University-Industry Collaborations and Open Innovation: Methodology for Creating Profitable Relationships

Mémoire

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Résumé

Le contexte économique actuel force les compagnies à fabriquer des produits plus novateurs, à satisfaire entièrement les besoins des clients et à répondre rapidement à la demande du marché. Néanmoins, les organisations n’ont pas nécessairement tout le savoir-faire nécessaire à l’interne pour mener à bien toutes leurs activités. Les collaborations avec d’autres organisations peuvent donc permettre de répondre à certains besoins que seule, une compagnie ne serait en mesure de satisfaire. De ce point de vue, les universités peuvent s’avérer des partenaires clés pour favoriser l’innovation et faciliter son transfert vers les compagnies. Pour mieux exploiter l’apport de telles ressources externes et l’innovation découlant de la collaboration, l’innovation ouverte semble une avenue de plus en plus prisée. Cette étude propose un cadre facilitant l’implantation de collaboration entre les universités et l’industrie, tout en développant une méthodologie supportant l’implantation de l’innovation ouverte dans les organisations. Des mécanismes de collaboration dans deux centres d’expertise sont aussi étudiés pour comparer le cadre proposé avec des façons de faire réelles. Les analyses démontrent que la façon dont les deux centres collaborent avec les entreprises coïncident avec le cadre proposé dans le mémoire. Même si l’innovation ouverte n’est pas explicitement implantée dans ces deux centres, il semble y avoir un fort potentiel pour son développement.
Abstract

Competitive markets force companies to produce innovative products, meet customers’ needs, and respond quickly to market demand. Nevertheless, firms do not necessarily have all the competencies to perform every operation in-house. Therefore collaboration with other organizations could help them in solving problems which may not be solved individually. In this regard, universities can be considered as the appropriate partners for firms. Moreover, innovation process as a key factor to create new solutions should be embedded in companies’ strategy. To properly take advantages from external resources, the innovation process and inter-firm collaborations are becoming more open leading to the open innovation concept. This study proposes a general framework for creating successful university-industry collaboration, while developing a step-by-step procedure for describing how open innovation can be implemented in a company. Collaboration mechanisms in two centers of knowledge are also investigated to compare and adapt these proposed framework and structure. The analyses reveal that the way the two centers collaborate with companies greatly matches with the presented collaboration framework. Although open innovation model is not significantly applied for collaboration in these organizations, there is a high potential for its implementation.
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Chapter 1. Introduction

In this competitive world, if companies want to ensure good economic performance, they have to produce innovative products, meet customers’ needs, and respond quickly to market demands. But companies do not necessarily have all the competencies to perform every operation in-house. Therefore collaboration, as a pooling of substantial resources (e.g. information, money, labor, etc.) between two or more partners, can help in solving the set of problems which may not be solved individually. The main motivation for firms to collaborate is to reduce cost and share the risks, while accelerating product development (Parker, 2000). But according to the type of business, many other advantages of collaboration can be introduced for each partner, for instance: economies of scales, sharing costs of associated activities, and improved understanding of supply chain’s environment for better decision making.

Furthermore in recent years, many organizations have established collaborations with research centers like universities. In one hand, companies have limited access to all required competencies, skills, equipment, capital, etc. On the other hand, universities need commercializing scientific results, financial supports to precede research projects and improve their reputation. This is why collaborations between industry and universities are a good way to combine knowledge and ideas as well as decide on how using and developing new concepts. In order to create new products and solutions, innovation is also a key factor for organizations; so they have to embed innovation process in their daily business and long term strategy. To properly exploit the external resources, the innovation process and collaboration in new product development are becoming more open leading to a new concept called open innovation. It is a growing issue that increasing numbers of companies are using it. So far, most of the literature is focused on describing open innovation concept and its motivations, and more recently to define competent business strategies (Antikainen, 2011). But less effort has been devoted to implement open innovation model and study university–industry collaboration in open innovation context.
Open innovation literature has traditionally concentrated on knowledge and ideas flowing from one firm to another. Nevertheless, universities can also be a useful source for knowledge and technology transfer. Therefore, linking between open innovation and university-industry collaboration, another issue that is remained unresponsive, capture the real advantages of integrating many skills and information in product development. In fact, there are different motivations for universities and companies to collaborate in an open innovation system: accessing new technologies, accessing additional competencies, finding new ideas, reducing product development time to market, reducing cost and sharing risk are some examples of the main motivations of companies. Commercializing new technologies, accessing empirical data, selling patents and finding financial support could be presenting as the main motivations of universities.

This study is about developing a framework for collaboration between universities and companies in order to explain how to select partners and how to manage relationship in order to achieve outcomes. The outcomes of collaboration framework need to be profitable for both parties. Moreover, a structure for implementing open innovation in a company is developed. Current study helps in understanding which benefits are desired to achieve in a collaboration and open innovation. In this regard, forest products industry, which is one the main manufacturing sectors in Canada, could benefit from the proposed framework. In fact, by developing even more partnerships with key organizations such as universities, the forest products industry could tend towards greater innovation in product development, improved knowledge of market needs, high qualified resource hired in the future, and so on. One of the main goal of this study is therefore to develop a framework to support collaboration between forest products companies and universities in Canada. This is why Forac consortium and VCO network have been chosen as real case studies to understand the specifications of university-industry collaboration in these centers and to investigate whether they tend to open innovation or close innovation.

In order to understand the dynamic of university-industry collaborations and develop a university-industry collaboration framework that could be useful for both companies and institutions, many collaboration projects among academics, government and industry have first been studied. Specifically, a key paper from MIT University describing the results of a
A three-year study at 25 multinational companies has been analyzed in order to identify the best practices for university-industry collaboration from an industry point of view. A second one related to European universities’ activities for developing collaborations with industry has given good insights on how this type of collaboration can be managed from a university point of view. Furthermore, a third one presenting six cases studies in UK to manage university-industry collaborations was particularly useful. Also, to investigate the role of government in university–industry collaborations, a comparison between Canada, USA, UK and Australia has been applied so as to determine the Canada position. Based on these studies, a framework describing general university-industry collaboration has been developed.

The concept of open innovation and how implementing it in a company have next been explored, leading to a step by step methodology. An investigation has also been conducted to link open innovation and university-industry collaboration. The analysis showed that high relational links between academics and industry play an essential role in driving innovation processes.

Finally, three interviews have been conducted to better understand how Forac and VCO, two organizations that try to develop methods, tools, and strategies for Canada’s forest products industry, establish and manage university-industry relationships as well as the benefits they get from these partnerships. Two face-to-face interviews have been held, one with an industrial partner of Forac (Maibec), and another one with the director of Forac. The last interview was conducted by phone with a manager of FPInnovations, a research center that is involved with VCO network and Forac consortium. Data from 23 university-industry collaboration projects in VCO network from 2011 to 2013 have also been used to measure the outcomes in terms of knowledge and technology transfer. In addition, the effect of the number of meetings on university-industry collaboration results has been surveyed.

Comparing the university-industry collaboration framework to collaboration mechanisms in Forac consortium and VCO network has shown a high level of correspondence. The main difference concerns the selection of the partners. In fact, in these real cases, they
seem to not being able to choose any partner they prefer, because of financial/funding and technical problems, or rejection of considered partners. Comparing open innovation methodology to the way of doing of Forac and VCO showed some differences too. In particular, some steps of proposed open innovation structure are getting executed in Forac, such as gathering and screening ideas from different resources, managing intellectual properties, and creating knowledge databases. But these steps are not in the form of proposed open innovation structure in the consortium because the partners are not familiar with it. Since VCO is a research center where universities, government and FPInnovations are its main members and there are no permanent industrial partners, VCO could certainly benefit from implementing open innovation in collaborated companies, which it seems not the case right now.

The research has contributed to highlight the particularities of industry-university collaborations while proposing some facilitators and steps to put into practice for establishing them efficiently. Nevertheless, other project could be conducted to explore some ideas in greater depth. For example, it could be interesting to investigate whether universities need to implement open innovation inside their organization or not and validate if the proposed structure is effective for universities or a new structure should be necessary. While looking at real cases of collaboration between universities and companies, we have analyzed the effect of the number of meetings on collaboration outcomes, but the effects of other collaboration indicators could be assessed, so the effective factors on collaboration outcomes could be prioritized. The quality performance has not been considered in measuring collaboration outcomes in this study. Thus improving measurement indicators to achieve more effective university-industry collaboration outcomes assessment could be considered as a future work.

This document is organized in five chapters. Second chapter has been dedicated to present a review of the relevant literature and concepts. This chapter has discussed about collaboration, university-industry collaboration, innovation, and open innovation. In chapter three, under taken research methodology, proposed framework for university-industry collaboration, and structure for open innovation have been presented. Chapter four
has compared the proposed frameworks with \textit{VCO} and \textit{Forac} real case. Finally, research conclusions and potential future works have been shown in chapter five.
Chapter 2. Literature review

In this section, preliminary notions regarding supply chain, supply chain management, and collaboration are presented. In this regard, the different types of collaboration and steps to create collaboration are explained. Moreover the concepts, benefits, and challenges of collaboration, as well as university-industry collaboration and open innovation definitions are given.

2.1 Overview

In today’s economy, many operations have to be performed in order to produce more complex and innovative products. In the past, these activities have been separately done and managed, but individual organizations are now interested in linking them together. As a result, even more firms with complementary resources and capabilities work together to meet customers’ needs while generating benefits for all the participants. This set of organisations that operate in these networks to create economic value is known as value creation network. Precisely, the value network includes all the process of flow and conversion of goods, from the raw materials to finished products, as well as information and financial flows (Ballou, 2004). As a result, a value network is the hierarchy of value adding actions which is performed by group of firms to produce a product that fulfills market demand.

In the value network, each firm gains material from suppliers, produces its products and sells them to downstream customers. Firms may change supplier or downstream production capabilities or even technological rationale to acquire economic value in competition (Vermeulen, 2012). In general, each value network could contain one or more supply chains defined as the sequenced network of facilities and activities involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer (Mentzer et al., 2001). In fact, the role of supply chain is to support the production and delivery of a good or service (Cholette, 2010). A supply chain includes all parties involved directly or indirectly, not only the manufacturer and suppliers, but also transporters, warehouses, retailers, and customers themselves, in fulfilling customer
requirements (Chopra et al., 2004). Long term competitiveness depends on the design of supply chains to fulfill customer needs in terms of cost, service, quality, and flexibility (Domenica, 2002).

To increase profitability and efficiency of a supply chain, all related parts should be synchronized and tuned perfectly. Any disruption in supply chain synchronization can lead to customers’ dissatisfaction, and consequently economic value lost. For this reason, supply chain management (SCM) concept which is the integration and management of supply chain organizations and activities, has been strongly undertaken in literature. In other words, supply chain management is the processes of integrating suppliers, manufacturers, warehouses, and stores in order to produce and distribute goods at the exact amounts, to the right locations, and at the right time while minimizing costs (Simchi-Levi et al., 2000). The objective of supply chain management is improvement in the company’s profitability by reducing the costs of inventory level and increasing the revenues by improving customer service. In order to achieve the objective of supply chain management, each company should coordinate and integrate its activity with other companies (Bolumole, 2000).

In the competitive global market, individual businesses cannot be successful alone. Collaboration through networks enables all the participants in a value chain to prevail and grow. In fact, firms participate in collaboration to develop, maintain, and even enhance supply chain capabilities that improve competitive advantage of the firms (Hardy et al., 2003). So supply chain can be considered as the driving force of effective supply chain management (Kotler, 1997).

2.2 Collaboration

Collaboration often occurs when individuals or organizations work together towards some common goals. In inter-organizational collaborations, at least individuals in one organization collaborate with individuals in other organizations, and at a maximum, many complete organizations collaborate in harmony. In fact, collaboration is valuable because it is a good way for achieving goals which are difficult or impossible to be achieved
individually (Huxham, 1996). In Huxham’s study, collaboration has been defined as a positive form of organizing the relations in a network to achieve the mutual benefits. In a profitable collaboration, organizations should exchange information and share resources, risks, responsibilities, as well as rewards (Mattessich et al., 2001). Since the key point in collaboration is that a company cannot be successful alone, firms need to collaborate with other entities and coordinate the associated activities in order to meet customers’ needs (Kotler, 1997).

As companies move towards supply chains, collaboration becomes a strategic activity of a company. In the last decades, organisations have tried to increase the efficiency of their internal supply chain activities such as purchasing, manufacturing, and logistics (Fawcett & Magnan, 2002). Although their attempts have led to significant improvements in local networks, the results in supply chain wide perspective were not considerable, and it could be interpreted as the redistribution of costs and inventories in a supply chain (Ireland & Bruce, 2000). But today, especially after the success of Wal-Mart in collaboration with upstream suppliers, supply chain collaboration concepts are extensively applied and become one of the common norms for many companies (Simchi-Levi et al., 2000). Collaboration forces all supply chains’ parties to participate in different tasks related to supply chain such as planning, forecasting, replenishment, information sharing, resource sharing, and incentive sharing (Ramanathan & Muyldermands, 2010). In practice, the benefits of SC collaborations have been proved in terms of cost reduction, sales improvement and forecast accuracy.

2.2.1 Advantages of collaboration

As mentioned before, firms cannot support all customers’ demands alone, so creation of alliances and partnership with one or more firms is often a necessary solution to deal with business processes (Lehoux et al., 2008). For example, in order to meet diversified customers’ needs, product development is usually required, and the main motivation for firms to collaborate is in this case to reduce and share the risks and costs of product development (Parker, 2000).
The impact of collaboration in South African textile and clothing industry has been analyzed by Parker (2000). This survey was conducted by sending a questionnaire to random companies. Based on collected information, the respondents mostly believe that one the main advantage of the collaboration is to accelerate the product development process and to reduce the process time. Many of the respondents have also declared that collaboration helps companies in being more responsive to customers’ needs and in better responding to market opportunities and changes. These improvements are achieved by using the other entities’ skills and expertise which are not possessed within the company.

According to the type of business, many other advantages of collaboration can be introduced for each partner (Patel et al. 2012), for instance: economies of scales, sharing costs of associated activities (transportation, warehouses, etc.), improved understanding of supply chain’s environment for better decision making, and risk reduction have been presented as collaboration benefits by Barratt (2004) and Simchi-Levi et al (2008). In this context, information sharing has a key role to achieve the benefits, and it can be investigated from two aspects: first it helps in better planning activities and, as a result, eliminates backorder, lost sales, etc. On the other hand, it could increase the risk of leakage company confidential information (Lehoux et al., 2010).

Moreover, collaboration develops and strengthens the capabilities of supply chains such as inventory reduction and forecast accuracy (Barratt, 2004), while limiting the bullwhip effect which represents uncertainty in demand. Generally, bullwhip effect is caused by the lack of communication among different parties of supply chain (Lee et al., 1997). Ramanathan et al. (2012) have explained that collaboration achieves several goals including allowing companies to realize a task that would be impossible for the single entities, combining complementary skills and expertise, assisting the application of several strategies and problem solving methods, and facilitating the consideration of multiple perspectives in the resolution of a problem.

Hansen & Nohria (2004) have classified the collaboration advantages in five main categories: 1) Cost savings through the transfer of best practices, 2) Better decision making as a result of advice obtained from colleagues in other subsidiaries, 3) Increased revenue
through the sharing of expertise and products among subsidiaries, 4) Innovation through the combination of ideas, and 5) Enhanced capacity for collective action that involves dispersed units.

Collaboration advantages according to Hansen & Nohria’s study (2004) are summarized in table 2-1.

Table 2-1: Collaboration advantages categories

<table>
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<tr>
<th>Categories</th>
<th>Mechanisms</th>
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<td>Cost savings</td>
<td>Economies of scales</td>
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<td></td>
<td>Sharing costs (transportation, warehouses, etc)</td>
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<td></td>
<td>Saving time</td>
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<td></td>
<td>Sharing risks (backorder, lost sales, etc.)</td>
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<td></td>
<td>Information sharing</td>
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<td></td>
<td>Inventory reduction</td>
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<td></td>
<td>Limiting uncertainty</td>
</tr>
<tr>
<td>Better decision making</td>
<td>Respond better to market opportunities and changes</td>
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<tr>
<td></td>
<td>Information sharing</td>
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<tr>
<td></td>
<td>Forecast accuracy</td>
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<tr>
<td>Increase revenue</td>
<td>Complementary skills and expertise</td>
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<td></td>
<td>Information sharing</td>
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<tr>
<td></td>
<td>Limiting uncertainty</td>
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<tr>
<td>Improve innovation</td>
<td>Information sharing</td>
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<tr>
<td></td>
<td>Complementary skills and expertise</td>
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<tr>
<td>Enhance capacity to collective action</td>
<td>Information sharing</td>
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2.2.2 Types of collaboration

According to Barratt (2004) and Simatupang & Sridharan (2002), collaboration is differentiated by three dimensions: vertical, horizontal and lateral integration. In vertical collaboration, a core company collaborates with external resources including the downstream (suppliers) or upstream (customers) as well as internal collaboration across functions. Vertical integration may also occur at different levels of the supply chain. As an example for vertical type, collaboration between a producer and its distributor can lead to improvement in material and information flows, inventory management control, and transportation systems (Soosay et al., 2008). In horizontal collaboration, a core company collaborates with external resources that are competitors or other non-competitor organizations such as universities or private and public centers (Barratt, 2004). As an example for horizontal type, two or more competing or non-competing organizations producing similar products work together in order to share resources such as warehouse space and manufacturing capacity (Simatupang & Sridharan, 2002), leading to reduced logistics costs, greater group purchasing power, reduced fixed costs of indirect labour such as marketing and quality assurance, improved access to markets because of supply stability, easier overcome of financial barriers to trade, etc. (Soosay et al., 2008, Manning & Baines, 2004) (figure 2-1).

![Figure 2-1: Types of collaboration (From Barratt, 2004)](image-url)
Lateral collaboration is a combination of vertical and horizontal integration. Integrated logistics is an example of lateral integration that aims at synchronising carriers and shippers of multi firms (Simatupang & Sridharan, 2002).

In this research, horizontal collaboration has been the one considered and the focus is on collaboration with university as an external non-competitor organization. Therefore, in the growing competition market, university-industry collaboration, as a form of partnership, is a way to advance product and service innovation.

2.2.3 Steps to create collaboration

When a company decides to apply collaboration as the answer to its needs, a framework to create the collaboration should be considered. Although there are various collaboration types, the steps to create these collaborations are similar. Gonzalez (2001) has proposed five steps to establish a successful collaboration. The first step is to define the strategy of collaboration i.e. identifying the competencies and needs of the firm, while defining the goals to achieve in collaboration. Whilst, planning of the strategy for each project should be performed, separately. In the second step that is related to the selection of partners, various selection criteria need to be applied. In a collaborative project, it is imperative that the company and its partners be strategically aligned, so cultural adaptation and mutual understanding could be considered as the criteria. The third step is related to the structure of the collaborative relationship. It is necessary to establish the legal framework of the relationship in order to determine authorities, types of involved resources and indicators used to measure the performance of the partnership. The fourth step is related to the management of the collaboration. To ensure that organizations are continuously aligned, regular meetings have been suggested to settle eventual conflicts and develop incentives. As the last step, evaluating the consequences of the collaboration is important, because the assessment provides a feedback that leads the partners to continue or change their procedure.

Lehoux et al. (2011) have presented the process of collaboration implementation as a dynamic cycle which is not a contractual relationship in corporate commitment. In fact, it
is a reciprocal commitment that needs to move forward together (figure 2-2). In order to create the collaboration cycle, a company should specify the incentives of collaboration. After that some steps should be followed to manage the relationship by building the collaboration (selecting partners, generating the legal framework of the relationship, etc.). Collaboration performance and synchronization of the network activities could be improved by applying some coordination mechanisms. Finally, generated consequences should be evaluated to reveal the profitability of the collaboration performance and incentives or to share the benefits more adequately; otherwise, collaboration steps should be revised.

Figure 2-2: Steps to follow for creating collaborations (From Lehoux et al., 2011)

2.3 University-industry collaboration

In the growing competition market, knowledge and competencies are essential factors for firm’s competitive advantages and actually for its economics (Buser & Jensen, 2010). It involves that firms seek new ways for product and service development and their
improvement. To increase the number and speed of innovation generation, university-industry collaboration could be an appropriate solution (Bezić et al., 2011).

Banal-Estañol et al. (2011) have mentioned two characteristics of collaborative and non-collaborative projects: type and quality. A non-collaborative project focuses on more basic ventures than a collaborative project. The collaborative type is rather based on preferences of project participants. Since more partners invest in collaborative projects, it is expected that the quantity and impact of the outputs will be higher than non-collaborative in ones. But collaboration on the project’s quality can have two opposite effects: on the one hand, collaboration could increase investment levels; on the other hand, collaboration can lead to more costs for the project because of the complexity of joint working. In university-industry collaboration context, the authors have pointed out that the interested type of project between university and industry is different. Typically, academic researchers tend to solve more general problems so their potential applicability is low, at least in short time (basic research). In industry, companies tend to more applicable research projects (applied project). The difference between a basic project and an applied one is not its scientific content but the potential applicability of the results. Therefore, to strengthen mutual collaborations and add value, much more attention from both sides should be paid to this issue.

Because of changing economic world, the need for university-industry partnership has increased. In this regard, governments encourage university-industry collaboration as a means of increasing national competitiveness and value creation (Barnes et al., 2002). Van Horne et al. (2008) have indicated that in most of the university-industry research, three actors are involved: governments, universities, and industries. Government membership such as government research labs, granting agencies, etc., can be represented on a regional, national, provincial or local level. University membership includes researchers, professors, graduate and post-graduate students. Industry membership consists of Small and Medium Enterprises (SME) or large multi-nationals companies.

In the literature, different objectives and potential advantages have been presented to motivate universities and industry to collaborate. In fact, collaboration with industry is
helpful for academia to create scientific knowledge and access industrial data, and is
helpful for industry to develop solutions for production and service problems (Kaymaz &
Eryiğit, 2011). Turk-Bicakci & Brint (2005) have stated that the main objective of
universities in collaboration is to find out scientific knowledge using different applications,
whereas financial profit and obtaining funds for research are secondary importance. Based
on a survey over 100 academicians, Lee (2000) has expressed that the main reasons driving
collaboration for universities are to provide research funding, to give finances for
laboratory equipment, to create job opportunity for students, and to gain a practical
perspective on academic research and theories. On the other hand, this study has offered
different reasons for industry to collaborate: accessing new knowledge and technologies in
order to develop new products or to improve product quality, conducting collaborative
research leading to new patents and intellectual properties, finding opportunities to recruit
university graduates, and reorienting R&D agenda. In another study accomplished based
on 49 managers and academics from Portuguese and Finnish companies and universities,
Hurmelinna (2004) has concluded that the main collaboration motivation for universities is
the development of teaching followed by financial resources and reputation development.
For firms, obtaining knowledge from academia is valuable because it decreases costs,
improves the organization’s reputation, increases the learning capacity (Ryan, 2006), and
develops the firm’s human resource (Bruneel et al., 2010). Finally, Van Horne (2009) has
summarized the motivations of university-industry collaboration actors as shown in table
2-2.
### Table 2-2: Motivations of university-industry collaboration (From Van Horne, 2009)

<table>
<thead>
<tr>
<th>Actors</th>
<th>Motivations</th>
</tr>
</thead>
</table>
| University | • Accessing to more funding/financial resources  
 |          | • Accessing to industrial and empirical data  
 |          | • Assisting university to create more patents  
 |          | • Spin-off creation  
 |          | • More responsive to government needs  
 |          | • More job opportunities for graduate students  
 |          | • More publications  
 |          | • Enhancement of reputation  
| Industry | • Employ well qualified staff  
 |          | • Get training and support from universities  
 |          | • Product development  
 |          | • Access to university research facilities (for SME)  
 |          | • More responsive to government needs  
 |          | • Upgrading R&D potential  
 |          | • Accessing and commercialize university-based technologies  
| Government | • Decreasing unemployment rate  
 |          | • Building or improving innovation systems locally/nationally  
 |          | • Improving industry productivity  
 |          | • Increase wealth creation  |

In university-industry collaboration context, the process of transferring knowledge from university to industry could be occurred in two formats: formal and informal. The formal transfer that leads to tangible and visible results of a project is identified as outcomes such as patents, research papers, licensing agreement, etc. While the most attention has been given to the formal type of process transfer, the informal type can bring benefits for both parties. The informal transfer which leads to intangible results of a project is identified as an impact like conferences, workshops, social networking, joint research projects, consultation, and qualified employees. Here, the impact is any positive effect on the
companies’ efficiency and competitive advantages that are usually developed among human resources (Van Horne et al., 2008).

To create value, the knowledge and technology transfer could be considered as the outcomes of collaboration (Laundry, 2008). Knowledge and technology transfer concepts are closely related. To make a distinction between them, knowledge transfer consists of learning techniques (either on an individual or organisational level) or thinking styles, methodologies, and principals transfer (Gopalakrishnan & Santoro, 2004). Technology transfer is rather involved with an object or tool to explicitly visualize the knowledge and it could affect the environment. Unlike knowledge transfer that could happen without technology transfer, technology transfer without knowledge transfer is impossible.

Although the potential achieved from university-industry collaboration have been well recognized, there are barriers for ensuring successful partnerships. In fact, beginning and continuing university-industry research partnerships needs much effort from industry and university partners who have different cultures, different goals and missions, and different timeframes for working (Trune, 1996; Boschi, 2005). These obstacles have been categorized by Van Dierdonck & Debackere (1988) in cultural, institutional, and operational barriers. Rohrbeck & Arnold (2006) have explained these barriers in more details. To elaborate the cultural barriers, it is mentioned that the mission of universities is to advance science and make it public, while the mission of industry is to make private profit and wealth for its stakeholders. This contradiction in the mission is similar to what exists on the level of goals. The universities’ goal is publishing scientific results in order to advance their scientific reputation while the industry’s objective is creating products and services which bring profit for them. Companies usually believe keeping R&D results as private is the best way to maintain their competitive advantage. So, industry is not interested in dissemination of research results which is essential for achieving the universities’ goals. Institutional barriers are raised from the different natures of work in universities and industry. Universities usually tend to basic research, sporadic and complex goals, while industry is motivated by clear, practical, and applied research. In addition, companies look for short term profit and fast conclusions, whereas universities are sometimes not enough fast and precise in terms of technical results. In university-industry
collaboration, defining and selecting the best outcomes of a project is another challenging problem. For instance, any advance in knowledge is considered as a result in university but in industry, only a profitable product or service would be regarded as a success. In practice, the change of responsibilities and the organizational structure within companies is an important challenge especially when the responsible person on the company’s side changes. Operational barriers cover another aspect of the obstacles; universities are public organizations and they do not offer clear incentives to encourage their researchers, while companies are profit driven organizations which have well defined structure and incentive systems. Since universities are much more bureaucratic, the processes of budgeting, task definition and task execution are very different than in firms. The university researchers focus less on deadlines because they are not directly committed to companies’ profit. Inefficient project management and the lack of information about the partner’s preferences also often lead to project delay or failure in collaboration. These three types of barriers have been summarized in table 2-3.

**Table 2-3: Barriers of university-industry collaboration (From Rohrbeck & Arnold, 2006)**

<table>
<thead>
<tr>
<th>Barriers types</th>
<th>Collaboration barriers</th>
</tr>
</thead>
</table>
| Cultural      | • Different functions and aims  
                • Incompatible tendency concerning IPR  
                • Lack of common languages |
| Institutional | • Different natures of work  
                • Divergent understanding of what is outcome  
                • Change of responsibilities and structure on the firm’s side |
| Operational   | • Different organizational processes of partners  
                • Inefficient project management  
                • Lack of information about partner preferences related to results |

Moreover, Kaymaz & Eryiğit (2011) have investigated the university-industry collaboration from the viewpoint of academics, and they have presented eight factors as the potential barriers for university-industry collaborations: lack of interest in industry’s staff
and academicians, bureaucracy, isolation of field studies, lack of publicity, weak communication, ineffective rules, lack of university-industry collaboration centers and previous inefficient experiences. To enhance university-industry collaborations, authors have recommended both sides to have meetings, visits to firms, networks established among the organizations, regular news bulletins, and periodic reports made by academicians.

Although effectiveness of university-industry collaborations seems obvious, we need more precise indicators to measure and quantize the productivity of scientific research collaborations (Irvine & Martin, 1983). Since the measuring of intangible knowledge is difficult, the focus is on those aspects of knowledge which are more explicit and easy to be measured. A measurement approach could be proposed based on quantitative indicators and codified characters such as: the number of patents and inventions made by firms, universities or both, the number of solved technical problems, the occurrence of spin-off firms, and so on. As an important advantage, this evaluation method applies variables that are easily accessible. Some techniques could be utilized to collect evaluation information such as: interviews, questionnaires, peer review, quantitative methods, and case studies (Geisler & Rubinstein, 1989). Also, the outcome and success of the university-industry collaboration could be expressed by comparing the expected performance and the actual performance. Consequently, big gap between those represents unsuccessfulness of collaboration (Bonaccorsi & Piccaluga, 1994). Evaluation of benefits and amount of successes also depend on who performs the evaluation, because university and industry often have different point of views which can decrease the reliability of evaluations. Even though, different results might be gained by different methodologies of measuring, especially if the evaluation is made by different people inside the organization (Bailetti & Callahan, 1993).
2.4 Innovation and open innovation

In competitive environment, organizations have to create new solutions to overcome existing problems and satisfy customers. Innovation is a phenomenon that brings advantages and value for the company which is in competition with other companies (Barney et al., 2001). In the literature, there are different definitions of innovation but Manual (2005) has presented the most useful and complete one which is: “the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practises, workplace organisation or external relations”.

Generally, organisations have four main categories of sources for creating innovation which are: 1) internal sources such as R&D units and employees in the firm 2) external sources such as suppliers, customers, agreements with competitors, etc. 3) expert sources such as consultants and private or public sectors and 4) collaborations sources like joint ventures and university-industry research centres (Von Hippel, 1988; Rogers, 2003; Walters & Rainbird, 2007). It is worthwhile to mention that one-time innovation could not be a permanent solution for companies. In contrast, continuous innovation is the only way to satisfy customers’ need while improving and advancing companies’ business (Gumus & Cubukcu, 2011).

Because of wide boarders of knowledge, no company can achieve all required competencies alone. So organizations should adopt a new “open” model of innovation, called “open innovation” (Chesbrough, 2003). Open innovation has been defined in Chesbrough’s study as: “the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. [This paradigm] assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology”. Open innovation creates new opportunities for companies to benefit from external resources. In fact, core of open innovation stands to use external ideas like the internal ones.
Although Chesbrough (2003) has perfectly defined the open innovation concept, there are still degrees of ambiguity in its realization and effectiveness. Therefore, comparison between close innovation as the old model and open innovation could be helpful. In this regard, figures 2-3 and figure 2-4 provide and compare the main points behind two innovation models. In close innovation (figure 2-3), lunched research projects progress within the firm boundaries, and some projects are stopped while others are selected for further work. A number of these selected projects go through to the market. In this model, projects can only enter in one way, at the beginning, and can only exit in one way, by going into the market. Open innovation model (figure 2-4) consists of projects that can be started from either internal or external sources. There is also the possibility to engage new technologies with the process at various stages; it implies that company’s boundaries are not strict. Furthermore, projects can enter to market in different ways such as through licensing or a spin-off venture company.

Figure 2-3: Close innovation scheme (Chesbrough, 2003)
Table 2-4: Comparison of close innovation and open innovation principals (Chesbrough, 2003)

<table>
<thead>
<tr>
<th>Close innovation principles</th>
<th>Open innovation principles</th>
</tr>
</thead>
<tbody>
<tr>
<td>The skilled people work for us.</td>
<td>We need to work with skilled people inside and outside the company. Not all the skilled people work for us.</td>
</tr>
<tr>
<td>We must develop R&amp;D part by ourselves.</td>
<td>External R&amp;D can bring value or help internal R&amp;D to create a part of that value.</td>
</tr>
<tr>
<td>If we develop it ourselves, we will get it to the market first.</td>
<td>We do not have to start off the research project to profit from it.</td>
</tr>
<tr>
<td>The company that presents an innovation to the market first will win.</td>
<td>Building a better business model is better than getting to the market first.</td>
</tr>
<tr>
<td>If we create the most and the best ideas in the industry, we will win.</td>
<td>If we make the best use of internal and external ideas, we will win.</td>
</tr>
<tr>
<td>We should control our IP, so that our competitors don't profit from our ideas.</td>
<td>We should profit from others' use of our IP, and we should buy others' IP whenever it advances our business model.</td>
</tr>
</tbody>
</table>

There are several factors that force organizations to pass through close innovation and move toward open system. For instance, nowadays experienced people easily go from one company to another, so a huge volume of knowledge is transferred by them. Another factor
is growing the availability of capital venture that facilitates development of innovative ideas outside the firms (Gumus & Cubukcu, 2011).

To elaborate the open innovation application, presenting a real example could be useful. In this regard, Procter & Gamble (P&G) is a great case study (Chesbrough & Appleyard, 2007). In the late 1990s, P&G’s competitive strategy had focused on product innovation, but their performance had been falling down; they found that some things in innovation program were wrong. Therefore, P&G had reviewed their Research and Development (R&D) strategy and increased their budget for the five years. By 1999, R&D costs had increased from around 4% to nearly 7% of sales, while rate of product development was stuck at 35%. In fact, P&G had had a bank of patents, but less than 10% of them led to actual products. The problem was that the increase in R&D spends did not improve their performance. As a dramatic consequence, the P&G stock price dropped from $118 to $52.

Briefly, while they had allocated a huge amount of resources to innovation, they had not gotten significant achievement. It implies that P&G had strong commitment to innovation but it was not along with significant innovation competence. Therefore, to improve their innovation outcomes and solve the problem, they applied open innovation. In this regard, P&G first decreased their innovation infrastructure and R&D spends. Also, they revised their innovation metrics and only focused on activities that lead to the actual outcomes. In the next step, P&G started to get more ideas from external resources and fit them to purposes and needs of the company. Also, P&G improved the executing of ideas and using of resources within the new open innovation approach. By consolidating new findings, reinvesting money into innovation and improving idea selection process, they were able to improve innovation commitment and competence simultaneously. In conclusion, some P&G’s achievements were: a) the percentage of patents used in products increased from less than 10% to more than 50%, b) success rate of new products increased from 35% to more than 50%, c) the percentage of new products that use external ideas increased from 15% to over 35%.

Munkongsujarit & Srivannaboon (2011) have classified open innovation in two groups: inbound open innovation in which ideas inflow from external sources, and outbound open
innovation where ideas and information outflow from the firm to external parties. For inbound open innovation, the firms try to get the new ideas and knowledge from outside of their boundaries. This knowledge allows the company to obtain the best technological solution within a shorter period of time to respond to market needs instead of doing the entire R&D in house. In outbound open innovation context, firms can get additional revenue by opening up their ideas to external parties. Traditionally, the firms only generate revenue from the knowledge that is embedded in their products. This capability of open innovation encourages the firms to acquire additional revenue from commercializing unused knowledge.

Although it has been proven that open innovation activities could bring major profits and value for organizations, there are still some significant risks and barriers that hinder organization from fully profiting. A study accomplished by Enkel et al. (2009) has surveyed the potential risks in 107 European SMEs and large companies. Their investigations have revealed that most of the companies face with loss of knowledge, higher coordination costs, loss of control, and higher complexity in applying open innovation approach. Moreover, significant barriers could hinder the effectiveness of open innovation like the difficulty in finding the appropriate partners, communication barriers, lack of commitment, conflict between open innovation activities and daily business, legal barriers, and inadequate time and financial resources for open innovation activities.

Open innovation system helps company to share and decrease R&D costs while saving time, too much openness could lead to loss of core competences, and as a consequence, could affect the companies’ long-term innovation success negatively. In other side, a closed innovation approach does not meet the rising and fast demands of market in shorter innovation cycles. Nowadays, companies need to use every available resource to create products and services faster than their competitor and at the same time protect their core competencies. In this regard, they require making an appropriate balance between the open and close innovation approaches. In practice, determining the degree of openness is an important challenge; companies should consider the cause-and-effect relationship of open and closed innovation activities, find the appropriate partners and integrate the mechanisms needed for ensuring their success (Enkel et al., 2009).
In open innovation context, university-industry collaboration becomes challenging. Broström & Lööf (2008) have studied the collaboration between firms and universities as perceived by R&D managers in open innovation framework. This study has been established based on interviews with R&D managers at 45 randomly selected firms that have collaboration with two research universities in Sweden. They have showed that collaboration has significant contribution to develop the firm’s R&D capacities and manage corresponding costs and risks. Also, collaboration allows firms to strengthen their innovation networks and manage human capital, while helping them in promoting the capabilities necessary to successfully translate market opportunities evolving within the firm or from contacts with other firms into technical or organizational problems. They have concluded that the impact of university-industry collaboration in open innovation model on R&D results is important as much as creating new R&D programs.
**Chapter 3. Research objectives and Methodology**

In order to understand the dynamic of university-industry collaborations, identify the potential benefits, as well as find the best implementation method in practice, many case studies have been analyzed. Specifically, a key paper from MIT University describing a three-year study at 25 multinational companies that identified university-industry collaboration best practices from an industry point of view (Pertuze et al., 2010) has been analyzed. Another research concerning European universities’ activities for developing collaborations with industry (DG Education & Culture, 2011) was also considered. The objective of surveying these case studies was to understand all the activities necessary to develop beneficial university-industry collaborations.

Furthermore, to investigate the role of government in university–industry collaborations, a comparison between Canada, USA, UK and Australia has been applied. All the studies analyzed have conducted us to develop a general framework of university-industry collaboration presented in the next chapter. The methodology followed is summarized on figure 3-1. Colored parts shown in figure 3-1 indicate the steps that are investigated in current chapter while gray boxes will be elaborated in chapter 4.
Activities of 6 universities in Europe in context of university-industry collaboration (2011)

Best practices of 100 university–industry collaboration projects at 25 multinational companies as case studies in MIT University in US (2010)

6 case studies of university-industry collaboration in UK (2001)

Main resources of open innovation

Procedure for open innovation implementation in a company

University-industry collaboration actions from academic vision

University-industry collaboration actions from business vision

General framework for university-industry collaboration

Linking between university–industry collaboration and open innovation

• Government-university-industry collaboration in UK, US, Australia, Canada
  • University-industry collaboration in Canada

Figure 3-1: Methodology structure
3.1 Case studies

In this section, we investigate the principle activities that universities, industries, and the government perform in context of university-industry collaboration. In this regard, different case studies are shown in following parts.

3.1.1 Some activities of European Universities for university-industry collaboration

A study analyzing distinct activities from 15 case studies around the European Union was explored to better understand how collaborations between universities and industry could be developed. This study is in support of University Business Forum (UBF) which develops collaboration between businesses and universities. Hybrid methods have been used to select case studies in this research. At first, a desk research including the mapping of all previous speakers of UBF, investigating the work of previous and existing contracts of UBF, and surveying an overview of financed projects with university business cooperation, led to a list of forty five cases which reflect different practices and processes. Among these case studies, six cases covering all the university activities toward developing university-industry collaboration have been analyzed in details and they are explained in the following sections.

Babes-Bolyai University (Romania)

This university uses practical methods to overcome the barriers of collaboration with industry, especially with SMEs. In 2008, it has launched the Institute of Technology to support research activities of university, including the increase of marketing and technology transfer, as well as different aspects of spin-off company organization. This Institute tries to gather researchers, academics and even technicians from different fields in the university especially to work on favourite projects of industrial partners. It also encompasses the Centre for International Cooperation which develops the international relations of the university in EU and non-EU programs. This Centre elevates the educational programs outside the university, establishing summer schools and international events while promoting joint degrees and joint research programs with industry. Its experience showed that for international companies, soft-skills and language skills of
university graduates are more important than their earned knowledge. As a result, to ensure the development of these abilities, the university tries to present innovative training methods and prepare students to meet needs of the industry in the future.

**Charles University (Czech Republic)**

Charles University (CU) uses a decentralized approach to collaborate with industry. It means that each faculty has autonomy in deciding to collaborate with relevant firms. The students of each faculty collaborate with relevant industry for their study. CU has established in 2007 a unit as a center for Technology and Knowledge Transfer (CPPT). CPPT staff helps researchers who want to commercialize their results and collaborate with marketing networks. The CPPT also offers training courses in Intellectual Property Right (IPR) issues and technology transfer for supporting entrepreneurship. In 2009, CU focused on improving the conditions for innovation transfer to industry.

**Aalborg University (Denmark)**

Aalborg University (AAU) uses a centralised model for collaboration with business called Project and Problem Based Learning (PBL) model. A close contact between theory and action is necessary in this model. PBL or ‘Aalborg model’ is a teaching and learning model which begins with the formulation of a problem. Students define and analyze the real-life problem within a specified framework as a project. As a result, the students can understand the complex dimensions of a real-life problem. They cannot achieve this understanding just by facing with academic questions within the university. The privilege of cooperating through PBL is a continuous interaction with business. AAU also offers two types of courses. One type concerns the courses related to the project problem and these courses present theories that can be used in the project. The other type is the courses which present general knowledge of a chosen field. By differentiating the curricula, students gain the ability to integrate different kinds of knowledge, that is, interdisciplinary approaches are used for solving the problems. Students may work in companies and meet company partners during the research projects while they may be involved in companies’ projects too.
To avoid that companies’ problems become a secondary problem while students’ projects a priority, the university holds a forum every year. Companies are invited to show their potential problems while students have the opportunity to share their barriers and achievements. Firms and students are therefore informed from each other’s problems and potential solving. After this event, the university prepares a catalogue for students to choose beloved projects.

AAU also applies ‘matchmakers’ to facilitate collaboration with industry. Internal matchmakers in each department help industrial partners to find related academic researchers. External matchmakers in the local area help industry to get information about collaborating with AAU. International matchmakers are abroad and assist Aalborg University to develop its contact. There also are some networking centers which generate groups between business and academics. For example, by holding meetings between researchers and employees for discussion, they can convince industry to supply research projects. The university provides an opportunity for industry to use its laboratories too.

**Katholieke Universiteit Leven (Belgium)**

Leuven Research and Development (LRD), which was founded separate from the rest of the university, manages the Katholieke Universiteit Leven’s R&D part and operates in four fields. The center first negotiates research contracts with companies and tries to promote an entrepreneurship culture. It next manages activities concerning patent and intellectual property policies. The Intellectual Property Advisory Group has been established to set up internal procedures related to these rules. Patent funds are also available to support the researchers in maintaining their own research portfolio, scanning their potential economic profit and writing patent application. It then establishes spin offs for supporting business development and elevating venture funds with applying educational activities. For example, the Bio-incubator has been established in the university to support the spin offs in partnership with the Flemish Institute of Biotechnology (FIB) and a local biotech company (AVEVE). It finally tries to create open innovation platforms and foster the cooperation between the Centre and the market.
Slovak University of Technology (Slovakia)

There are some organizations and institutions in Slovak University of Technology (STU) dedicated to increase collaboration with industry. The Institute of Life-Long Learning (ILLL) is a department focusing on the teaching of languages and information technologies while providing support services online. STU established the Alumni Club to create communication between graduates over the last 70 years and the university. The main objectives of Alumni Club relate directly to exchanging practical knowledge between the academia and industry, including developing issues for student dissertations and student placements in companies. In 2006, the STU established the first University Technology Incubator in Slovakia. It provides consultations in the area of intellectual property rights and aspects of entrepreneurship, while applying for grants from various sources including the European Funds for the incubated firms as well as for the public.

Université de Technologie de Compiègne (France)

The Université de Technologie de Compiègne (UTC) was set up to develop a new kind of collaboration between university and companies. In particular, the university’s executive board consists of both academics and people from the industry. All departments participate in collaborations but there are some directorates who are in charge of particular features:

- one directorate is responsible for promoting the research results towards companies;
- one directorate is in charge of scientific partnerships;
- another directorate is in charge of curricula, incessant education, and the recognition of prior learning.

The Innovation Center has been established in 2008 in order to support the research projects and adapt them to industrial needs. Table 3-1 summarizes the particularities of each university.
Table 3-1: Activities towards university-industry collaboration in some European Universities

<table>
<thead>
<tr>
<th>Universities</th>
<th>Activities</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Babes-Bolyai University (Romania)</td>
<td>• Establishing Institute of Technology (2008)</td>
<td>• Supporting research activities of university</td>
</tr>
<tr>
<td></td>
<td>• Establishing Center for International Cooperation</td>
<td>• Supporting different aspects of spin-off companies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Supporting foreign students and mobility of them</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Training personnel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Elevating educational programs outside the university</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Holding summer schools and international events</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Promoting joint research</td>
</tr>
<tr>
<td>Charles University (Czech Republic)</td>
<td>• Establishing Center for Technology and Knowledge Transfer</td>
<td>• Helping researchers to commercialize their research results via cooperating with patent owners and marketing networks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Running courses in technology transfer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Assisting to establish spin-off companies</td>
</tr>
<tr>
<td></td>
<td>• Holding forums every year that invite companies and students</td>
<td>• Companies and students share their problems and barriers in this event</td>
</tr>
<tr>
<td></td>
<td>• Applying matchmakers to facilitate collaboration with industry</td>
<td>• University prepares a catalogue for students to choose projects</td>
</tr>
<tr>
<td></td>
<td>• Establishing Nouhauz Networking Centers</td>
<td>• Helping industrial partners to find related academic researchers</td>
</tr>
<tr>
<td></td>
<td>• Sharing laboratory facilities with businesses</td>
<td>• Creating networks with external actors to convince industry to supply researchers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Universities and industries both get advantages of sharing laboratories (e.g., cost sharing)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Speeding up knowledge transfer to business</td>
</tr>
</tbody>
</table>
Table 3-1: Activities towards university-industry collaboration in some European Universities (continued and end).

<table>
<thead>
<tr>
<th>Universities</th>
<th>Activities</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Katholieke Universiteit Leuven (Belgium)</td>
<td>Creating Leaven Research and Development (LRD)</td>
<td>• Managing industry part of KUL’s R&amp;D portfolio and support researchers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Adapting to the KUL complex structure and spread its activities through the university</td>
</tr>
<tr>
<td>Slovak University of Technology (Slovakia)</td>
<td>Establishing ALUMNI Club</td>
<td>• Creating communication between graduates over the years and the university itself</td>
</tr>
<tr>
<td></td>
<td>Establishing the first University Technology Incubator</td>
<td>• Exchanging practical knowledge between academia and industry</td>
</tr>
<tr>
<td></td>
<td>Establishing Career Advance Center (CAC)</td>
<td>• Offering consultative services in the part of IPR</td>
</tr>
<tr>
<td></td>
<td>Establishing the Institute of Life-Long Learning (ILLL)</td>
<td>• Preparing better job accession for STU students via advice on writing CVs, motivation lists and self-presentation at interviews.</td>
</tr>
<tr>
<td>Université de Technologie de Compiègne (France)</td>
<td>Involvement of industrials in curricula and teaching activity</td>
<td>• Teaching languages and information technology, supporting service</td>
</tr>
<tr>
<td></td>
<td>Launching Innovation Center</td>
<td>• Enabling university to benefit from adapting the training programs to industrial needs</td>
</tr>
<tr>
<td></td>
<td>Launching UTC foundation</td>
<td>• Supporting essential interaction of knowledge and skills transfer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Supporting the development of prototypes to adapt them to industry needs</td>
</tr>
</tbody>
</table>

Investigating university activities revealed that they mostly try to develop their interaction with industry by establishing different plans and even centers to better join universities and
firms. In fact, these proceedings could be considered as the prerequisites to begin the process of collaborative projects.

3.1.2 Best practices for university-industry collaboration from industry perspective

After a three year study, the MIT University has determined seven practices for better supporting university-industry collaboration (Pertuze et al., 2010). This study has involved more than 100 projects conducted in 25 multinational companies. This study has been done by interviewing with responsible project managers and senior technology staff related to industry-university collaboration projects. These projects involve both successful and unsuccessful cases. Seven best practices for managing collaborations have been defined according to quantitative and qualitative information regarding the levels of success of the collaborations. From these seven practices, the first four practices concern how selecting the collaboration and next connecting it to the university research. The last three practices concern the project management and how to promote productive relationships between the company and the university researchers.

Practice1) Defining the strategy of a project

The university-industry collaboration should be based on company’s needs and should follow company’s development. Thus, the university activities should meet the goals of the company in terms of technological and R&D leadership. On the other hand, there should be a vision about achievements of collaboration with universities within the company. The university also needs to be linked to company’s research portfolio and to relevant internal units. Otherwise, results may not be useful. In fact, by connecting to internal units of the company, the university can access different channels of knowledge that can help it in achieving best results. In order to have research impact, it is also important to addressing the observed requirements of company’s participants.

Practice2) Selecting Boundary Spanners

Boundary Spanning is used for recognition of information. Boundary spanners discover information from external resources and bring it into their organization. Their main role in
success of collaboration appears in two ways. The first is broadcasting collaboration results inside the company while clarifying the findings to staff. The second is providing feedback to the university researchers in order to keep the research in line of company’s requirements.

Companies which use new technologies need a particular type of boundary-spanners called technical boundary-spanners. Their responsibility is simplifying knowledge exchange between the university and the company as well as turning collaboration outcomes into tangible impacts for the company. The technical communities within the company are responsible for the formation of these boundary-spanners. Technical communities give opportunities to younger specialists to develop various networks, leading to perception of different ideas, and help in detecting and developing new ideas.

**Practice3) Informing university researchers on how they can help the company**

The study showed that if researchers are familiar with the company practices and strategies and if they have knowledge about business situation, it may have a positive impact on the company. Furthermore, working with similar companies may help university researchers to link project results to company needs and practices more efficiently. Some project managers may prefer to not aware university researchers about their goals and strategies. The main reason is their concern about losing competitive privilege of the company. Overall, trust between the company and the university is the key to control the strain between isolation and openness. Companies usually are more open in working with universities they already have collaborated with.

**Practice4) Investing in long-term connections**

The company and the university have their own scheduling for fulfilling the project. It depends on the economic issues and the product cycle in the company as well as the graduate programs in the university. But overall, in long-term relationships, the participants achieve better uptake of the project problems and they are able to establish greater communication.
Practice5) Creating strong communication with university researchers

The study also showed that strong interactions between the company staff and the university researchers are profitable. In particular, the tacit knowledge which is not written on paper can be exchanged within regular communications. Even companies can encourage project managers to meet researchers inside the university in order to ensure face-to-face meetings. Generally geographic proximity has not great effect on their communication. Nowadays video conferences and teleconferences can replace face-to-face meetings.

Practice6) Creating broad awareness of the project within the Company

Connection between the university and the company should not stay in the level of the university researchers and the project managers. Specifically, broadening awareness of the project among individuals in the company may increase the researchers’ access to new ideas and suggestions. If project managers and university researchers develop their methodology without any connections with other groups in the company, they may receive some feedbacks from staff about situations they did not consider, causing to stop the project.

Practice7) Supporting the project until it can be exploited even after finishing

The internal representation of the project results must continue even after finishing the project. Successful completion of the project is a precondition for the great impact in the company, but not enough to guarantee it. The project manager is responsible for ensuring the proper implementation of the research results after completion of the project until it can be exploited. Table 3-2 summarizes the best practices of companies for university-industry collaboration.
<table>
<thead>
<tr>
<th>Practices</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Defining the strategy of project</td>
<td>• Find opportunities for collaboration based on company’s research portfolio</td>
</tr>
<tr>
<td></td>
<td>• Define specific results of collaboration which bring profit to the company</td>
</tr>
<tr>
<td></td>
<td>• Identify internal beneficiaries of collaboration outputs</td>
</tr>
<tr>
<td>2- Selecting Boundary-Spanners with three attributes</td>
<td>• The ability to get and use new technology</td>
</tr>
<tr>
<td></td>
<td>• The tendency to broadcast the results inside the company and provide feedback to the university</td>
</tr>
<tr>
<td></td>
<td>• The ability to make connection between research and opportunities for commercializing</td>
</tr>
<tr>
<td>3- Informing university researchers in the vision of how they can help the company</td>
<td>• Select university researchers who are familiar with the company’s practices and strategy</td>
</tr>
<tr>
<td></td>
<td>• Ensure that the university partners understand the context of the project</td>
</tr>
<tr>
<td>4- Investing in long-term connections</td>
<td>• Plan for long-term collaboration schedules</td>
</tr>
<tr>
<td></td>
<td>• Promote collaboration with current university researchers</td>
</tr>
<tr>
<td>5- Creating strong communication with university researchers</td>
<td>• Provide face-to-face meeting situation</td>
</tr>
<tr>
<td></td>
<td>• Develop regular and routine communications</td>
</tr>
<tr>
<td></td>
<td>• Exchange people between the university and the company</td>
</tr>
<tr>
<td>6- Creating comprehensive understanding of the project within the company</td>
<td>• Develop interaction of university researchers with different parts of the company related to the project</td>
</tr>
<tr>
<td></td>
<td>• Provide feedback to the university about project accordance with the company objectives</td>
</tr>
<tr>
<td>7- Supporting the project until it can be exploited even after finishing the project</td>
<td>• Provide internal support for management oversight</td>
</tr>
<tr>
<td></td>
<td>• Take responsibility of the project until it can be exploited as part of the project manager role</td>
</tr>
</tbody>
</table>
According to this study, it could be concluded that company’s practices have been planned based on companies’ benefits and their limitation and situation. A better understanding of this point of view will help us in developing university-industry collaboration framework in the next chapter.

3.1.3 Government- university-industry collaboration in UK, US, Australia and Canada

Many studies have shown that the government can have a real influence on the success of university-industry collaborations. In fact, the government may contribute to reduce companies’ costs, increase the innovation rate in technology, increase national companies’ authority in global competitive market, and ensure information flow among universities, public and private sectors (Hagedoorn, Link & Vonortas, 2000). As a result, government should try to define an incentive framework to encourage universities and industries to collaborate together. For example, government could provide financial advantages like tax reductions for firms that work with universities or it may set up technological research projects (Kaymas & Eryigit, 2011). By helping university-industry collaborations, the government plays a key role in increasing industry efficiency, providing skilled and knowledgeable students, and rising living standards of people.

Currie (2011) compared the intensity of industry-university collaboration in Canada, US, UK and Australia. Results showed that Canada is not a leader in this type of collaboration but based on The World Economic Forum’s (WEF) survey, Canada had a 7th place in 2010. Surveying the policies established by governments showed that they are advocate of university-industry collaborations inside their countries. Furthermore, US, UK, and Australia hold national forums in order to bring university researchers and business managers together for strengthening collaboration. However, there is not such kind of permanent forums in Canada.

If we look at the observations related to each country, we can first see that “US is the most innovative knowledge-intensive national economy in the world” (Branwell et al., 2012), while its institutional structures are fragmented and decentralized. Generally, local and
state governments support university-industry collaborations more than federal governments, but there are a number of long-lasting federal programs for promoting university-industry collaborations. This legislation helps universities to patent the results of their research and to license their IP with federal funding. Other programs related to technology transfer and commercializing process have also been created to better support universities.

The study also highlighted that the UK government is the most advocate and the main funder for university-industry collaboration, strengthening them with a clear roadmap. In fact, UK government tries to convert UK to the best place for investing in innovate technology companies and universities (Currie, 2011). For example, it invests significantly in Intellectual Property (IP) development to gain advantages of commercialization. From 1990, many programs have started and the Higher Education Funding Council for England (HEFCE) has provided substantial funds for universities to develop their relation with business (Bramwell et al., 2012).

In Australia, the government publishes annual results of university-industry collaboration as international benchmarks. For encouraging university-industry collaborations, Australian government also supports some research funding associations and follows out an agreement model which asks universities to submit new ideas in order to improve innovation and product development.

Based on these observations, Currie (2011) has identified four roles that the government may play to encourage university-industry collaboration. These are advocate, enabler, funder and rule-maker.

- **Advocate**: The government as advocate provides strategies to better support university-business collaborations while changing some current mandates and revise organizational rules. The government can also sponsor and support university-business collaboration studies, hold conferences, and provide public awards to recognize their contribution and increase their visibility.
• **Enabler**: The government as enabler supports intermediaries which connect universities and industries, influence research assets, and facilitate employee and researcher exchanges.

• **Funder**: The government can also act as a funder by providing funds that universities need for conducting research and establishing business partnerships.

• **Rule maker**: The government can regulate intellectual property rights while having an influence on university management.

The table 3-3 summarizes the roles played by the government in the four countries.

**Table 3-3**: Government as advocate, enabler, funder and rule-maker in US, UK, Australia and Canada

<table>
<thead>
<tr>
<th>Government as advocate</th>
<th>Strategies, Reports and Policy Statement</th>
</tr>
</thead>
</table>
| **US**                 | • Holding public consultation on commercialization of federally funded research by the US Office of Science and Technology, and the US National Economic Council.  
                          | • Holding regional forums on commercialization of research by the US Secretary of Commerce. |
| **UK**                 | • Mobilizing the attention of governments, businesses and universities by Lambert Report Center.  
                          | • Studying challenges’ emerging in UK university-business research collaboration |
| **Australia**          | • Defining university-business collaboration as one of the main parts of Australia’s economic as well as one of the main priorities of federal government’s Powering Ideas Innovation Agenda. |
| **Canada**             | • Defining an Expert Panel to observe federal support for business and commercialization related to R&D. |
Table 3-3: Government as advocate, enabler, funder and rule-maker in US, UK, Australia and Canada (continued).

<table>
<thead>
<tr>
<th>Government as advocate</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Changing current mandates and revising organizational rules</strong></td>
<td></td>
</tr>
</tbody>
</table>
| **US** | - The US federal government has established an Office of Innovation and Entrepreneurship (2009) and an Advisory Council on Innovation (2010) where each of them plays a role more than just encouraging university-business collaboration.  
- The US National Science Foundation supported the development of the University-Industry Demonstration Partnership in 2004. |
| **UK** | - Technology Strategy Board (TSB) has been established in 2004 to deliver main research funding programs to industry.  
- TSB mandate expanded in 2010 to include oversight of the new Technology and Innovation Centres and also some programs from UK Regional Development Agencies. |
- A new organization created in 2010 to centralize the delivery of research commercialization programs. |
| **Canada** | - Several provinces have reorganized their innovation policy departments and agencies in order to transform them as better advocates of U-B research collaboration. |
| **Supporting intermediary organization** |  |
| **US** | - Providing start-up funding for several organization which are important channels for federal research funding of U-B research |
| **UK** | - Supporting intermediary organizations and assigning great investment to Technology and Innovation Centres (TIC). |
| **Australia** | - Connecting Federal government’s enterprise program assigns to investment in intermediary organizations (six manufacturing centres and six innovation centres). |
| **Canada** | - Providing considerable financial support by federal and provincial governments to organizations in order to connect business and university research communities.  
- Supporting national and regional networks for research commercialization by government. |
<table>
<thead>
<tr>
<th>Government as enabler</th>
<th>Leveraging government research qualities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>US</strong></td>
<td>• Spending 14 percent of all federal R&amp;D expenses to supporting Federally Funded Research and Development Centres (FFRDCs) by The US federal government.</td>
</tr>
<tr>
<td><strong>UK</strong></td>
<td>• Decreasing co-location as a policy to encourage U-B research collaboration by UK government.</td>
</tr>
<tr>
<td><strong>Australia</strong></td>
<td>• Facilitating co-location with universities by Commonwealth Scientific and Industrial Research Organization.</td>
</tr>
<tr>
<td><strong>Canada</strong></td>
<td>• Facilitating co-location with universities by The National Research Council’s research institutes.</td>
</tr>
<tr>
<td></td>
<td><strong>Supporting employees and exchanging researchers</strong></td>
</tr>
<tr>
<td><strong>US</strong></td>
<td>• The US National Science Foundation‘s Advanced Technology Program funding has been increased in order to encourage collaboration between businesses and 2 year colleges.</td>
</tr>
</tbody>
</table>
| **UK** | • Seeking strengthen connection between universities and companies by UK Government’s Knowledge Transfer Partnerships Program.  
• Providing funds for the Institute of Knowledge Transfer which aims to improve knowledge transfer in university and industry. |
| **Australia** | • Various programs in place (e.g. Researchers in Business Program). |
| **Canada** | • Various small programs to facilitate mobility of university researchers between the university and business sectors (e.g., the Natural Sciences and Engineering Council’s Collaborative Research and Training Experience program).  
• Supporting strengthening professional skills for knowledge transfer by different organizations with degrees of government |
Table 3-3: Government as advocate, enabler, funder and rule-maker in US, UK, Australia and Canada (continued).

<table>
<thead>
<tr>
<th>Government as funder</th>
<th>Funding research in universities with business partnership</th>
</tr>
</thead>
</table>
| **US**               | • Defence and Energy Advanced Research Project Agencies, and the Small Business Innovation Research Program, are the most well-known federal R&D programs on encouraging U-B research collaboration.  
• Considering U-B collaboration as a criterion for funding by National Science Foundation Grant. US funding of university research is significant and has often been allocated to encourage U-B collaboration. |
| **UK**               | • Providing over £ 1 billion to universities for knowledge-based interactions and specially to support university knowledge transfer, funding to generate a proper environment for U-B research collaboration by The UK Technology Strategy Board, the key business R&D funding institution. |
| **Australia**        | • Reconsidering the Institutional Grants Scheme (IGS) for universities to encourage U-B collaboration by federal government.  
• Funding a Cooperative Research Centre involving businesses, universities and government research agencies by federal government. |
| **Canada**           | • Allocating much money annually on programs to encourage U-B collaboration by federal government, the two main being the Business-Led Networks of Centres of Excellence program; and the Centres for Commercialization & Research program. |
Table 3-3: Government as advocate, enabler, funder and rule-maker in US, UK, Australia and Canada (continued and end).

<table>
<thead>
<tr>
<th>Government as rule maker</th>
<th>Regulating Intellectual Property rights</th>
</tr>
</thead>
</table>
| **UK**                   | - Focusing on IP practices as barrier to U-B collaboration.  
                          | - Collaborating with business and universities in order to show standardized IP management processes by UK Intellectual Property Office  
                          | - Doing an independent review on how the UK IP system can help to growth and innovation by the UK government. |
| **Australia**            | - Legal challenge to current university ownership model in Australia may spark federal government action.  
                          | - Identifying IP management in university settings as a challenge area by Powering Ideas innovation agenda. |
| **Canada**               | - Providing better flexibility in managing IP associated with federally funded research by federal granting councils. |

Despite the positive role of government in university-industry collaborations, increasing laws and principals to adjust university, industry and government interactions may lead to high degrees of bureaucracy and, as a result, slow down the projects speed (Kaymas & Eryigit, 2011). It becomes therefore important to ensure the deployment of an efficient government structure to facilitate industry-university collaborations.

### 3.1.4 Active institutions in university-industry collaboration in Canada

In Canada, some institutions have been established to support creation of new university-industry collaboration and reinforce existing university-industry partnerships. For example, the National Science and Engineering Council (NSERC), the Social Sciences and Humanities Research Council (SHHRC), the Canada Foundation for Innovation (CFI), and the Canadian
Institutes of Health Research (CIHR) all try to develop knowledge flow and facilitate technology transfer. Intermediary organizations as known Technology and Innovation Centres (TICs) are other important actors for transferring ideas into innovation.

In particular, NSERC is the main supporter for research advanced. The strategy of NSERC for collaboration and innovation is based on four steps. The first step concerns the creation of lasting partnerships by providing to researchers the conditions needed to show their abilities to firms and start exchanging ideas with them. Setting up centers for solving problems, identifying benefits and challenges of these partnerships and facilitating collaborations are other examples of this first role.

The second step is simplifying contacts between partners knowing that there are many differences between industry and university for exploiting the research. For example, for the issues related to the innovation process like intellectual property problems, NSERC tries to play an intermediate role. Supporting market surveys as a primary step of technology development, supporting some project costs to assist releasing of results, and supporting small and medium enterprises (SMEs) are some activities in this context.

The third step concerns attracting qualified people and preparing situations for people to get non-technical skills that are important for the industry such as teamwork and communication skills, while encouraging companies to engage students in projects and employ them after graduating.

The forth step is greater emphasis on national priorities. For maintaining competitive role in global R&D investments, Canada should focus on increasing competencies and capacities in priority projects of Canadian businesses. NSERC supports research that lead to solutions addressing internal challenges and opportunities. Its approach is flexible and dynamic to make Canada an attractive place for researchers and innovators.

### 3.1.5 University-industry collaboration position in Canada

In August 2011, an online survey was done by the Board of Trade of Metropolitan Montreal in collaboration with Léger Marketing in order to get information about
collaboration with universities and the vision of the Canadian university system (The Board of Trade of Metropolitan Montreal, 2011.) 402 Canadian business leaders were involved half of these companies were located in Quebec, while the other half came from other places in Canada. All the companies had at least 10 employees and their sales were of 1million dollars or more. Some results obtained from this review are:

**Result 1:** Close to 62% (51% of Quebec companies and 65% of other Canadian companies) of these business leaders believe that university-industry collaboration is relevant to the company's development (figure 3-2). Moreover 80% of current collaboration partners plan to continue their cooperation in the future.

![Figure 3-2: Business leaders’ opinion about relating of companies’ development to collaboration](image)

**Result 2:** The main fields of university-industry collaboration in Canada from 2008 to 2010 were respectively:

- Internship
- Mentoring
Donation to universities and their foundation
Collaborative research

**Result 3:** However, the sequence in Quebec was a little different:
- Internship (very high)
- Collaborative research
- Donation to universities
- Mentoring

**Result 4:** Other areas of collaboration were:
- Contract research
- Investments
- Licensing agreement
- Clinical trials
- Association with a research chair
- Business incubation project

**Result 5:** Both in Quebec and in other parts of Canada, the most important motivation that encourages companies to collaborate with universities concerned the access to skills and competencies of university researchers. The others were respectively:
- Access to new technologies
- Development of a new product or service
- Access to a scientific network
- Access to R&D tax credits
- Development of “scientific credibility” with international customers
- Risk-sharing regarding the innovation

**Result 6:** More than two thirds of the reviewed companies assign a part of their incomes to the R&D parts. Also, less than half of these companies assign some of the R&D budget to university research centers. Meanwhile, Quebec and other Canadian companies allocate
almost equal budget to the R&D parts but Quebec firms allocate less money to research centers.

**Result 7:** Among companies that have collaborated with industries from 2008 to 2010, most of them believe that better alignment between university and industry is useful for the future of collaborations with university. Also, most of the companies which have not collaborated with universities during these three years believe that greater awareness of collaboration opportunities would be effective.

**Result 8:** A third of the surveyed Quebec companies claim that they have no specific challenges with universities for collaboration while their Canadian peers claim less than this amount. The common challenges from the respondents’ vision are respectively:

- Lack of proper understanding of universities toward business situations
- Bureaucratic paperwork
- Lack of sufficient in-house resources to do collaboration
- Difficulty agreeing on the intellectual property aspects
- Cultural differences
- Difficulty respecting budgets

**Result 9:** When university-industry collaboration includes innovation, the challenges are more prominent.

- 9% of Quebec companies and 17% of companies in other places in Canada have expressed that they had problems with comprehending legal rules of intellectual property.
- 3% of Quebec companies and 11% of companies in other places in Canada did not respect the specified budget for collaboration.
- 24% of Quebec companies and 11% of companies in other places in Canada have seen cultural differences between themselves and their partners.

In this chapter, we have investigated the roles of universities, companies and governments in developing university-industry collaboration. In fact, this chapter has attempted to
recognize and present the activities and practices that will be considered in our general university-industry collaboration framework presented in next chapter.
Chapter 4. General framework and procedure

In this chapter, a general framework for university-industry collaboration is developed and then a step by step procedure for open innovation implementation in a company is explained. An investigation is also conducted to link open innovation and university-industry collaboration. According to the previous chapter, different activities are performed in order to develop collaborations between academic centers and industrial centers. In this chapter, the proposed framework mostly uses the practices of companies which have been considered in chapter 3 as well as the ones described in a study conducted in the UK in 2002 for managing university-industry collaborations (Barnes et al., 2002). The steps of this chapter are indicated by colored parts in figure 4-1.

![Diagram showing methodology structure]

**Figure 4-1**: Methodology structure
4.1 General framework for university-industry collaboration

As mentioned above, many activities have to be done in companies and universities in order to develop beneficial university-industry collaboration. As a result, creating a framework for facilitating collaboration establishment may be useful. Barnes et al. (2002) studied six case studies of university-industry collaboration in the United Kingdom. Based on their observations, they developed a framework that includes the main practices to implement for establishing university-industry collaboration. Using Barnes et al.’s model as well as best practices for university-industry collaboration that MIT has developed in 2010 (Pertuze et al., 2010), we propose a new framework for university-industry collaboration (figure 3-3). It starts by the selection of the partners based on evaluation factors. The next step is managing university-industry collaboration involving universal factors. If these steps perform well, following some success factors, it leads to mutual outcomes which are divided into technology and knowledge transfer.

1- Selecting partners based on evaluation factors

The company as well as the university should select the partner carefully, based on some specified criteria as the ones shown in figure 3-3. The right choice is important because even if the parties are champions in their field, without perfect matching the collaboration may fail. All of these factors could be considered by companies when they are looking for the partners but based on different projects, some of them will become more important. According to main challenges of universities for collaboration (lack of understanding, different cultures and conflicts in sharing information) mutual understanding, compatibility culture, and collaborative experiences could be the most important ones.

2- Managing university-industry relationships

This step concerns the management of the relationship between companies and universities. All the parties’ goals and responsibilities should be defined clearly. The importance of it in collaborative projects is that partners usually have different perspectives and therefore they may get into unreal expectations. In a successful management of collaboration, project planning and monitoring of process implementation should not be
done by either university or industrial partners. It should involve joint project planning. A continuous communication must be established to overcome the lack of common language and mutual articulation. Frequent meetings also help in solving intellectual property rights issues while educating universities and companies regarding their culture. Interaction between academia and industry continues with exchanging people and knowledge such as graduate students and postdoctoral fellows from universities to firms (Schartinger, 2002). Supporting the project until it can be exploited even after finishing the project is also very important.

3- **Universal success factors**

These steps would not succeed without four key factors: mutual trust, flexibility, commitment, and continuity.

- Trust needs time and repeated collaborations for being developed among partners. It is unreal to expect companies setting trust over a short time. Therefore it is better for companies to collaborate with new partners in smaller projects in order to achieve mutual trust and develop it step by step. Failure in small projects has also less risk. As a result, prior experience of collaboration is an essential factor for prosperous university-industry collaboration.

- Beside trust, commitment is another universal factor for successful collaboration. “Commitment infers dedication to a course of action and exposure to a certain degree of risk in doing so, and is therefore a key factor in collaboration success.” (Barnes, 2002).

- Flexibility, another universal factor, may be defined as “the ability of a system to perform proactive and reactive adaptations of its configuration in order to cope with internal and external uncertainties.” (Winkler, 2008). Flexibility improves partner’s ability to react the needs and requirements of the organization in collaboration. There are not a set of specified rules and ways in collaboration, so flexibility is important for firms that want to survive in dynamic environments where uncertainty is high. As mentioned previously, collaboration requires the development of relationships between partners. Trust and commitment between partners develop the close relationships and as
a result, help to maximize the flexibility of them. Indeed, close relationship cause to more willingness in sharing information with partners (Hadaya & Cassivi, 2007).

- Lack of continuity of the personnel in companies for collaborative research projects might be disruptive. Partners could see the change as a lack of commitment or an inability to choose qualified staff from the beginning. Accuracy in the selection of the personnel as well as support and reward till the end of the project is therefore essential.

4- Outcomes

All the outcomes of university-industry collaboration are usually groups into two categories: technology transfer and knowledge transfer. It can therefore take multiple forms such as patents, publications, software, etc. (see the section on knowledge and technology transfer for more information).
Because even more companies work with universities for being more competitive, it becomes interesting to try to link this concept with hot topics such as open innovation. In the next sections, the process for implementing open innovation system in firms will be analyzed. After that, the collaboration with university, as a kind of external resources, will be discussed.

4.2 Open innovation implementation

During the recent years, many companies have decided to introduce open innovation philosophy progressively for improving ideas generation and developing unique products and services. There is however still a need to define open innovation systems more clearly, as well as their advantages and disadvantages, so as to encourage more organizations in focusing on this new way of doing business. In fact, an organization should know why they want to use open innovation and how their organizational chart will change with open innovation. Furthermore, they need a roadmap for implementing it.

In this section, we propose a structure that involves different steps for open innovation implementation in a company. These steps can be modified, or even remove, depending on companies’ context and situation but the process is in general like shown in figure 3-4.
All these steps are explained as follows:

**Step 1: Cultural adaptation.** It means that mindset and skills of people involved in the process are important to implement the open innovation strategy. In particular, according to Lindegaard (2010), it involves:

- People who can manage communication and relationships with other partners based on open communication. Flexible people who have some social skills are required.
- Accepting that all the employees are not necessary perfect, so it is important to rather help them in focusing on their capabilities. It also means using people outside the company too. In fact, the company should use the best of both internal and external competencies while trying to establish equilibrium between them.
• Employees that learn that failing in one part of innovation could be an opportunity to get experience. In fact, they should not be disappointed too soon and quit the system. In addition, the responsibilities and behaviour of managers are important for encountering with open innovation and other projects.

• Willingness to help employees to create knowledge and to learn how an idea turns into innovative products and services.

• Willingness to take more risks because in open innovation systems, everything is not pre-determined.

• Accepting that companies do not need to make everything by themselves because they can buy other’s IP and also profit from other’s use of their technology and knowledge.

• Understanding that trust atmosphere is necessary because open innovation needs open communication where IP rights, knowledge, and technology are exchanging in it.

• Having capacity of not being first all the time. Making good structure for company is better than being first at market.

Culture of networking is also a necessary part of the company philosophy for developing innovation. Even though the company works in the global market and does not use open innovation model, the networking ability can be very useful. More specifically, since recent technologies and required knowledge are complex, internal people of the company cannot achieve it lonely even if they are talented.

Ibarra & Hunter (2007) identify three kinds of networking (table 3-4):

1) **Operational networking:** This network involves all the actors who have an impact on the project in the company. The purpose of this network is cooperation between people that must come to know each other and trust each other while satisfying immediate requests (Oprica, 2012).
2) **Personal networking:** The personal network is developed outside companies. It is a network for personal improvement by finding opportunities. It is useful for companies too for facilitating access to new information.

3) **Strategic networking:** This network helps in discovering and investigating new opportunities to achieve company’s goals.

There are some tips for maximizing the effectiveness of each network (Lindegaard, 2010):

- Not networking everybody and joining a group with clear purposes.
- Searching before networking about what you want to meet.
- Having answers about how helping others and letting them to know how they can help.
- Teaming up with complementary skills. Some people are good speakers, some good in writing and others are great with people.
Table 4-1: Comparison of operational, personal and strategic network

<table>
<thead>
<tr>
<th>Position</th>
<th>Operational</th>
<th>Personal</th>
<th>Strategic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose</td>
<td>Doing tasks efficiently, maintaining the capability of the group</td>
<td>Upgrading personal advancement, getting useful references and contacts</td>
<td>Discovering future priorities and challenges, attracting supporters for them</td>
</tr>
<tr>
<td>Localization and temporal</td>
<td>The contacts are mainly internal, in direct connection with company and in</td>
<td>The contacts are mainly external, and in towards the fulfillment of some</td>
<td>The contacts are both internal and external and in towards the future.</td>
</tr>
<tr>
<td>orientation</td>
<td>towards current requests.</td>
<td>current personal concerns, or potential interests in future.</td>
<td></td>
</tr>
<tr>
<td>Players and recruitment</td>
<td>The contacts mainly are limited and they are defined by their tasks and</td>
<td>The contacts are generally unlimited, the relevant contacts are not</td>
<td>Key contacts limited to strategic context and the organizational</td>
</tr>
<tr>
<td></td>
<td>structural organization. The relevant contacts are clear.</td>
<td>always clear.</td>
<td>environment, but particular membership is unlimited and the relevant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>contacts are not clear always.</td>
</tr>
<tr>
<td>Network attributes and key</td>
<td>Building very close working relationships</td>
<td>Built on ability of contacts who can make transfers</td>
<td>Linking between inside and outside relationship</td>
</tr>
<tr>
<td>behaviours</td>
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Step 2: Defining company’s competencies and requirement. This is important to know which authority to give to innovation team and which resources are available for them. It is also necessary to define company’s capabilities (Stark, 2011).

The capabilities of a company can be categorized into three types (Pontiskoski & Asakowa, 2009):
1. Core capabilities
2. Critical capabilities
3. Contextual capabilities

Core capabilities are the excellence and distinctive activities of the company, compared with other rivals. These capabilities should be kept in house as far as possible. Critical capabilities have completion role for success and can be shared with selective partners, while contextual capabilities are necessary for innovation, but there is abundance of them in the company and markets.

Having this information makes it easier to be honest about where the company does not have proficiency, and therefore where it can benefit from external innovation. From selecting ideas that should be coordinated with company’s capabilities till external collaboration in all levels, all depend on these capabilities. All the senior managers, innovation leaders, and also common employees should participate in preparing a list of company’s requirements. They have to create a prioritized list of needs as a start for the next steps. Idea generation can be oriented toward company’s requirements (Stark, 2011).

**Step 3: Gathering ideas.** In an open innovation system, companies gather ideas from inside and outside the organization. They should provide an open situation for employees to express their ideas. If employees find managers determined and strong in implementation of open innovation and also enthusiastic to gather ideas, they will be eager to participate (Lindegaard, 2010). The company can also encourage customers and suppliers to express their opinion and comments about products and services, and prepare required conditions to support it, like toll-free telephone and website (Innovation Point & Idea Crossing, 2006). The continuousness of this participation depends on how they can see the company taking cares of their opinion and even feel the changes in products and services based on their ideas.

The challenge of idea generation concerns the generation of qualitative ideas that will potentially have a positive impact for the company (Innovation Point & Idea Crossing, 2006). The essential point is that having lots of ideas is not a success factor of innovation.
If the company gets many ideas into its system without having enough time and resources to work through all of them, it may cause some disappointments.

**Step 4: Screening ideas and selecting a few of them.** After gathering ideas with external collaborations, screening ideas is necessary to reach a few ideas among all of the ones collected. Idea competition may happen between participants, but there are some points for this competition that must be specified (Innovation Point & Idea Crossing, 2006). At first, some default rules and determined structures are necessary for considering ideas. It is next important to go through the ideas so participants will feel they have a role in the process. Criteria should therefore be defined to evaluate and prioritize ideas, and the results of the ranking should be clearly communicated. In fact, responding to participants avoid discourage (Lindegaard, 2010). These criteria need to be based on company’s requirements and competencies.

As mentioned earlier, getting lots of ideas may seem good at first but after some time, the result is that there are not enough resources to go through all of them. Lindegaard (2010) specifies that there are usually two approaches: A team with perfect people and an average idea and a great idea with ordinary people. If a company wants to be innovative in each of its business activities, people should be prioritized rather than ideas. So focusing on ideas more than enough is not useful. Pontiskoski & Asakowa (2009) mentioned that innovation and new products development usually fail because of poor implementation, not poor ideas.

**Step 5: Develop Intellectual Property strategy.** Intellectual Property of a company requires to be modified for using open innovation. It means developing an open communication and collaboration strategy for enabling companies to collaborate with external resources. The concepts of open innovation and Intellectual Property Right (IPR) may seem contradictory at first. Open innovation implies a willingness to exchange knowledge and technology with external resources whereas IPR implies a protection to exclude others from using inventions and knowledge (Hall, 2010).

Ming (2010) has explained how IP can be profitable in different ways as follows:
**IP licensing and transfer:** IP licensing is a way to gain maximum profit. “*It is the permission for others to use the IPR under certain conditions in premise of the holder retains the proprietary of IP.*” The most common kind of IP licensing is patent licensing for solving the patent crossing problems between firms. So the company sells its patent to other companies instead of keeping it for itself. P&G and IBM are examples of company that both benefit from selling their patent.

**IP alliance:** “*IP alliance mainly refers to patent alliance or patent pool in the process of technical innovation. It forms with related patents for the common interests among enterprises.*” For example, one time Apple abstained from cooperating with other companies based on IP alliance because of its technological excellence. At the same time, IBM entered into partnerships with Microsoft and Intel. Finally, because of this collaborating, IBM went over Apple and succeeded in competitive market.

**IP cooperative R&D:** To create new IP, a company can develop collaboration projects with other companies or universities. For example, Japan established university-industry-government collaboration system. Universities, firms and institutes use this system in order to share their IP resources and complement each other.

**IP for free:** Some patents may be not exclusive and partners might disagree about patent issues, so they can put their patent in a common pool, grant them to an independent association or change them to unlimited license that anybody would be able to use.

In open innovation, the effective IP management is essential because in addition to finding useful external knowledge, the way for capturing the value of IPs is crucial. Ming (2010) has suggested three steps for presenting transferred knowledge and technology to the market: technology import, R&D and commercialization.

**Technology import:** In technology import stage, search and evaluation is important to get full information on patent, avoiding working on similar parts and
achieving results that have been done before, causing wastes of time and IP disputes.

**R&D:** In R&D stage, companies use knowledge in the previous stage to create new technologies independently or with collaboration. Before launching any technology in the market, patents should be controlled and protected. There are different protection methods which have various intensity and effect based on characteristics of the new technology, the industry, and the economic capacity of the company.

**Commercialization:** In commercialization stage, new technologies are diffused outside the organization valuably. In order to have effective IP management, internal and external IP contract management should be considered. In internal IP contract management, the technological achievement flows through the company. Guiding employees in understanding what is forbidden to divulge and what is not, training them to update their knowledge are examples of tasks that could be helpful. External IP contract management involves technology diffusion to the market and authorization for using it.

**Step 6: Collaborating with external resources.** In the next step, when the company decides to collaborate with external resources, it should begin by finding the best partners for the specified projects (Stark, 2011). According to Gassmann & Enkel (2004), based on an empirical study of 124 companies, two core open innovation processes can be put into practice. They are not quiet exclusive and companies are able to use a combination of them according to their situation and requirements. These are:

- **The outside-in process:** Improving a company’s own knowledge base through the integration of suppliers, customers, and external knowledge sourcing, buying intellectual properties and patents.

- **The inside-out process:** Externalizing the company’s knowledge and ideas in different markets, selling intellectual properties and multiplying technology by transferring ideas to other companies.
As mentioned before, collaborating with some external resources like customers, suppliers or intermediaries may occur in the previous steps. But collaborating with other resources like universities, laboratories, scientific institutions, SMEs, etc., in order to work on specific projects may happen after the first steps. However, collaboration with some partners like universities sometimes starts from generating ideas (as explained in U-I collaboration in previous parts). So there is not a clear arrangement for the starting point of collaboration with external partners.

**Step 7: Creating knowledge base.** Creating knowledge base usually happens after the first year of using open innovation in a company because it is a long-term process. This knowledge base can be used to survey which practices are the best ones, see the progress of open innovation, and access the stats and results of previous projects. The company can also request from people who have been succeed in their projects to train others. So this step can help in ensuring durability of the open innovation system.

**Step 8: Accountability.** This is a key aspect of a program since this is satisfying and pleasant for employees when others know about their capabilities and success. In other words, declaring and highlighting the results of successful projects to the world encourage employees to believe in. “Open innovation does not entail the creation of a massive business concept. Instead, it is the transformation of an internal culture, and the development of a process to encourage and promote innovation from every available source.”(Stark, 2011)

### 4.3 Linking between open innovation and university-industry collaboration

As explained earlier, new competencies could not be achieved from internal resources, but take the advantage of external resources’ skills. In particular, the open innovation approach involves universities and public research institutes as external resources. They perform basic research with high risk that private firms cannot (Saito, 2010). Therefore, universities are considered as key actors to drive and raise knowledge and technology transfer. As a result, while open innovation literature has traditionally concentrated on knowledge and ideas flowing from one firm to another, universities can also be a useful
source for knowledge and technology transfer, without being limited to the transfer of intellectual property (Padilla-Melendez & Garrido-Moreno, 2012). In fact, there are different motivations for universities and companies to collaborate in an open innovation system. Accessing new technologies, accessing additional competencies, finding new ideas, reducing product development time to market, reducing cost, and sharing risk are some examples of the main motivations of companies. Commercializing new technologies, accessing empirical data, selling patents and finding financial support are illustrations of the main motivations for universities.

Perkman & Walsh (2007) have defined university-industry links in seven ways which are:

- **Research partnership:** performing collaborative R&D activities between organizations;
- **Research services:** contract research, consulting, financing of university research by firms;
- **Human resource transfer:** graduate requirement by industry, training industry employees, internships and learning in the industry;
- **Academic entrepreneurship:** development and commercial exploitation of technological inventions of a university through a company;
- **Commercialization of property rights:** transferring of university-oriented IP like patents and licensing to the industry;
- **Informal interaction:** social relationship, networking, conferences, etc;
- **Scientific publications:** joint publications like articles in journals.

Different levels of interaction may exist between industry and academics in research partnership and research services. While academic entrepreneurship and human resource transfer are related to a medium level of relational involvement, commercialization of property rights needs less relationship intensity. Scientific publication and informal interaction, depending on the situation, can accompany all forms. In high relational links, individuals and teams from academic and industry work together on specific projects to
achieve common outputs. In context of open innovation, inter-organizational relationships play an essential role in driving innovation processes. All the links between university and industry and their relationship intensity are shown in figure 3-5.

Figure 4-3: University-industry linkage (Adapted from Perkman & Walsh, 2007)

Nevertheless, this type of collaboration may sometimes be difficult to implement. In 2009, the Conseil de la science et de la technologie du Québec (CST) presented some recommendations to Quebec government in order to conduct innovative performances towards open innovation practices. Recommendations showed that in many innovative firms, managers prefer temporary collaboration and are not necessarily willing for sharing IP rights. Moreover, most of the business managers do not have adequate knowledge about IP management and their requirement to improve their competencies, which is a main obstacle of open innovation (Deschamps et al., 2013). Companies also believe that
universities are slow when they come to collaborate with industry. The use of intermediaries can therefore be a good way to face these barriers and facilitate the establishment of this type of partnership.

Intermediaries are some organizations which stand between a company and external resources. As mentioned earlier, in an open innovation dynamic, companies get the required skills from inside and outside of their firms. These ways are placed in opposite sides but are not exclusive. Companies use the combination of them according to their situation and requirements. In the first way, companies focus on improving and creating capabilities for open innovation inside the company. As a result, companies can be the owner of knowledge and efficiently use skills of people who work for them. Intermediaries can form a part of internal capabilities by long-term collaborations with other companies. In the second way, companies use external sources to develop their capabilities. Intermediaries help companies to gather determined information, selecting suitable partners, finding solutions for technical problems, etc. The basic role of intermediaries is providing required information about potential partners and opportunities for meeting in order to facilitate collaboration and coordinate joint research projects as well as other collaboration activities. Intermediary organizations also reduce search and bargaining costs (Kodama, 2008).

According to Kodama (2008), the main activities of an intermediary organization between universities and industries should be:

- Information networking between university researchers and company members by setting up for example a database of new technologies or research activities;
- Supporting R&D activities of firms by coordinating regional R&D approaches with universities or other firms and joint research between universities and companies;
- Supporting firms to recruit human resources through collaboration with universities;
- Providing opportunities for firm members to use laboratory equipment of universities and other public research institutions;
• Organizing meeting with members located near each other.

4.4 University-Industry collaboration models in open innovation systems

We have presented a step-by-step methodology for open innovation as well as the links that can be established between universities and companies. Nevertheless, the border of openness is a challenge for each organization that uses open innovation systems. Generally the degree of openness depends on some factors like the importance of the technology, the strategy of the firm, characteristic of the industry, etc. Barrett et al. (2011) presented different collaborative models classified in this way:

Ad hoc model: In an ad hoc model, the company connects to external partners for a certain project. This connection is a bilateral relationship between focal firm and other parties but in this model, other external partners do not collaborate with each other. In general, the control is concentrated on the central firm. This control is contractual and there is no specified platform for this collaboration (figure 3-6).

Figure 4-4: Ad hoc model

Hub and spoke model: The difference between hub and spoke model with ad hoc model is a closed platform which is defined in this model. A closed platform is a specified framework for collaboration which is dedicated to the focal firm. The standards are determined by the focal firm (figure 3-7).
Network model: In this model, interaction between all partners is possible but still with closed platform which is dedicated to the focal firm. The control of collaboration is also applied by the focal firm (figure 3-8).

Open platform model: In this model, all the partners interact with each other and there is an open innovation platform which is shared among all the participants. In the open platform model, there is no centralized control: the control is rather distributed among all of them (figure 3-9).
There is another clarification for collaboration, which is presented by Pisano and Verganti (2008). It encompasses four collaborative models:

**Closed-hierarchical:** In this model, the focal company selects the participants for collaboration and decides about new ideas. It means that the control is in the focal company’s hand. Home-products Alessi Design Company uses closed-hierarchical mode. It determines its participants in its network and also decides about the way products will be developed.

**Closed-flat:** The partners are still selected by the focal company but the participants make decisions together. They share information, costs, risk, and intellectual property. IBM uses closed-flat mode by selecting partners to collaborate with in its *microelectronics Joint Development Alliance* for developing semiconductor products. Each participant has its own role in product development.

**Open-hierarchical:** There is no selection for participants by the focal firm, but the company surveys all the partners’ ideas and solutions for problems and has the control on final decisions. InnoCentive.com is an example of open-hierarchical mode where anyone can suggest solutions for scientific problems of sponsor companies.

**Open-flat:** In this model, there is no limitation for bringing up ideas by anyone and none of the participants has priority over decisions. For example, Linux Software Company uses open-flat mode. Anyone can participate in the innovation processes and bring up any code they guess is useful.

There is some specification for each option. From the open dimension, the company collaborates with other partners without limitation but from the close dimension, the company gets ideas and solutions from the selected partners. Also from the hierarchical dimension, control and decisions are made by the focal company but from the flat dimension, none of the participants have authority over decisions and they share all the benefits and costs.
Another study conducted by Meles et al. (2009) has analysed relationships between companies and academic researchers based on interviews. The authors then extracted different collaboration models from it, as shown in table 3-5.

**Table 4-2**: Main models for university-industry partnerships proposed by Meles et al. (2009)

<table>
<thead>
<tr>
<th>Collaboration models</th>
<th>Description</th>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>One company and one university</td>
<td>A company and a university collaborate on a research project.</td>
<td>More concentration on an existing relationship. This agreement paves the conditions of new collaboration.</td>
<td>A company limits to knowledge and expertise of a single university.</td>
</tr>
<tr>
<td>One company and several universities (consortium)</td>
<td>A company collaborates with several universities which work on a specific project. These universities have interaction with each other.</td>
<td>Universities share their knowledge.</td>
<td>It might be a limitation for universities to collaborate just with one company.</td>
</tr>
<tr>
<td>One company and several universities without interaction between universities</td>
<td>A company collaborates with several universities for a specified project but these universities do not have interaction with each other.</td>
<td>A company exploits multiple participants to solve its problems.</td>
<td>University researchers with cutting their academic connections, lose a major source of information.</td>
</tr>
<tr>
<td>One university and several companies</td>
<td>More than one company collaborate with a university</td>
<td>Each company has access to researchers of university and university receives funding to focus on its research in a specific area</td>
<td>Companies ask researchers to keep information of each project proprietary.</td>
</tr>
</tbody>
</table>
As we can see, universities and companies can choose to collaborate in an open innovation system based on different forms to achieve some goals while taking into account their own reality. If they are willing to work together intensively and to open their borders to external partners, ideas and knowledge may emerge. On the other hand, the relationship usually becomes more complex to manage. The next chapter will explain how two key centers of knowledge in the forest sector already use some of these models and how they could go further in exploiting open innovation philosophy.

4.5 Performance measurement for industry-university collaboration in an open innovation environment

When companies and universities work together, sharing ideas and resources, the outcomes can be significant. However, to keep each partner motivated while convince others to participate, it becomes important to measure the profitability of the relationship. In the literature, two key elements have been proposed for reflecting the usefulness of industry-university collaborations: knowledge transfer and technology transfer. They may seem similar but Van Horne et al. (2012) believe that there is a difference between these two concepts. While knowledge transfer can happen without technology transfer, no technology can be transferred without knowledge transfer. A tool or an object transfers both a technology innovation and knowledge related to some theories, techniques and principles.

Etzkowitz (1998) defined technology transfer, as a source of knowledge, from university to companies, in two forms:

- the made products in the universities deliver to the companies in order to develop and commercialize the products;
- the industrial products which are produced outside the universities and deliver to the universities in order to improve the products.

Universities and firms use different types of knowledge interactions which have effect on intensity and direction of knowledge flow and on personal relations. D’Este and Patel (2007) have explained that among the different kinds of knowledge transfer, joint research
projects are the ones that provide the best access to facilities and skills. Schartinger et al. (2002) identified four categories of knowledge exchange:

- Joint research (joint publishing);
- Contract research (consulting, financial support of university researchers by firms);
- Personal mobility (movement of people between universities and companies);
- Training (training of industry staff, co-operation in education)

Identification and measurement of created knowledge as intangible activities are difficult. One approach for confronting with these difficulties is focusing on more explicit aspects of measuring, such as citation of university publication or licensing of patents. Another approach is determining what type of interaction is used between university and industry to exchange knowledge and asking researchers about the signification of these types. By using indicators some aspects of knowledge interactions can also be identified.

Some measurable variables that can be used to assess knowledge interaction are percentage of sharing information between an industrial center and the university, the total number of contracts for research projects, the total number of joint R&D projects and joint publications (joint research), the total number of researcher mobility, research assistant financing and joint supervision of Ph.D. and Master thesis, the total number of lectures by firm members, training courses for firm members, etc.

Furthermore, many universities in the world have launched their Technology Transfer Offices (TTOs) in order to facilitate transfer knowledge and technology to the industry. According to Bezić et al. (2011), transferring technology happens during four steps.

- At first, a TTO should encourage people in a university to express their inventions and research results.
- Afterwards, a TTO should consider these claims and decide to whether give a patent to the invention and undertaking the protection of it.
• In the next step, TTOs can help companies who are seeking for new technologies to commercialize.

• At last, companies and universities negotiate about licensing agreements in order to transfer knowledge from a university to a company.

TTOs should recruit people with marketing skills and business expertise in patent and licensing IP rights because those resources can attract companies and create more linkages with them. Giving rewards to TTOs for “making deals” could be a motivation for them to work more on university behalf.

In the next section, we will use the idea of measuring both technology and knowledge transfer to evaluate the intensity of the relationship between universities and companies.
Chapter 5. Comparison

In this section, the value network of the forest products industry is described, as well as the challenges currently faced by forest products companies. In this regard, VCO network and Forac consortium, two research centers within Canada dedicated to the development of models and methods for the forest sector have been chosen as real case studies for analyzing university-industry collaborations. The proposed university-industry framework and the open innovation structure are therefore next compared to the way of doing of these centers of knowledge. Moreover, the data collected considering university-industry collaborative projects in VCO network are analyzed to evaluate the outcomes obtained from this type of relationships. Some recommendations are then proposed based on best practices in the literature and the frameworks developed during the research.

5.1 The Wood Fibre Value Network

The forest industry is one of the main industries in Canada which supports about 5.3% of Canada’s employment, Canada being the world’s largest exporter of forest products. Several operations are involved in the production of wood products: harvesting, sawmilling, pulp and paper, lumber, panel and energy production, transportation, etc. As a result, many firms have to work together in the form of a network to create economic value, involving the use of coordination mechanisms so products may be available on time, the price and the inventory of products can be optimized, etc. (figure 4-1) (Lehoux et al., 2012).
In particular, the network includes four main supply chains, the forest; the pulp and paper, the lumber, panel and engineered wood and the energy. Because the forest supply chain is the starting point for all the following operations, it can effect on profitability of other chains. Efficient planning is therefore very essential for this chain. In the same way, many operations are needed to produce pulp and paper. It encompasses several locations where chips are produced, transported and used to produce pulp and then paper. In the lumber, panel and engineered wood supply chain, depending on the species used in the process, operations may vary. We usually distinguish softwood sawmills and hardwood sawmills, that will lead to many different intermediate and final products. The last chain involves using wood biomass to produce energy.

Therefore, because all the activities are related, several actors will have to interact with each other at different levels. Furthermore, in the past years, forest products have faced many difficulties, as highlighted by Benoit (2008). Since 2003, many plants such as pulp
mills, paper mills, saw mills, etc. have closed and many jobs have been lost. The type of jobs lost varies from province to province. Plant closures and job losses had hard effects on the economy and many communities that depend on the forest industry now face an uncertain future. The U.S. residential construction sector has been the main market for Canadian softwood producers for a long time. Slowdown in the U.S. housing market has reduced demands for materials which are produced from wood such as lumber and wood panels. As a result, Canada’s wood exports to the U.S have declined. Chinese producers of wood products, as competitors from abroad, have intensified this decline. Canada has been a main producer of newsprint for a long time. Collapsing North American demand for newsprint is putting huge pressure on Canadian producers. In fact, they have difficulties to compete against low-cost producers in Asia and South America and, as a result, they are being ejected of this market. The rapid appreciation of the Canadian currency damaged the prosperity of Canadian forest companies since most forest products are priced in U.S. dollars, whereas primary inputs (fibre, labour, energy) are priced in Canadian dollars. Furthermore under investing in research and development, new technologies, new mills and equipment for a long time is one the main troubles of the Canada forest industry. During the previous decade, many Canadian forest companies used Canadian dollar as their essential competitive advantage and neglected investments to improve their efficiency and reinforce their international competitiveness. Fibre costs vary from region to region across Canada. In British Colombia, wood costs are more competitive because of the major but passing increase in harvest volumes. By contrast, in Eastern provinces, fibre costs are considered high by international standards. The cost for transporting wood as well as the cost of the energy required for processing represents a significant part of total production costs for the Canadian forest products industry. The largest industrial energy user in Canada is the pulp and paper sector. This sector generates some of its own energy needs from renewable sources but it has been harmed from expensive fossil fuels and industrial electricity.

Universities could help forest products companies in better reacting to these challenges. This is why some centers of expertise have been created to develop the tools and methods needed for ensuring the competitiveness of the industry. Forac consortium and VCO
network are examples of research centers that, based on university-industry collaboration, try to develop methods, tools and strategies for Canada’s forest products companies. They work on many collaboration projects among academics, government and industry. They are thus appropriate case studies for comparison to our methodology. In order to document university-industry collaboration’s mechanism used in these centers, interviews have been done and are explained in the next parts.

5.2 Forac consortium context

Forac consortium is a strong partnership between Laval University, businesses and governments. In order to improve the Quebec’s forest products industry, the consortium develops new models, techniques, and technologies for management of the forest products supply chain. This organization has some objectives which are:

- training qualified personnel in the fields of the engineering business and supply chain management;
- studying and developing new technologies for decision support for the supply chain management;
- contributing to the advancement of companies in the forest products industry;
- sharing research results with industry, governments and the scientific community.

In order to understand the dynamic of the center and validate the potential for this university-industry collaboration, we have conducted face-to-face interviews with two key experts: a manager from the industry (Maibec) and a director from the direction of the center. They were selected because of their knowledge, their proximity and their willingness to participate to the study.

5.2.1 Interview 1

Among all Forac’s company partners, we have chosen Maibec as a representative of the industry part. The company has a long experience of collaborations with universities in different projects such as projects related to lumber production and marketing. As a result,
it was a good reference for interview. In particular, the interview was conducted in collaboration with Francois D’Amours who is working in the company as a marketing director. It took about one hour and the routine of interview was answering and discussion about following five key questions:

1. What are their motivations and benefits for collaboration with universities and intermediary organizations?
2. What are their challenges for collaboration?
3. When do they prefer to collaborate with universities or intermediaries instead of working in their R&D part?
4. What is the level of company satisfaction from collaboration and what is their future planning for collaboration?

The results collected can be summarized as follows:

Motivation

In some specific projects, employers work on topics which need specified expertise. For this context, the company prefers to collaborate with academics instead of hiring new employees for these projects. Moreover people who are working in companies try to devolve some of their works to the universities. It is a motivation for Maibec Company to collaborate with universities.

Benefits

The most important benefit of collaboration for Maibec is knowledge transfer. They believe that academic solutions are not practical and useful most of the time but the prototypes, ideas, and guidelines that universities provide help them in better knowing what they should do or not do in the future.
Challenges

The most important challenge for Maibec is that university and industry are not on the same pace and synchronizing everything is difficult. In competitive market, the speed for answering customers’ demands is very important. Nevertheless, because of students’ exam or other situations, the universities cannot put all of their time and energy on the research project. As a result, the company would like to access results quicker than what researchers would expect. It does not mean that the company is always waiting for research’ results, sometimes it is the opposite. Researchers are ready to share the results but the company is not, having other priorities in short time. Maibec believes that regular meetings and communication may help in keeping everyone informed about the work progress. But having a clear timeline and agenda for meetings is a challenge too. Sometimes, because of intend problems and lack of coordination, the meeting is not useful for parties. For instance, PHD students who work on the specified project and are close to end of their study can have delay.

Preference

Maibec prefers to collaborate with universities in long-term projects and working in-house in short-term projects. In order to access high level ideas in different projects and topics, collaboration with universities is the best options. But when requiring a quick answer to a specific question, referring to R&D part or intermediary organization is better. They believe that an intermediary organization has a real view about company situation and it is quick to submit a proposal. The company expects specific and quick answers from an intermediary organization in compare with a university.

Satisfaction

Maibec’s satisfaction from collaboration experiences depends on researchers and individuals, not only the research center they have been dealing with. The records of academia in collaboration affect the company for choosing in the future. Maibec does not use formal indicators for choosing research centers and researchers, but one of the most
important things for them is how universities are quick in solving the problems and finding solutions.

5.2.2 Interview 2

Another interview was conducted with Luc LeBel, professor in the Department of Wood Science and Forestry at Laval University and director of Forac. He is one of the best references who are informed of Forac consortium and Laval University and he explained both points of view during the meeting. The interview was conducted in Professor Lebel’s office in Wood Science and Forestry Department at Laval University. The interview took more than one hour and it was based on the following questions:

1. What are the benefits and challenges of collaboration with industry?
2. What is the mechanism of collaboration and strategy of sharing and accessing information?
3. How does Forac collaborate with external resources?
4. How do they find external partners?

The results collected can be summarized as follows:

Benefit

There is a motivation to work on a project where there is a real and maybe a worldwide problem behind that. There is also an opportunity to see what should be done in order to implement solutions and innovations in a real case. By working with industry, they understand the kind of training they have to apply for their students.

Challenges

Everything is an emergency for industry and any problems should be solved soon. But it is difficult for universities because they should train people in two years for a master and more for a PHD degree.
Industry looks for short-term benefits, so it tries to communicate with universities in order to present new issues or at least main issues it is interested in. It is a challenge for universities to make industry understand that there is no quick answer for many problems.

Mechanism of collaboration and sharing information

Many professors and researchers in Forac consortium have forestry expertise and are familiar with forest problems. Furthermore, FPInnovations is a key partner in the consortium that helps Forac in making sure that they understand the problem correctly and in anticipating what must be done for transferring innovation to the industry.

All partners can access to a part of the information generated from the consortium using a database (i.e., Sharepoint), but there are some rules used to control their access. For example, when Forac comes up with a model for a specific company, other partners can use this model but not the data. If there is any software, IP or information, internal partners access them but they cannot use them for commercialization. Only Forac can commercialize these innovations out of the consortium. When Forac wants to sell an IP to an external resource out of consortium or license invents, all the companies and partners must agree too.

Collaborating with external resources

Convincing companies to share all of their information with others is difficult. Many of them are not small companies and they have lots of competitors, so they are worry to lose their position in the market. Forac believes that it is not profitable for consortium to change all the programs or partners.

Accessing to others’ ideas is a good motivation for companies to be part of the consortium. But the important thing that they really want to have is exclusivity of the results and methodology. They are ready to pay more money to omit some of their competitors from the consortium. Companies think the benefit of membership of the consortium is a chance to discuss with others and see what they do. It improves the occasion of learning, not only from the researchers, but from the best practices that they are going on. However,
industries with very high commercial potential and high strategic, like health science, do not go to consortium.

Finding external resources

Forac consortium intends to establish an observatory in order to find external resources. Observatory provides a flexible structure to attend resources that just come for a project or a contract with temporary collaboration. In the past, they just wanted to work with their partners, but now they wish to add other partners for specific projects. The mission of observatory is collecting information from many sources which are related to what Forac is doing, using and making sense of it, and then transferring it to the knowledge they can share. Observatory is a way to access to the right databases and to guide in establishing projects ideas.

5.2.3 Comparison

Based on these interviews, we understand that the researchers in Forac collaborate with industrial partners inside the Forac consortium for many projects. It means they usually do not use selecting criteria for finding partners because the partners are determined and limited in consortium. Partners know and trust each other while being committed to the group, which are key factors for profitable collaborations. The management of relationship between industry and academic is coinciding with the university-industry collaboration framework of our methodology. It leads to outcomes which are patents and IPs, scientific publications, joint research, personal mobility, etc. However, Forac has decided to find new partners for different projects by establishing an observatory in the future. It will therefore increase Forac flexibility by collaborating with external resources that could have more openness.

It seems that Forac follows up the network model inside the consortium for their collaboration (figure 4-2). All partners have interaction with each other, but under the control of focal core which is consortium. There is a closed platform because for instance, they share their information but not their data. When the consortium, as a component unit, collaborates with external resources, it follows up Hub and Spoke model (figure 4-3).
Forac collaborates with external partners and they share their information with Forac but in a closed platform. These external resources cannot share the information among themselves.

**Figure 5-2:** Network model for collaboration with internal partners in Forac consortium

**Figure 5-3:** Hub and Spoke model for collaboration with external partners in Forac consortium

Some steps of our proposed open innovation structure are getting executed in Forac, such as gathering ideas and screening them from different resources, managing intellectual properties, and creating knowledge databases. But these steps are not in the framework of open innovation implementation structure in the consortium because the partners are not familiar with it. It seems that by establishing observatory and collaborating with external
partners, the situation will be better for starting open innovation implementation. The university-industry collaboration has an essential role in implementing open innovation because the consortium is the key agent to combine industrial knowledge and academic expertise while facilitating collaboration with each other.

5.2.4 Recommendation

- Forac consortium could evolve from the Hub and Spoke model to Network model as a step to more openness but the industrial partners of the consortium, which are companies might resist against it. However, collaborating with external partners who have open collaboration experiences could help this process.

- Working on projects which need university-industry relations like research partnerships and research services would help to convince industrial partners in Forac to move towards more opening and provide situation for cultural adaptation of open innovation inside the consortium.

- Observatory could help consortium to establish useful knowledge databases for sharing information which are necessary for implementing open innovation.

5.3 VCO Initiative

Value Chain Optimization (VCO) is an initiative that has started its work under the supervision of NSERC in February 2010, in order to develop methods, tools, and strategies for Canada’s forest products value network. FPInnovations identified VCO as a key element of its Transformative Technologies Program, aiming at transferring VCO research results to industry and governments.

More specifically, this organization has some objectives, which are:

- supporting decision-makers to design optimized forest bio economy networks;

- increasing value gain from forest with adequate and efficient tools;

- improving competitiveness by having structured implementation of optimized business models;
• improving better executive networks;
• improving culture of analytical decision making in forest bio economy.

By providing analysis tools and decision support for optimizing modern forest bio economy networks while training high qualified researchers in value chain modeling, VCO aims at improving Canadian forest industry profitability.

Therefore, a phone interview was conducted with an expert from VCO to understand the collaboration mechanisms for supporting universities-companies relationships.

5.3.1 Interview 3

We conducted an interview with Jean-François Audy, the researcher and network liaison manager in Scientific Committee of VCO network. During the meeting, Jean-François explained the different collaboration projects and FPInnovation’s role in VCO network. He also provided some data for evaluating the benefit of university-industry collaborations.

The governance of the network is shared between three entities. The first one is Scientific Committee (SC) which proposes research plans and monitors the scientific program. The second one is the Steering Committee (SC) which recommends research plans and transfer plans to the Board of directors. The Board of directors is responsible for partnership, budget and research program acceptance. Besides research projects, there are some transfer projects in VCO network to give additional funding to researchers to transfer their results to the partners in industry, government and FPInnovations. The primary proposals should identify how the research team and the company will work together to ensure that the knowledge and technology will be transferred. It must identify the research results to transfer, the benefit for each partner and how each one will exploit the results within a reasonable time frame. These applications are evaluated by the VCO Network Steering committee. As a result, in VCO Network, research phase of a project and transfer phase are sometimes not together.

In the VCO network, different collaboration projects involving the industry, governments, and universities are conducted, with different levels of interaction between partners in each
An intermediary is also used to facilitate communication and knowledge transfer between universities and companies. In particular, FPInnovations is a private, non-profit forest industry research center that helps the Canadian forest industry in developing innovative products based on Canada’s forest attributes. FPInnovations is informed from industry’s point of view and so in steering committee, it tries to modify projects with partners’ agreement. FPInnovations helps VCO to gather determined information, select suitable partners, and manage the relationship with industry partners by organizing for example meetings with members located near each other. FPInnovations also collaborates with universities in VCO as a partner rather than as an intermediary organization.

5.3.2 Analysis of the VCO network as university-industry collaboration

In this part, we purpose to measure the outcomes of university-industry collaboration in VCO Network. In particular, we use the number of knowledge and technology transfer outcomes as a performance indicator based on:

- Case studies in collaboration with partners;
- Analytical tools developed;
- Discussion on research works held;
- Data and information in input of the research work provided.

Based on the data which has been mainly collected from students’ progress reports (each VCO-funded student has to fill up this kind of report each semester), exchange with the research team, and also by indirectly means, e.g. partner name on the scientific poster of a student that triggers aforementioned exchange from 2011 to 2013, 23 collaboration projects have been performed: 4 of them are collaboration between industry, university and FPInnovations; 9 projects are collaboration between industry and university; 8 projects are collaboration between FPInnovations and university, and 2 projects involve government and university. In just 17% of the projects, there are more than two participants. It shows that partners prefer to collaborate with one organization in a specific project. The participation of government as a partner in projects is less than 1%. FPInnovations has participated in almost 52% of the projects but it has operated as an intermediary
organization just in 15% of the projects (projects in collaboration with university, industry and FPInnovations). In almost 38% of the projects, FPInnovations collaborates with universities as a partner (figure 4-4).

Data showed that in all 23 collaborative projects, a presentation on research works as technology transfer and discussions on research works as knowledge transfer are included. Case studies and analytical tools can be found in 40% projects, while providing data and information as input of the research work is in almost 58% projects. Only one project includes an internship as knowledge transfer (figures 4-5 and 4-6).
In figure 4-7, it shows the ratio of knowledge transfer to technology transfer and vice versa. As explained before, technology transfer without transferring knowledge is not possible. There is also no project with only knowledge transfer.

In 11 projects, we can find a one to one ratio (technology transfer/knowledge transfer) while in 8 projects, there are two technology transfers against three knowledge transfers. In 4 projects, there are two technology transfers and one knowledge transfer.
Communication and meetings

If we look at the 23 projects, there are just three projects with more than 5 meetings during two years. Two of them have happened between a university, a company and FPInnovations, with 13 meetings for one and 7 meetings for another. The third project has happened between a university and a company with 8 meetings (figure 4-8).

![Number of meetings during 2 years period](image)

**Figure 5-8: Communication**

We linked the number of collaboration outcomes based on the number of meetings as shown in the figure 4-9. We have divided the area diagram into four parts:

I) Projects with less than five meetings and less than four outcomes are in area I. This area consists of 13 projects from 23 projects. 10 projects showed weak communication (one or two meetings) and low outcomes (just two).

II) Projects with less than five meetings and more than four outcomes are in area II. This area consists of 7 projects from 23 projects. Just three projects of this area showed weak communication (three or less than three meetings) and high outcomes (five outcomes).
III) Projects with more than five meetings and less than four outcomes are in area III. There is no result for this area.

IV) Projects with more than five meetings and more than four outcomes are in area IV. 3 projects from 23 projects are in this area. Just one project occurred in strong communication (13 meetings) but not very high outcomes.

Figure 5-9: The number of projects with the specified number of meetings and outcomes

Based on figure 4-10, it seems that growing the number of meetings involves growing the number of outcomes. Nevertheless, the relationship between the number of meetings and outcomes does not seem linear.
Based on these data, we can make two observations:

- If we consider meetings as a communication tool, more outcomes do not necessarily occurred by more meetings. For example, a project with 13 meetings has 6 outcomes, while another one with 8 meetings has 5 outcomes. However, there are other factors like the quality of the meetings or the use of other forms of communication that have not been taken into account and that could certainly affect the final outcomes.

- More meetings do not necessarily happen among more partners. The project with 13 meetings has happened among three partners, while the other projects with three partners have less than 5 meetings.

5.3.3 Comparison

The collaboration in VCO network focuses on university and industry relationships, but some projects also combine collaborations between government, industry, university and an intermediary (FPInnovations). The VCO university-industry collaborations match with the general framework university-industry collaboration in our methodology. It is
interesting to see that in VCO network, defining the project and determining the parties’ profits and expectations happen before starting the collaboration and maybe selecting partners by submitting proposals. Otherwise, the VCO uses criteria for selecting industrial partners from various universal factors according to different projects. Communication and interaction between industry and academic parts happens via face-to-face meetings, phone calls, video conference, social networking, summer schools, workshops, web meeting, upcoming conferences, etc. As a result, managing the relationship of universities and companies leads to technology and knowledge transfers as outcomes.

VCO is a research center where universities, government, and FPInnovations (sometimes as an intermediary) are partners, but there are no permanent industrial partners. VCO can benefit from implementing open innovation system in companies which collaborate with them because these companies are more flexible in sharing information. Comparing our open innovation structure with implementing open innovation in the VCO is not exactly possible because we have developed a step by step procedure for implementing open innovation in a company, not a university which is the main part of the VCO. Based on the VCO data, knowledge and technology transfer, except internship that is a kind of human resource transfer, are the types of research partnerships and research services provided. As it was explained in section 3.4, the research partnerships and research services are inter-organizational links with high relational involvement, which are interesting in open innovation context. The VCO collaboration projects have therefore great potential to get executed in an open innovation system.

5.3.4 Recommendations

- In the steering committee, all proposals are monitored to be adapted with academics and industry expectations, but it could benefit from more flexibility. Without enough flexibility, finding appropriate partners will be difficult. It means that when the research team faces with non-concurrence in academics’ and industry’s point of view, flexibility of partners can be useful for starting collaboration.

- Although there are financial constraints for finding industrial partners, applying some selected criteria help them in finding the best partners. Universal success
factors which are flexibility, trust, commitment, and continuity could be used by the VCO team to analyze past companies’ collaborations and facilitate their selection.

- VCO Network could hold conferences, workshops, etc., in order to improve understanding of open innovation among partners and industry. In this way, companies would be encouraged to determine their core competencies and their openness while trying to use open innovation system based on that. As it has been mentioned, the outcomes of collaboration are not just IPs and patents, which are difficult to share. Open innovation system can be used for other outcomes such as research partnerships, research services, human resource transfer, etc.

- FPInnovations should highlight its intermediary role, because sometimes, in major projects, companies prefer to collaborate with an intermediary organization instead of universities directly. They think these organizations can explain companies’ problems and situation to researchers more effectively. Also, FPInnovations can improve capabilities of industry partners for creating open innovation by collaborating with VCO network (section 3.4). In this way, VCO network can gain from implementing open innovation system in partner companies. Information networking between university researchers and company members by setting up databases of new technologies or research activities and supporting firms to recruit human resources are the other roles that FPInnovations could undertake.

- Since new technologies are not developed just internally in the open innovation system, the formation of network and its performance is important in this approach. Collaboration among universities can increase access to most advanced equipment, financial support from government and speed of knowledge gathering and innovation for academics (Tsai & Liao, 2009). Universities in VCO network can share their ideas and best practices with counterparts. The collaboration among universities could be considered as a knowledge and technology network.

Finally, we conclude that a match exists between the way VCO and Forac collaborate with companies and the university-industry collaboration framework in our methodology. Many involved factors of collaboration such as finding partners criteria, managing the
relationships, flexibility and trust can be found in both cases. However, it seems that all the factors do not have the same value and assessing some of them is difficult. In particular, it is not easy to assess the effect of trust on collaboration. The use of technology and knowledge transfer seemed a tool for measuring collaboration profitability. Nevertheless, measuring collaboration outcomes, especially implicit outcomes, is still an issue that needs to be explored deeper in the future. Regarding open innovation model, we found that it is not significantly applied for collaboration in these case studies, but there is a high potential for implementing it. Open innovation is a trend that be introduced within organizations and the proposed structure for open innovation in our methodology can help to clarify the concept.
Chapter 6. Conclusion

Applying collaboration as a way to develop products and services that better respond to customers’ needs is crucial in today’s market. Furthermore, open innovation, as a new approach for gathering ideas and improving innovation, help companies in easily creating inter-organizational linkages. Therefore, firms including forest products companies could collaborate with external resources that bring complementary knowledge and technology to their organizations. Among the different kinds of potential partners that could be selected, universities have been investigated in this study. In particular, we have tried to investigate university-industry collaboration dynamic and what should be the stages as well as the key factors to focus on in order to ensure profitable relationships. We have also analyzed the open innovation philosophy and how this type of system could be linked with university-industry relationships.

In order to propose a framework for the establishment of university-industry collaborations that reflects best practices in the literature, two case studies with two different viewpoints have been analyzed. The first one was related to activities that European universities have been done to develop university-industry collaboration (university’s viewpoint). Another one was associated with the best practices of university-industry collaboration that could be done by companies (industry viewpoint). A third paper related to six case studies in the UK for managing university-industry collaborations helped us for identifying success factors for this type of collaboration. We then developed a framework with a flexible structure that could be applied for different universities and companies’ contexts, including forest companies. The role of government has also been studied by comparing its impact in UK, US, Canada and Australia.

In addition, to present a clear structure for implementing open innovation, we have determined a step-by-step process for putting it into practice in a company. When linking open innovation and university-industry collaborations, we found that universities, as key external resources for companies, could help in facilitating open innovation model execution. High relational links, like research partnership and research services between universities and industry, play an essential role in driving innovation processes in the
context of open innovation. Finally, comparing the university-industry collaboration framework to collaboration mechanisms in Forac consortium and VCO network has shown a high level of correspondence in both case studies. Surveying open innovation structure has been displayed that Forac consortium has potential for implementing it and VCO network can exploit open innovation indirectly in collaboration with companies which use open innovation models.

Since it is essential when creating collaborations to measure their profitability, we have analyzed the collected data of 23 university-industry collaboration projects in VCO network from 2011 to 2013. The idea was to measure the outcomes, as knowledge and technology transfer, of collaborative projects while surveying the effect of the number of meetings on university-industry collaboration results. We concluded that knowledge and technology transfer may be easily used as performance indicators by measuring the number of case studies conducted, the number of analytical tools developed, the discussion on research works held as well as the data and information in input of the research work provided.

**Future work**

In this study, the proposed framework for university-industry collaboration is general and not completely allocated to the forest industry, but has the capability to improve the global situation of this industry. Meanwhile, this framework has been developed without regarding activates which could be introduced as the preliminary steps of our framework. In this regard, the universities’ activities such as establishing centers to develop university-industry collaboration and holding forums to join universities and companies have been mentioned in chapter 3. As a result, expanding the proposed general framework with prerequisite steps could be considered as a future work. We have proposed a general structure of open innovation implementation within a company. For future work, it could be interesting to investigate whether universities need to implement open innovation inside their organization or not, or if the proposed structure is effective for universities or not. We have also limited the analysis of the VCO data to the measure of knowledge and technology transfer outcomes. Improving measurement indicators to achieve more
effective university-industry collaboration outcomes assessment could be considered as a future work. It is worthwhile to mention that we have just analyzed the VCO data, while analyzing the Forac collaborative data, between universities and companies, is interesting as a future work. As another potential work, simultaneous coordinated structure to execute open innovation could be presented. Finally, a few interviews with some experts of the forest products industry have been conducted. It could be relevant to conduct more interviews with other companies and experts inside and outside the two centers of knowledge chosen to better understand forest sector’s particularities and adapt the methodology based on this context.
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