contract negotiation

1 2 3 4 5 6 7

1= Very difficult, 7 = Not difficult

What can be done? Explain:

Contractual arrangements make it difficult to patent the research results

1 2 3 4 5 6 7

1= Very difficult, 7 = Not difficult

What can be done? Explain:

Contractual arrangements make it difficult to patent the research results

1 2 3 4 5 6 7

1= Very difficult, 7 = Not difficult

If there were other contractual issues please describe:

Overall, how satisfied were you with the collaboration with businesses / industry within the last three years period?

1 2 3 4 5 6 7

1= Very satisfied, 7 = Not satisfied at all

How can the collaboration with industry be improved through better use of students?

- Through M.Sc. or B.Sc. thesis
- Student projects related to the industrial need (individual courses)
- Other types of involvement of students

Explain

How can dealing with contractual issues be improved?

What can be done?

Other instruments for improving collaboration with businesses and matching their research needs

Networking between employees in companies and researchers at the university is one way in which collaboration between academia and businesses can be improved and new opportunities for collaboration can be identified. In the following we want your views on how networking can be a tool in order to enhance collaboration between researchers and businesses.

1.The university invites companies in order to promote Ph.D.; M.Sc. or B.Sc. students that can collaborate with firms.

	1	2	3	4	5	6	7
1= Very important, 7 = Not important	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

1.The university invites companies in order to promote Ph.D.; M.Sc. or B.Sc. students that can collaborate with firms.

	1	2	3	4	5	6	7
1= Very important, 7 = Not important	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

The university invites companies in order to promote Ph.D.; M.Sc. or B.Sc. students that can collaborate with firms.

	1	2	3	4	5	6	7
1= Very important, 7 = Not important	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

University invites companies to present firm's particular problem. Students that are interested in solving the problem would be invited to internship program with the firm.

	1	2	3	4	5	6	7
1= Very important, 7 = Not important	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Seminars where businesses and academy will meet and discuss certain problems or topics related to industrial needs (speed meeting)

	1	2	3	4	5	6	7
1= Very important, 7 = Not important	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

4. Would you and your research group benefit from a matchmaker that can connect you with the industrial R&D needs within your area of research?

1 2 3 4 5 6 7
1 = Very important, 7 = Not at all

Matchmaking tools for scientists and innovation professionals

The unique innovation matchmaking tool might be a web-portal where interested members can contact each other or share the ideas about the problem solving and organize meetings related to technology / service innovation.

How would you rate the importance of such tool?

1 2 3 4 5 6 7
1 = Very important, 7 = Not important

This might increase the opportunity for new research projects, increase the university's scientific expertise and increase the interest from the industry for future collaboration.

100 % completed

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Appendix 3

Guide for qualitative research with the R&D representatives from start-up firm,
medium size company and large company

1. Describing your company's approach to networked innovation:

a. Does your company consider and evaluate, for any innovation/product development projects, the opportunity to collaborate with external actors?

- If answer is YES, what those actors might be (university, other research institution, company...)?

b. Does your company collaborate with a wide variety of external actors? Which ones, especially? Why?

c. How does your company evaluate the contribution given by the different partners with which you have technological collaborations?

d. What are the innovation processes in which your company have collaborated / collaborates with external partners that you know for (in the last three years)?

e. Which are the main objectives and the most relevant benefits expected from external sources of knowledge and technology?

2. Describing your company's organisation for managing technological collaborations and open innovation projects:

a. Which organizational forms does your company use for the collaborations? Equity alliances, joint venture, R&D contract, educational collaboration...?

- b. Do you have specific techniques and tools for managing and monitoring collaborations and networked innovation projects?

3. Understanding the perceived advantages and main problems in innovation collaboration:

- a. Which are the main benefits achieved with past external collaborators (please name the collaboration-university, other research institution or company)?

- b. In the experience of your company, which are the main reasons determining the failure of technological collaborations with universities?

4. Possibility for participating the networked matchmaking-online-platform

- a. According to you, would this participation facilitate inter-organizational interactions and thereby increase the chances of innovation success? Describe your answer?

- b. Who are the key individuals you network with in order to start the innovation process?

- c. What type of communication is involved in such networking?

- d. What % of your working time is spent in this networking activity?

e. How important to you is the communication with the regional university scientists?

f. How do you characterize your relationship with university scientists? Is it formed by sponsored contract research, consulting, technology licensing, technology development or commercialization?

g. What individuals do you network with at the university or any research institution? What type of communication is involved in such networking?

h. Would you prefer to communicate directly to university scientists or through the university's Technology Transfer Office? Why?

i. Do you think that a platform for innovation matchmaking between the firms, universities and other research institutes should exist? Why?

j. Do you think that technology/service matchmaking is convenient in order to encourage informal relationship and social networks related to innovation possibilities and /or designing flexible technology transfer and Intellectual Propertie Rights? Why?

Appendix A

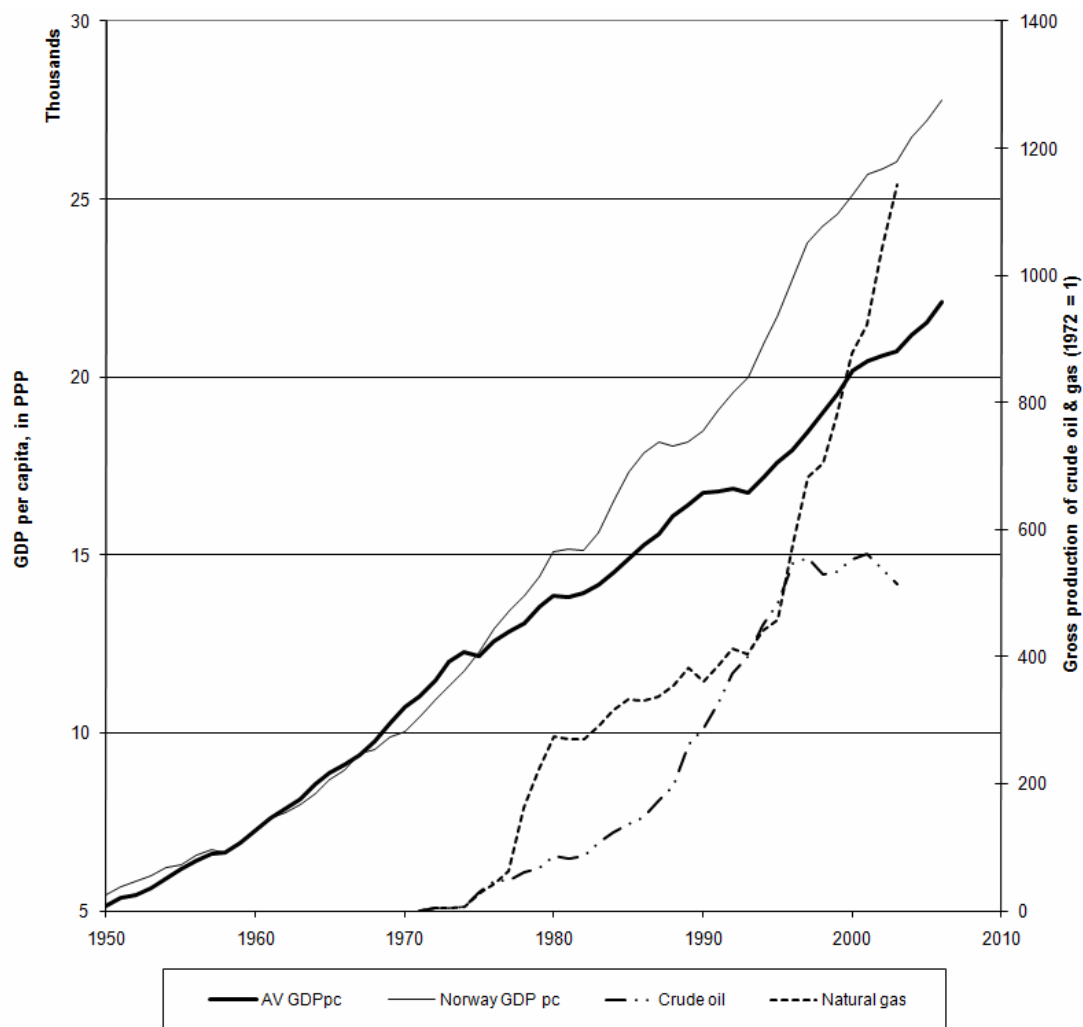


Figure 3. Norwegian economic growth and the rise of the oil and gas sector, 1950–2007.

Source: GGDC Total Economy Data Base www.ggdc.net for GDP pc data, Statistics, Norway for oil and gas data. Taken from Fagerberg et al. (2009).

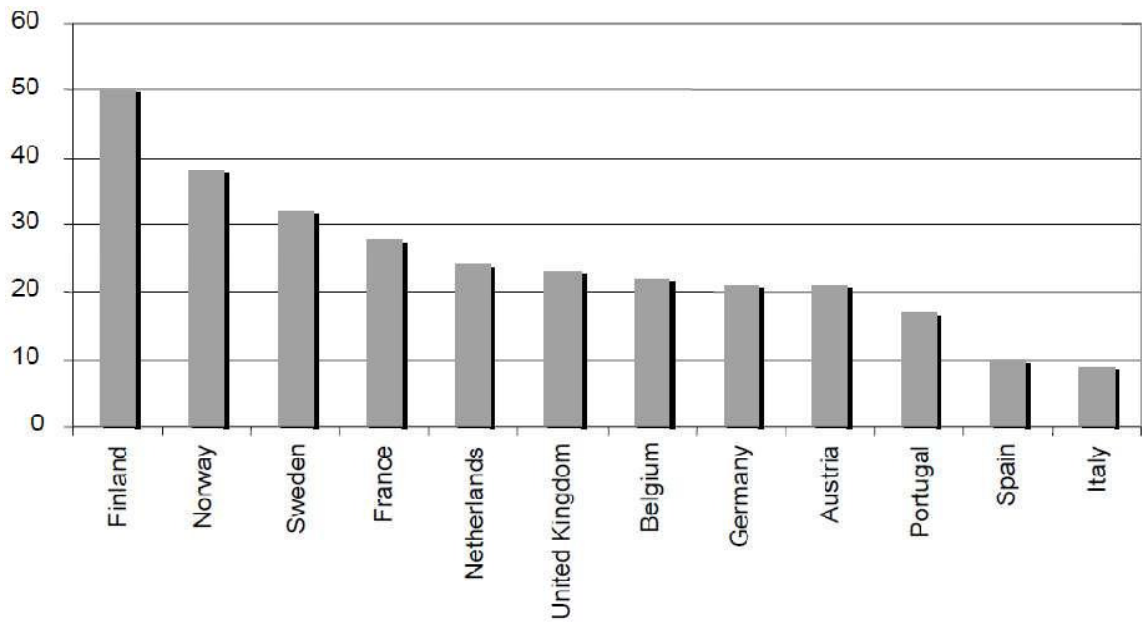


Figure 4. Share of innovative firms with cooperation arrangements on innovation activities, Norway and a reference group, 2001/2002. Taken from: Fagerberg et al. (2009).

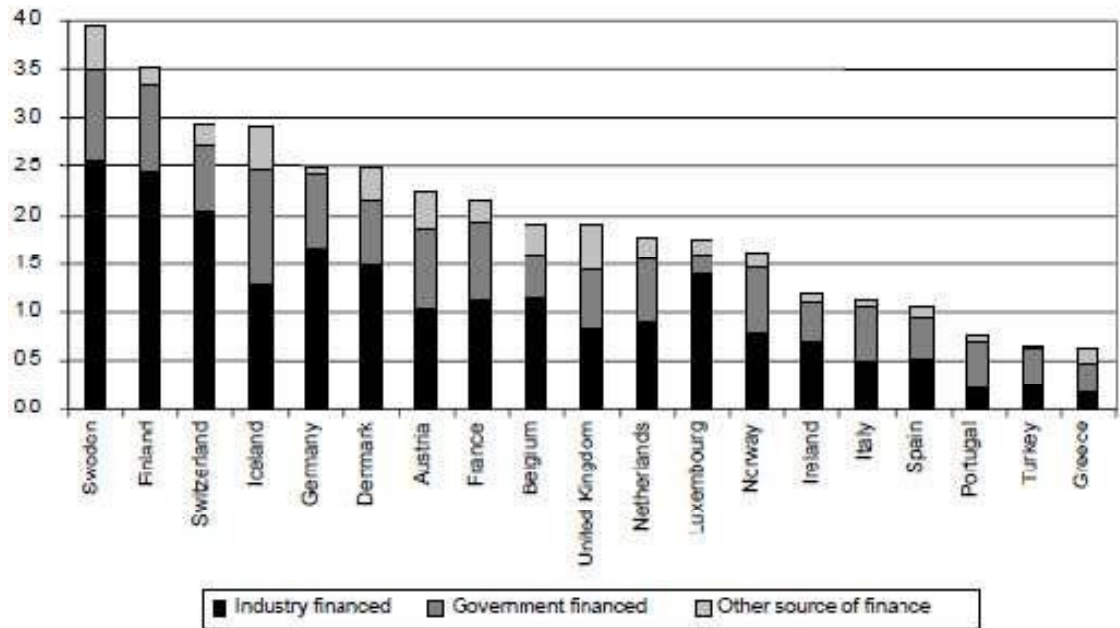


Figure 5. R&D as a percentage of GDP: Norway and a reference group of European economies, 2004. Taken from: Fagerberg et al. (2009).

Extramural R&D expenditures, by provider. 2009. NOK million

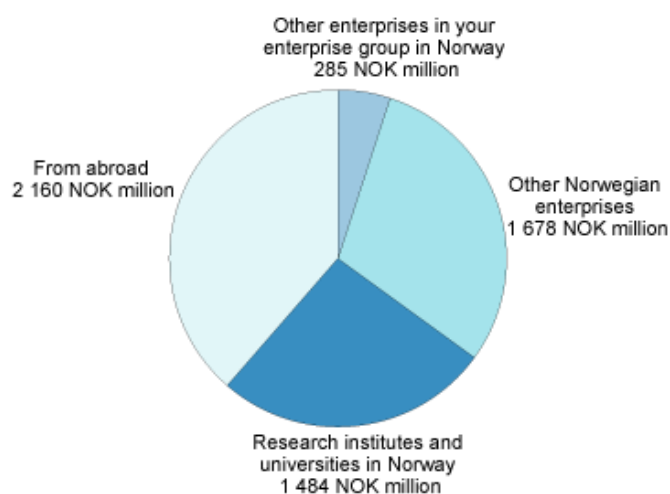


Figure 5a. Norwegian R&D expenditure in 2009. *Source: Norsk statistisk sentralbyrå, 2011*

Table A. Industrial Intra and Extramural R&D expenditure in million NOK (2008 & 2009)

Size of enterprise <i>No. of employees</i>	2008		2009	
	<i>Intramural</i>	<i>Extramural</i>	<i>Intramural</i>	<i>Extramural</i>
10 to 49	4374,00	819,70	4362,30	955,90
50 to 200	4455,50	1118,10	4498,30	1308,60
> 200	9401,70	3441,00	9341,20	3341,60
Sum	18231,20	5378,80	18201,80	5606,10
Area of business				
Fishing / Aquaculture	316,30	49,90	298,90	69,20
Food	616,80	133,80	693,80	125,10
Wood and Paper	182,70	61,00	192,80	62,10
Pharmaceuticals	496,90	250,50	456,70	325,10
Water/Sewage/Waste	32,50	3,60	25,4	41,70
Scientific R&D	365,50	106,20	328,30	126,30

Source: Norsk statistisk sentralbyrå, 2011

Table B. Total funding of R&D expenditures in the Business sector, by source, industry and size class in 2009 (NOK million)

Size of enterprise		<i>Used by research institutes and universities in Norway</i>
<i>No. of employees</i>	<i>Funding</i>	
10 to 49	4362,30	234,70
50 to 200	4498,30	437,10
> 200	9341,12	811,70
Sum		18201,72

Area of business

Fishing / Aquaculture	270,00
Food	567,40
Wood and Paper	195,00
Pharmaceuticals	428,40
Water/Sewage/Waste	24,70
Scientific R&D	317,60

Source: Norsk statistisk sentralbyrå, 2011

Appendix B

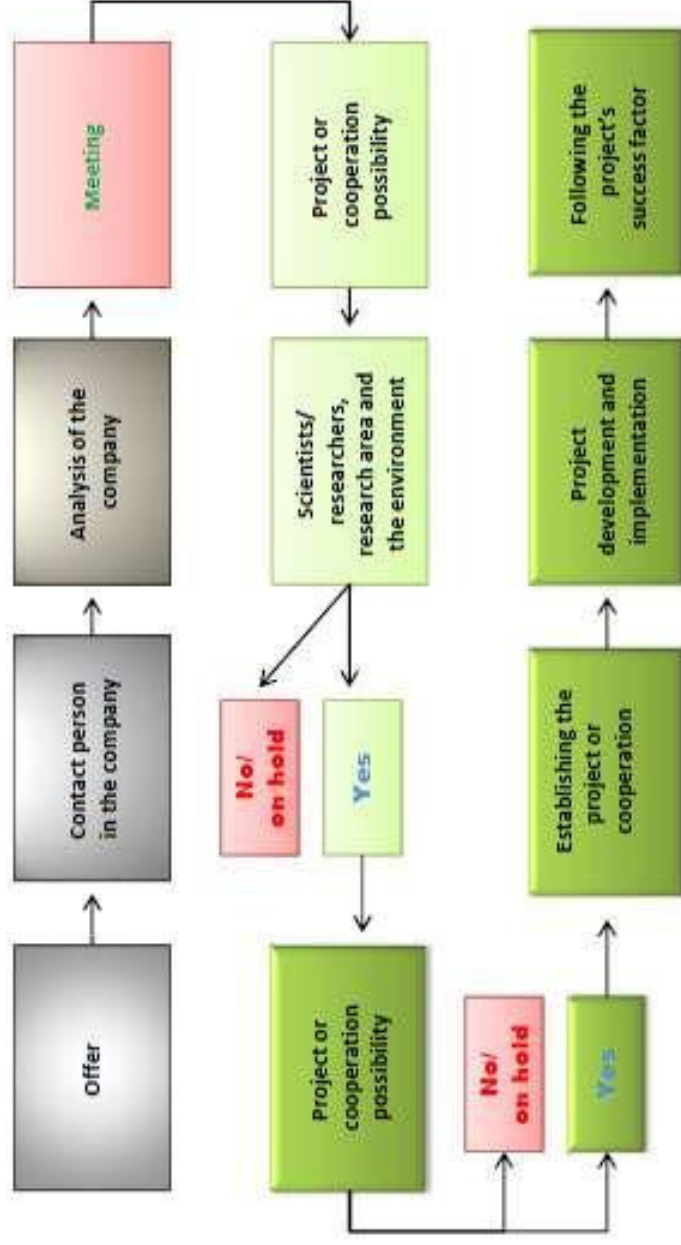


Figure 9. Matchmaking process (suggestion for other scenario)

Appendix B

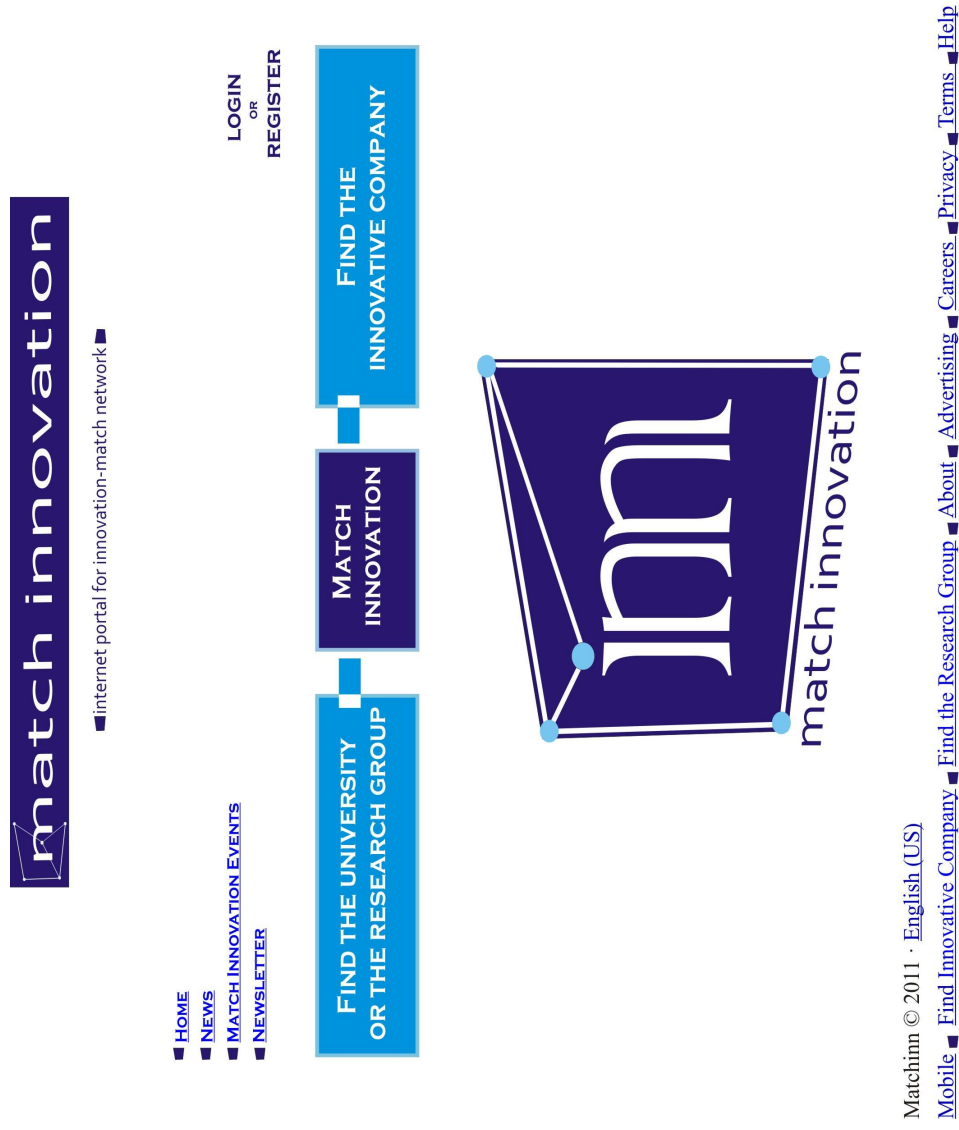


Figure 10. The online R&D matchmaking data-based system (match innovation®)

Appendix B

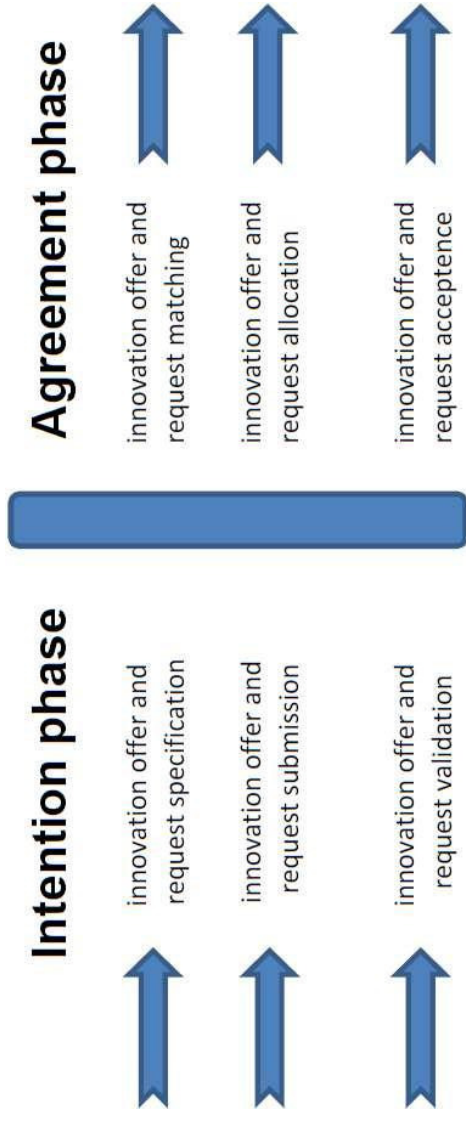


Figure 11. Innovation-intentional phase and the phase of agreements for online-based matchmaking portal

Appendix C

Table 1. Average time distribution for different seniority of scientists in year 2010

	Seniority	
Average % of the time spent on:	JUNIOR SCIENTISTS	SENIOR SCIENTISTS
RESEARCH (%)	65	42,5
TEACHING (%)	12,5	40
CONSULTING THE INDUSTRY (%)	12,5	12,5
OTHER (ADMINISTRATION, ETC.) (%)	10	5
PROJECTS FINANCED BY INDUSTRY (%)	45	42,5
RESEARCH FINANCED BY INDUSTRY (%)	22,5	29,4

Table 1a. Different financial resources* for the research collaboration, time spent on it and its overall output for the last 3 years

	Time spent on collaboration with industry in the last 3 years financed by:				
	INDUSTRY	PUBLIC SOURCE	RESEARCH COUNCIL	SCIENTIFIC PARTNER	
Number of respondents	8	1	5	2	
Collaboration based on APPLIED SCIENCE (%)	47,5	20,0	30,0	60,0	
Collaboration based on FUNDAMENTAL SCIENCE	15,0	-	45,0	-	
SCIENTIFIC PAPERS PRODUCED (range)	1 to 5	1 to 5	5 to 10	5 to 10	
NUMBER OF PHD DEGREES (average)	1 to 3	-	1 to 3	1 to 3	
FILED PATENT	1	1	2	1	

*Financial resources are defined solely by the respondents

APPENDIX C

Table 2. Satisfaction on collaboration with the businesses and collaboration difficulties perceived by university scientists at UMB & the mean values of the importance score for the questions from pilot research subjected to respondents

	Seniority (%)		Gender (%)		Mean score (Likert 1-7)				p values (M-W u test)*		
	(1) (S)	(2) (J)	(3) (M)	(4) (F)	S	J	M	F		Seniority	Gender
Satisfaction (1 - Not satisfied; 7 - Satisfied)	N=8 N=8 N=8 N=8										
SATISFIED WITH THE COLLABORATION	75	75	75	75	5	5	5	5	0,96		0,87
Collaboration difficulties (1 - Very difficult; 7 - Not difficult)											
DIFFERENCES IN MANAGEMENT / CULTURE	62,5	50	62,5	50	5	4,4	4,89	4,5	0,39		0,42
COMMUNICATION	62,5	50	62,5	50	5	4,38	4,63	4,75	0,42		0,91
TRAVEL	87,5	75	87,5	75	6	5,88	6,13	5,75	0,69		0,78
LACK OF COMPLEMENTARY FUNDING	25	62,5	62,5	25	4	4,5	4,75	3,75	0,52		0,24
CONTRACTUAL ISSUES	50	62,5	62,5	50	4,88	4,88	4,38	5,38	0,91		0,31
INTELLECTUAL PROPERTY RIGHTS	50	62,5	50	62,5	4,75	4,75	4,38	5,13	1,00		0,67

Note: The values presented in columns 1-4 (seniority and gender) are the percentage of respondents who identified a particular item recognised as *"satisfied"* with the collaboration with the industry and *"no difficulties have occurred"* during the collaboration with the industry.

S-Senior scientists; J-Junior scientists; M-Male; F-Female. N=8 is the number of respondents for certain group (S,J;M and F).

The values displayed in the columns under the "Mean score" S, J, M and F are the means for every answer respondents have given.

The values displayed in the last two columns are p values for **Mann-Whitney U test** statistics for differences in responses values between each class of a survey group.

*If values in last two columns are lower than $p < 0.1$ it is accepted as statistically significantly different for Mann-Whitney U test statistics.

APPENDIX C

Table 3. The most important outcomes produced by collaborating with businesses & the mean values of the importance score for the questions from pilot research subjected to respondents

	Seniority (%)		Gender (%)		Mean score (Likert 1-7)				p values (M-W u test)*	
	(1) (S)	(2) (J)	(3) (M)	(4) (F)	S	J	M	F	Seniority	Gender
Collaboration outcome (1-important; 7-not relevant)					N=8	N=8	N=8	N=8		
ACCESS TO COMPLEMENTARY KNOWLEDGE	87,5	100	85,5	100	2,88	2,13	3	2	0,21	0,08
ACCESS TO WIDER SCIENTIFIC ACTIVITY	87,5	100	75	100	2,75	2,25	3,13	1,88	0,25	0,23
ADDITIONAL FUNDING	87,5	87,5	75	100	2,13	2,13	2,75	1,5	0,96	0,13
INSIGHT INFORMATION ON INDUSTRIAL CULTURE AND MECHANISM	37,5	87,5	37,5	87,5	4	2,5	4	2,5	0,09	0,05
ESTABLISHING NEW PARTNERSHIP FOR FUTURE COLLABORATIONS	75	87,5	62,5	100	3	2	3,38	1,63	0,20	0,05
JOINT PUBLICATIONS	62,5	62,5	37,5	87,5	3,5	3,25	4,13	2,63	0,07	0,16
HIGHER INTERNATIONAL VISIBILITY	87,5	62,5	50	100	3,75	3	4,5	2,25	0,34	0,02
GAINING A PRESTIGE	62,5	62,5	50	75	3,63	3,5	4	3,13	0,96	0,28
INCREASE THE AWARENESS OF PROBLEMS THAT INDUSTRY TRIES TO SOLVE	75	100	75	100	2,88	1,5	2,5	1,88	0,03	0,62
BECOME A PART OF THE PROFESSIONAL NETWORK	75	100	75	100	3,38	2	3,63	1,75	0,09	0,02
GET FEEDBACK ABOUT THE TECHNOLOGICAL VIABILITY FOR SCIENTIFIC RESEARCH	75	100	75	100	3,25	1,63	3	1,88	0,03	0,27

Note: The values presented in columns 1-4 (seniority and gender) are the percentage of respondents who identified a particular item as an output of collaboration outcomes recognised as "important" while collaborating with the industry.

S-Senior scientists; J-Junior scientists; M-Male; F-Female. N=8 is the number of respondents for certain group (S; J; M and F).

The values displayed in the columns under the "Mean score" S, J, M and F are the means for every answer respondents have given.

The values displayed in the last two columns are p values for Mann-Whitney U test statistics for differences in responses values between each class of a survey group.

*If values in last two columns are lower than p<0.1 it is accepted as statistically significantly different for Mann-Whitney U test statistics.

APPENDIX C

Table 4. Tools for adaptation to better collaboration with businesses, its importance and the importance of using the matchmaking platform for increasing the collaborative possibilities. The mean values of the importance score for the questions from pilot research subjected to respondents

	Seniority (%)				Gender (%)				Mean score (Likert 1-7)				p values (M-W u test)*	
	(1) (S)	(2) (J)	(3) (M)	(4) (F)	(1) (S)	(2) (J)	(3) (M)	(4) (F)	S	J	M	F	Seniority	Gender
	N=8				N=8				N=8				N=8	
(1-Very important; 7-Not important)														
Tools for adaptation to better collaboration and its importance														
SHAPING FUNDAMENTAL SCIENTIFIC RESEARCH ACCORDING TO INDUSTRIAL NEEDS	75	87,5	75	87,5	75	87,5	75	87,5	3,5	2,38	3,13	2,75	0,17	0,70
FORM THE WIN-WIN SITUATION WITH THE INDUSTRIAL PARTNER FOR FUTURE COLLABORATION	100	100	100	100	100	100	100	100	2,25	1,13	1,38	2	0,01	0,18
NUMBER OF INDUSTRIAL AND SCIENTIFIC PARTNERS THAT ARE CONNECTED	75	87,5	62,5	100	75	87,5	62,5	100	3,75	2,25	3,63	2,38	0,08	0,36
FINDING OF ACADEMIC and/or INDUSTRIAL NEED and/or COMPETENCES	62,5	87,5	62,5	87,5	62,5	87,5	62,5	87,5	3,63	2,38	3,63	2,38	0,09	0,45
PROMOTION OF THE RESEARCH and/or ECONOMIC STRENGTH OF THE SCANDINAVIAN REGION	75	75	50	100	75	75	50	100	3,63	2,25	3,75	2,13	0,08	0,16
REPRESENTATION OF THE ACADEMIC RESEARCH GROUPS OR LABS and /or COMPANIES	75	75	50	100	75	75	50	100	3,63	2,38	3,63	2,38	0,09	0,42
Matchmaking platform usage benefit and administrators														
BENEFIT FROM A MATCHMAKER TO CONNECT SCIENTIST WITH BUSINESS NEEDS WITHIN -	37,5	87,5	37,5	87,5	37,5	87,5	37,5	87,5	4,88	2,38	4,75	2,5	0,03	0,05
-THE RESEARCH AREA	62,5	75	37,5	100	62,5	75	37,5	100	4,38	2,88	5	2,25	0,14	0,01
BENEFIT FROM AN ONLINE RESEARCH MATCHMAKING PLATFORM	87,5	100	87,5	100	87,5	100	87,5	100	3,63	2,13	3	2,75	0,03	0,87
SCIENTIST SUGGEST MATCHMAKER - REGIONAL UNIVERSITY	75	87,5	75	87,5	75	87,5	75	87,5	3,88	3,13	3,88	3,13	0,33	0,55
SCIENTIST SUGGEST MATCHMAKER - MATCHMAKING COMPANY														

Note: The values presented in columns 1-4 (seniority and gender) are the percentage of respondents who identified a particular item as possible tool for adaptation for better collaboration recognised as "important" for future collaboration with the industry.

S-Senior scientists; J-Junior scientists; M-Male; F-Female. N=8 is the number of respondents for certain group (S,J,M and F)

The values displayed in the columns under the "Mean score" S, J, M and F are the means for every answer respondents have given

The values displayed in the last two columns are p values for Mann-Whitney U test statistics for differences in response values between each class of a survey group.

*If values in last two columns are lower than p<0.1 it is accepted as statistically significantly different for Mann-Whitney U test statistics.