University of Tartu

Faculty of Economics and Business Administration

Institute of Economics

Mart Moora

UNIVERSITY-BUSINESS COOPERATION IN RESEARCH AND DEVELOPMENT: AN UNDERUSED OPPORTUNITY FOR THE ESTONIAN ECONOMY

Dissertation for the Master of Arts in Economics and Business Administration

Thesis Advisor: Jaan Masso, PhD

Tartu 2014

Recommended for defence .....
(supervisor's signature)

Accepted for defence " "..... 2014

Head of Chair; Chair of Economic Theory ….....
(Haid of Chair's name and signature)

I have written the Master's thesis independently. All works and major viewpoints of the other authors, data from other sources of literature and elsewhere used for writing this thesis have been referenced.

.....
Mart Moora

TABLE OF CONTENTS

INTRODUCTION

The most effective means of conducting research, development and innovation (hereinafter RDI) could be through successful university-business cooperation in research and development (hereinafter UBC in R&D). Nevertheless, UBC in R&D is too often considered a narrow research topic. This is despite the fact that the challenge to significantly improve RDI has now become the focal point of growth-seeking European economies.

The latter is especially true for small catching up economies like Estonia, which in order to complete their convergence, must grow even faster. Some neoliberals might argue that "a unique and globally stable growth path exists to which the level of labour productivity and income per person will converge" (Veugelers, Mrak 2009: 3). However, forces behind economic growth are more complex than the neoclassical theories depict, and convergence does not occur simply due to some anonymous reasons.

Instead, as it has been proven by the Schumpeterian semi-endogenous growth model, the economies' absorptive capacity to produce and commercialize intellectual capital has a substantial impact on economic growth (Cohen, Levinthal 1990). Specifically, states that manage to improve their internal RDI also improve their outlook for economic growth. More importantly, catching up economies (including Estonia) that resolve this challenge, will develop a strong endogenous growth.

The latter is especially important for avoiding the middle-income trap that is a considerable risk for catching up economies. While the mainstream economics has discussed this concept for quite some time, Eichengreen *et al* (2013: 3) have drawn particular attention to the importance of technology development for avoiding the risk of stagnation in the range of $15 000 – $16 000 per capita GDP. In the case of Estonia, as its current per capita GDP for 2013 in current USD was approximately $18 896 (Statistikaamet 2014), it is already

somewhat above the range of a potential middle-income trap as specified by Eichengreen *et al* (2013). Nevertheless, without developing a strong internal growth driver, resolving the challenge of catching up with the developed economies is unlikely.

Such challenges are independent for each state, just as for each firm and university. Although lessons can be drawn from developed economies, the paths cannot be directly copied. Furthermore, it must be clearly recognised that the businesses of catching up economies do not have the necessary finances, not to mention the necessary expertise, to independently invest into RDI (Staehr *et al* 2010). However, on the macroeconomic scale, especially during later growth stages, without increasing RDI intensity, it becomes impossible to complete the convergence (*Ibid*). UBC in R&D, particularly, could be one of the most resource effective paths to successfully improve the RDI intensity.

Herein, successful UBC in R&D is not relevant solely for small catching up economies. On the contrary, most of the developed economies puzzle over the very same challenge (Mower, Sampat 2005; Koschatzky, Thomas 2010; Knuuttila 2012; Fukugawa 2013). Nevertheless, as long as the *status quo* persists, UBC in R&D as a resource effective opportunity to revitalize sustainable economic growth remains overlooked. If, however, small catching up economies were to fully utilize the potential of successful UBC in R&D, a significant endogenous growth driver could be generated to complete the long-lasting convergence that would otherwise be stopped by a middle-income trap.

Also, UBC in R&D is not the single existing path towards improved RDI. Several other alternatives, such as companies' internal R&D activities; cooperation with specific think-tanks; consultancies; etc., could also function as paths towards intellectual capital production (Laursen, Salter 2004). Yet, UBC in R&D has the advantage of producing knowledge most resource effectively: "Collaboration provides companies with the means by which to advance technologically, at lower cost and with less inherent risk. [...] For universities, the benefits include additional public and private funding, and increasingly, licensing, and patenting income" (Barnes *et al* 2002: 2).

On the level of political statements, the European discourse seems to agree. First of all, the EU admits its need to urgently improve the "ability to convert knowledge into commercial ventures that yield economic benefit." (Goldstein *et al* 2011: 1) Secondly, stimulating the endogenous growth drivers (such as RDI through UBC in R&D) has been proven to work in the East Asian miracle economies of Taiwan, Singapore, Japan, and South Korea (Ang, Madses 2009). Thirdly, the high potential that UBC in R&D poses for Estonia has been recognised by most of the recent research on the state innovation systems (Seppo, Roolaht 2012; Varblane *et al* 2012; Laine, Varblane 2010).

Regardless, despite the widespread recognition of UBC in R&D as potentially a significant contributor to RDI, Estonia is still far from employing its full potential (WEF 2012). Moreover, as shown above, there lacks a clear-cut understanding for how to indeed enhance such collaboration. Therefore, the central goal of this thesis is to analyse the current state of Estonian UBC in R&D and provide recommendations for enhancement.

In order to meet the central goal, the following research objectives were formulated:

- analyse the key processes of UBC in R&D from a state perspective;
- analyse, what drives successful UBC in R&D;
- consider possible methods used to assess the current state of UBC in R&D;
- analyse the Estonian RDI system and specify the research methodology and sample;
- analyse the current state of Estonian UBC in R&D;
- provide policy recommendations to enhance Estonian UBC in R&D.

The research method builds on case studies at which particular collaboration projects were observed from both the university as well as business perspectives. The information was gathered via semi-structured face-to-face interviews that were independently carried out with the university and business representatives for each of the observed cases. In total, eight UBC cases in R&D were investigated. A similar approach for analysing the Estonian UBC was recently used by Vadi and Rajalo (2013). They also conducted semi-structured face-to-face interviews with business and university representatives. Nevertheless, differently from the

beforehand thesis, their approach did not involve both collaborating parties from the same projects, and they did not explicitly focus on success drivers for UBC in R&D.

While conducting the analysis within the theory sub-chapters, earlier research on the evolution of RDI as well as specifically UBC in R&D was thoroughly studied. The core framework was constructed based on the Triple Helix theory by Etzkowitz and Leydesdorff (2000), whereas the process description of UBC in R&D was primarily inspired by Perkman *et al* (2011). In addition, the best practice model of UBC by Barnes *et al* (2002) along with the collaboration drivers by Davey *et al* (2011) were used as the primary input for defining the key success drivers of UBC in R&D. In order to define the possible assessment methodologies for UBC in R&D, a combination of earlier research findings was used: e.g. the literature review by Piva and Rossi-Lamastra (2013); a success map of UBC in R&D by Perkmann *et al* (2011); etc. With regard to the recent theoretical findings on the Estonian UBC in R&D, particularly, the research conducted by Varblane, Kattel, Masso and others was used as basis (e.g. Varblane *et al* 2012; Kattel *et al* 2012; Masso *et al* 2013; etc).

The thesis is structured as follows: first, a framework for analysing UBC in R&D is constructed based on the synthesis of available literature. Secondly, drivers identified by earlier research that possibly contribute to successful UBC in R&D are defined. Thirdly, an overview of the possible methodologies to assess the current state of UBC in R&D is provided. Fourth, the research methodology and the sample are being elaborated, followed by analysis on whether the Estonian UBC projects in R&D generally employ these drivers to successfully reach their initial goals. Lastly, policy recommendations to stimulate the Estonian UBC in R&D as a potentially strong endogenous growth driver are being discussed.

The author would like to express sincere gratitude to the interviewees that provided their much valued input (Margus Sirel from Elektrilevi OÜ; Prof. Juhan Valtin from the Tallinn University of Technology; Richard Murutar from BoatArt OÜ; Tuuli Trei from the Estonian Academy of Arts; Maria Voznesenskaya from VTT-NTM OÜ; Aarne Kasikov from the University of Tartu; Marek Koit from Üle OÜ; Kristian Sülluste from KBFI; Mare Reiman from Tere AS; Jane Saatre from the University of Tartu; Kaspar Ratnik from Quattromed

HTI Laborid OÜ; Prof. Maris Laan from the University of Tartu; Karin Kustavus from Põltsamaa Felix AS; Andero Uusberg from the University of Tartu; Andres Mellik from JukuLab OÜ; Marek Link from the Estonian Academy of Security Sciences; Emöke Sogenbits and Sixten Kerge from Eolane Tallinn AS; Jaan Viru from CrystalSpace OÜ).

In addition, the author would like to express his gratitude to the thesis advisor Jaan Masso, whose insights have been highly valuable along with the explicit comments and feedback. Last, but not least, the greatest gratitude goes to my always helpful wife Kaisa, and our newly born son Uku.

1. THE SIGNIFICANCE OF UNIVERSITY-BUSINESS COOPERATION IN RESEARCH AND DEVELOPMENT

1.1 Key processes of university-business collaboration in research and development

A framework to analyse UBC in R&D can be constructed through defining the key phases of the cooperation process. Also, since UBC in R&D functions as an iterative process, the process should be viewed in a cyclical nature. Thus, the author constructs the process cycle of UBC in R&D. This foremost builds on the approaches of Perkman *et al* (2011) and Etzkowitz and Leydesdorff (2000). The first of the two proposes that in order to assess UBC in R&D, the stages of cooperation, including inputs, in-process activities, outputs and impacts are ought to be clearly understood. The latter generates a broadly accepted stepping stone for understanding the state level evolution of UBC in R&D.

Before proceeding, although Perkman *et al* (2011) are instrumental to structure the process of UBC in R&D, their low level framework focuses on project management, and excludes the high level macroeconomic motivation for UBC in R&D. First, they do not include explanations for the underlying demand for RDI; and secondly, their approach does not explicitly consider the mechanism of how UBC in R&D as specific form of RDI eventually contributes to economic growth. Yet, a state level framework that observes UBC in R&D as a significant endogenous growth driver, must include these aspects. Therefore, market demand for RDI is included as a starting phase; and the commercial benefits of UBC in R&D are added as an ending phase to the cycle of UBC in R&D. In short, all of the phases are defined as follows:

- Preliminary phase: formation of the need for RDI.
- Input phase: semi-formal university-business interactions.

- In-process phase: formal execution of UBC in R&D.
- Output phase: achievement of end results of UBC in R&D.
- Impact phase: commercial benefits that contribute to economic growth.

First, regarding the preliminary phase, the formation of an economy's need for RDI is ought to be understood. This will enable to define the significance of UBC in R&D in the context of a state level innovation system. Early studies assumed that the evolution of innovation is linear (Tunzelmann *et al* 2008); and the *raison-d'etre* for intellectual capital production is the emergence of new knowledge. Hence, also known as the science-push paradigm, the early linear innovation theories assumed that the emergence of new knowledge also feeds the need for intellectual capital production (Bush 1945).

However, although the science push approach might explain the underlying motivation behind basic research, it fails to account that applied research, including commercial applications, are an outcome rather than a driver of knowledge production. Thus, the reasoning for RDI cannot solely be described by science-push. Instead, the market need behind commercial applications should receive the foremost attention. Later theories have tried to account for this by replacing the science-push assumption with a market pull concept (Tunzelmann *et al* 2008). Although it is a step closer to understanding the preliminary stage of applied research (formation of the need for RDI), it still fails to acknowledge that the evolution of applied science, and thereof innovation, follows non-linear patterns.

In fact, because economies are not destined to grow by default, it is an oversimplification to assume that the need for RDI evolves in a linear fashion. In reality, catching up economies increasingly depend on the asymmetries of complex innovation systems. The latter in turn depends on the absorptive capacities of each individual economy. This capacity must be developed separately by each state. Its impact on economic growth cannot be fast-tracked similarly to stimulating the impact of some external measures (e.g. foreign aid, foreign capital investments, implementation of new technologies developed abroad, etc).

For businesses, universities and other actors, it is one of the very few functional methods to generate internal resources and skills for developing commercial applications. That is why convergence in terms of knowledge and skills "is a much slower and complex process than converging in terms of GDP measures." (Veuglers, Mrak 2009: 1) These issues, however, are not addressed by the linear models of innovation, regardless of whether they follow the science-push or market pull paradigms.

On the other hand, the Triple Helix theory by Etzkowitz and Leydesdorff (2000) has internalized the asymmetries of innovation systems, and it therefore helps to explain the dynamics of RDI with respect to the related counterparties (academia, industry, and state). To understand these dynamics in full detail, "one needs to transform the sociological theories of institutional retention, re-combinatorial innovation, and reflexive controls" (*Ibid*: 112). The latter clearly goes beyond the scope of this thesis. However, the puzzles and challenges that each of the growth seeking economies are facing, can still be analysed. Out of such analysis, an understanding of the economy's need for applied research (intellectual capital) via UBC in R&D can become formulated.

Foremost, the capacity to formulate such an understanding depends on which stage of Triple Helix an economy stands in. There can be three possible stages: phase one (Triple Helix I) represents the separation of university, industry and state. This is commonly found in developing, and mostly authoritarian economies that have a low absorptive capacity for intellectual capital. A second phase (Triple Helix II), often inherent to catching up economies, represents the *laissez fare* approach to UBC. In this phase, although there are no obstacles to industry-state interactions, there are also no enabling mechanisms to enhance UBC in R&D. The latter implies that the absorptive capacity of intellectual capital still remains low, and therefore, the potential of UBC in R&D as an endogenous growth driver is under-used (Ang, Madsen 2009). Currently, as elaborated in Chapter 2.1, Estonia is still in this stage.

A third stage (Triple Helix III) stands for tri-lateral networks and hybrid organisations in which there are little to no barriers for university-state-industry interactions, and the synergy

potential of UBC in R&D can become exploited at full extent. Economies that operate closer to Triple Helix III can formulate these understandings in a quicker and more explicit manner. This will in turn shorten the cycle of intellectual capital production, since the absorptive capacity is maximized for all market participants, and the time to enter into clearly specified collaboration agreements is significantly shortened. Thus, in conclusion, to set the stage for a successful preliminary phase of UBC in R&D, economies should thrive to enter Triple Helix III (see also Figure 1 below).

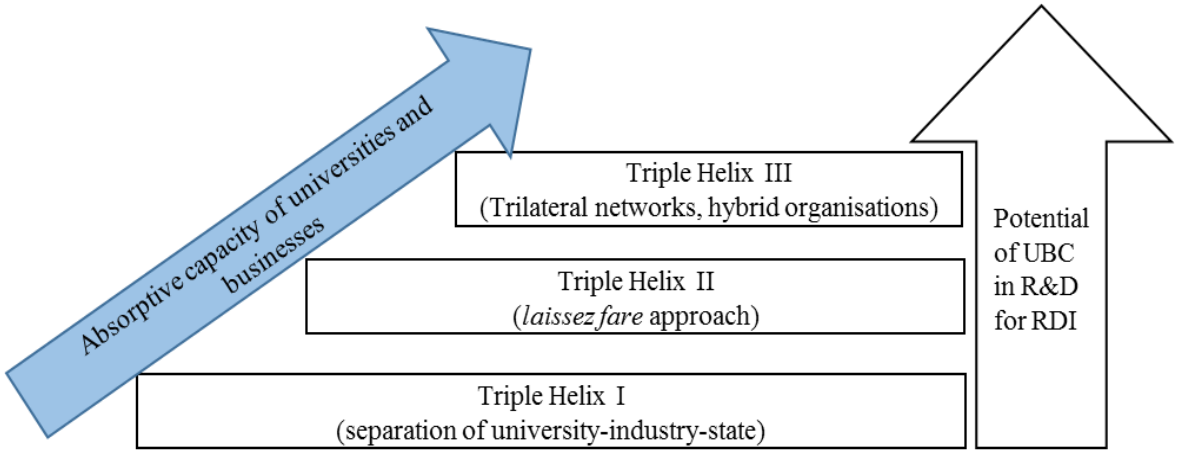


Figure 1. Interconnections between the absorptive capacity of universities and businesses, Triple Helix phases, and the potential of UBC in R&D for RDI (Source: Constructed by the author based on Etzkowitz, Leydesdorff, 2000; and Schumpeter 1934).

Within the Input phase of UBC in R&D, the specific need for intellectual capital production has already been formulated, and now partnerships are created to meet the respective need. This includes both numerous unofficial interactions as well as possible preliminary studies / feasibility analyses conducted prior to entering into full-scale cooperation (thus the term semi-formal university-business interaction). The Triple Helix framework by Etzkowitz and Leydersdorff again provides a good basis for understanding the high level prerequisites that set the conditions for a successful Input phase.

Theoretically, economies that lag in Triple Helix I have the smallest likelihood of formulating any constructive partnerships between universities and businesses. This also implies that such economies lack the opportunity of utilizing UBC in R&D as a potentially strong endogenous growth driver. The lack of interactions on the axis of state-industry-academia simply work

against the latter. Herein, the former states of the Soviet Union are still dealing with the consequences of long-term stagnation in Triple Helix I, which might also explain why the Eastern European UBC in R&D for a rather long period had a rather low contribution to intellectual capital production (Etzkowitz and Leydesdorff 2000: 111).

By now, although most of these economies have managed to enter at least into Triple Helix II (the *laissez fare* approach), this stage is still not characterized by strong semi-formal university-industry interactions, and simultaneously maximize the capacity of running successful UBC projects in R&D. On the other hand, economies that have reached some sort of Triple Helix III are clearly in a better position to formulate functional university-business partnerships. This is due to their intertwined nature of universities and/or businesses, which enables to utilize cross-organisational tacit knowledge, and to swiftly consider the possibilities of formulating partnerships for specific UBC projects in R&D.

To further understand the dynamics of the Input stage, states' levels of economic development should be compared. For example, in advanced countries, university-industry links tend to be varied as the patterns of UBC in R&D have already become formalised. At the same time, in catching up economies, university-industry links become more intense only after UBC in R&D has already become formalised (Campos 2009). The latter suggests that university-industry links cannot independently intensify within a *laissez fare* environment (Triple Helix II), which as discussed above, for a long time was the case for Estonia and other Eastern European catching up economies. To overcome this challenge, some state intervention mechanisms in which public incentives are generated to conduct UBC in R&D should likely be considered (Varblane *et al* 2012).

In addition, there are several low-level determinants that are also relevant within the Input phase. Universities and businesses need to be independently motivated to engage in these semi-formal interactions. From the business' perspective, there needs to be a clear understanding of the expected benefits. For example, pharmaceuticals such as GlaxoSmithKline and Novartis "access knowledge to gain deep expertise in specific disease areas;" Rolls Royce receives academic expertise in aerodynamics and system software

engineering; etc (Perkman *et al* 2011: 202). Thus, to improve the motivation to enter into cooperation, businesses as well as universities need a clear overview of the possible benefits that could be received from entering into formal collaboration.

The In-process phase will follow after the semi-formal university-business interactions have been successful and partnerships have indeed been formulated. This is the phase at which formal execution of UBC in R&D occurs, and thus, most of its significant denominators are rather low level. Herein, collaboration could be carried out in several forms. For example, Campos (2010) specifies three mechanisms: training of human resources; social networks and informal contracts; and contractual arrangements. The first mechanism captures that universities are the training ground for highly skilled labour. In many cases, this mechanism still represents the most common means of university-business collaboration (Schartinger 2001). The second mechanism is used for informal queries and spontaneous discussions; and the third mechanism, contractual arrangements, stands for large-scale cooperation projects. In the context of UBC in R&D as a form of intellectual capital production, the In-process phase stands for the third mechanism: Contractual arrangements (see also Table 1 below).

Table 1. Three mechanisms of university-business cooperation

Collaboration mechanisms	**Scope of university-business cooperation**	**Specification**
UBC mechanism 1	Training of human resources	A fraction of all human resources are trained in universities and hired by industry, where they make use of the knowledge and skills learned in universities.
UBC mechanism 2	Social networks and informal contracts	Resolutions to trivial queries are resolved informally, before triggering joint-research. In this mechanism, economic incentives are less important.
UBC mechanism 3	Contractual arrangements	Includes, but not limited to consultancy, joint-research, technology licensing and the creation of spin-off companies. Economic incentives have a central importance.

Source: Campos 2010.

Several factors determine, which projects will likely proceed to collaborate within the In-process phase. Perhaps most importantly, companies and universities willing to engage in Open Innovation practices are more prone to UBC in R&D. Open Innovation "is a paradigm that 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." (Chesbrough 2006: 4) It means that organisations that are looking to produce intellectual capital via UBC in R&D are ought to view R&D as an open system rather than performing in-house research behind closed doors.

Clearly, economies that are closer to Triple Helix III will be better equipped to indeed successfully enter and complete the In-process phase. Even the largest and most advanced businesses now face the inevitable need of collaborating with external knowledge sources. For example, Cisco as one of the largest and most innovative ICT companies conducts very little in-house R&D, whereas there are vast numbers of projects performed via external knowledge sources. IBM was at one point the World's eighth largest holder of biotechnology patents, although it clearly operates mainly in ICT- the latter indicates, that companies with primary focuses in other fields can employ the benefits of cooperation in several other industry verticals. As a more explicit example for Estonia, large companies from small economies such as ABB and Novartis from Switzerland, and Philips in the Netherlands "were pioneers in R&D internationalization" with the clear motivation of producing intellectual capital through Open Innovation (Gassmann 2006: 225).

Thus, conclusively, while considering the In-process phase of intellectual capital production via UBC in R&D, its greatest strength relates to the fact that businesses can access knowledge that can indeed eventually become commercialized in a resource effective manner. Nevertheless, within Estonia that at best is lagging in Triple Helix II, the fundamental problem is that only a handful of businesses and universities currently enter contractual arrangements (see also Chapter 2.1). Some of the reasoning relates to the historic implications of the Soviet Union. However, numerous other drivers determine whether the In-process phase can be reached and successfully completed. These drivers are defined in Chapter 1.2.

Regarding the Output phase, despite vast literature on university-business cooperation, there is no clear-cut definition for what exactly constitutes a successful output of UBC in R&D. On the one hand, it is clear that for businesses, intellectual capital production needs to result in commercial benefits. Nevertheless, it is not clear at all, whether and at which point will UBC in R&D indeed deliver these results. Often, UBC in R&D might simply result in a new kind of knowledge, which has little explicit connection with commercialization. Depending on the definition, the latter may be considered a successful result. Nevertheless, without commercial impacts, a successful UBC project in R&D has no contribution to economic growth. (Laursen, Salter 2004)

The latter is somewhat counterintuitive, because according to widespread assumptions, successful intellectual capital production will by default contribute to economic growth (Arundel, Geuna 2003; Fontana *et al* 2006, Davey *et al* 2011; Ukrainski 2008; WEF 2012; Knowledge-Based Estonia 2006). However, UBCs' contributions to fundamental knowledge could arguably be considered as an example of successful UBC, despite little commercial benefits. Also, from the perspective of academic integrity, it is not clear, whether strictly economic measures are correct to determine the success of universities' contributions in a cooperation project (Bergman 2009; Kuuttila 2012). Hence, the question remains: how to define a successful outcome of intellectual capital production via UBC in R&D, and in which cases will successful UBC in R&D result in commercial benefits?

For an explicit answer, the author finds it necessary to delineate between an output of UBC in R&D, and the subsequent impact. The output phase strictly determines whether the goal(s) of UBC projects in R&D have been achieved. These goals are defined on project-specific basis by the contractual arrangements between collaborators. Hence, the Output phase is successfully reached, if the cooperation terms rather than commercial objectives have been met. For example, Perkman *et al* (2011) define the Output phase as the point at which new technologies have been developed, new scientific knowledge has been formulated, and/or the project team has achieved a new set of skills.

These results may or may not include commercial outcomes. Also, for individual UBC projects in R&D, these outputs may indeed imply that the cooperation has been successful. Nevertheless, from a state level perspective, to assess the success of intellectual capital production via UBC in R&D, the commercial impact is also ought to be considered. Therefore, proceeding from the Output phase, an Impact phase shortly follows. Under this framework, successful intellectual capital production via UBC in R&D should include a clear-cut commercial impact, or an explicit outlook to reach such benefits as a result of collaboration. Such impacts may occur in the form of increased revenue or improved profitability of the firms and universities that are related to the cooperation. Also, within the cycle of intellectual capital production via UBC in R&D, the assumption is inherent to any collaboration project, regardless of whether the collaborating parties themselves knowingly seek these impacts.

On the first sight, this might seem like self-evident. Indeed, under the circumstances in which private enterprises are financing most of the UBC in R&D, it might be self-explanatory that clear-cut commercial impacts are expected from a collaboration project. Nevertheless, in cases where public financing is involved with UBC projects in R&D, the commercial benefits are not always granted. For example, the Estonian Competition Authority's recent assessment on using the Structural Funds for supporting the businesses concludes that most of the support has not reached the intended impacts, although the project outcomes have mostly been reported successful. (Riigikontroll 2013) The latter implies that projects tended not to have the goal of commercialisation linked to its explicit outcome objectives. Thus, it became possible to classify projects as successful, even if commercial impacts were not reached.

Along the same lines, several large corporations might have the risk of conducting external research projects simply due to the decision of engaging in external R&D cooperation (Laursen, Salter 2006). In other words, cooperation could occur for the sake of cooperation itself. Thus, to avoid these risks, the Impact phase should be separately scrutinized, and the drivers relevant for maximizing the commercial benefits of intellectual capital production via UBC in R&D should be better understood. In that regard, Chapter 1.2 will define some of

the most important drivers, whereas Chapter 1.3 will discuss on the methods to assess these drivers from high and low level perspectives.

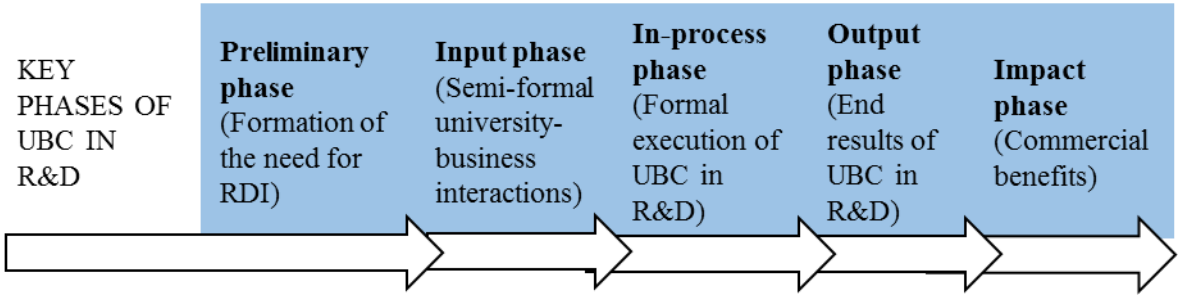


Figure 2. The five key phases for UBC in R&D (Srouce: Constructed by the author)

In conclusion, this sub-chapter defined the five phases of UBC in R&D: preliminary phase (formation of the need for knowledge production); input phase (semi-formal university-business interactions); in-process phase (formal execution of UBC in R&D); output phase (achievement of end results for UBC in R&D); and impact phase (commercial benefits that contribute to economic growth). All in all, since UBC in R&D could function as a significant endogenous growth driver, the better each of the phases can be completed, the more UBC in R&D can enervate economic growth. Thus, the following sub-chapter elaborates on the relevant drivers for each of the phases, whereas the third sub-chapter discusses on potential assessment methods. Figure 2 above captures the concept in a conclusive manner.

1.2 Drivers of successful university-business cooperation in research and development

Based on the key phases of intellectual capital production via UBC in R&D, the aim of this chapter is to map the drivers that support a successful completion of each respective phase. Focusing solely on drivers, and excluding barriers is somewhat contrary to several earlier studies on UBC in R&D (Mets 2009; Bruneel *et al* 2010; Bekkers and Freitas 2008). Nevertheless, some of the recent research has recognised that positive drivers for successful UBC in R&D are ought to be studied in greater detail, since these will eventually function as the primary contributors to successful collaboration (Davey *et al* 2011). Drivers are herein both the implicit as well as the explicit determinants that support the advancement of UBC projects into subsequent phases.

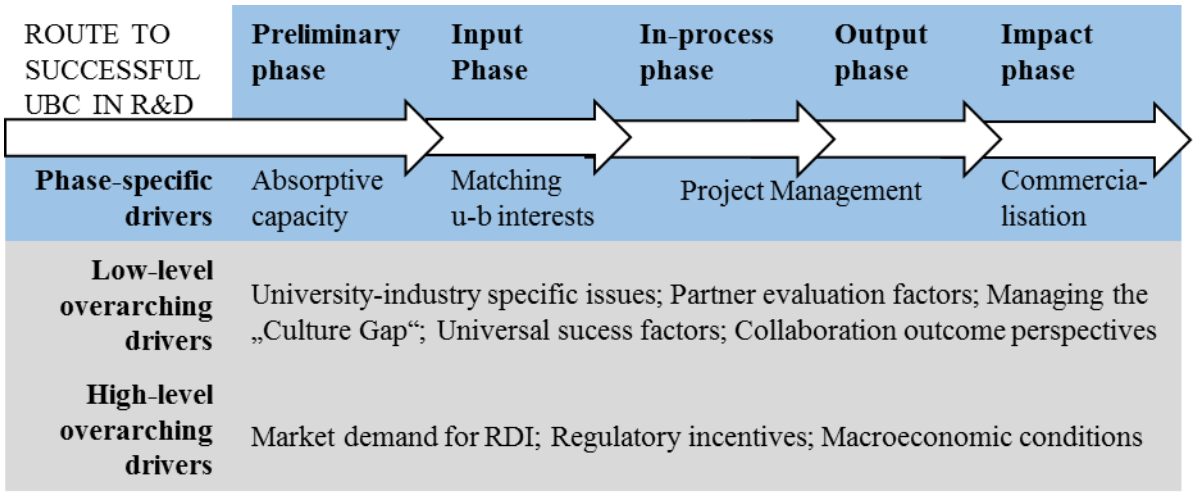


Figure 3. Drivers of successful UBC in R&D (constructed by the author based on Etzkowitz and Leydesdorff 2000; Barnes *et al* 2002; Perkmann *et al* 2011).

Within the Preliminary phase (formation of the need for RDI), the literature suggests that success drivers are primarily related to the existence of earlier experience with regard to UBC in R&D; and the economy's absorptive capacity for intellectual capital production (Cohen, Levinthal 1990). With regard to experience, these drivers are relevant due to the cyclical nature of intellectual capital production. As some earlier projects have reached the output phase (end-goals within the contractual arrangements) and/or the impact phase (commercial benefits), this will naturally feed the counterparties' motivation for entering into new collaboration projects.

At the same time, the motivation could also be explained by the evolutionary nature of innovation. After a successful collaboration, it is rather obvious that the need of returning to another cycle of UBC in R&D will be revived. It aligns with the findings of Mohnen and Horeauh (2002), who conclude that companies with ongoing R&D projects and organisations that already have overlapping connections between universities and businesses, are more likely to enter into new cooperation projects. Moreover, some of the collaboration could be explained by the spill-overs from R&D performed in universities. Since universities are constantly conducting research, their findings will inevitably generate interest to apply these findings with commercial purposes.

On the other hand, earlier experience also determines, whether and what kind of institutions spark on R&D cooperation. For example, Jaklic *et al* (2008) have found that while innovative Slovenian businesses rarely cooperate with local universities, they have a rather high inter-business collaboration intensity. This is due to the fact that inter-firm cooperation has been commercially successful, whereas UBC in R&D has not posted the same kind of success. The fact that earlier collaboration experience significantly increases cooperation intensity is also proven by the German manufacturers (Becker, Dietz 2004), although in their case, UBC in R&D is also rather wide-spread. However, while mapping the drivers of successful intellectual capital production via UBC in R&D, the German experience only verifies that earlier experience is clearly a significant driver within the preliminary phase.

In addition, the absorptive capacity of collaborating parties stands for a significant success driver within the Preliminary phase. Particularly, companies with internal R&D departments, and universities that have technology transfer units, are more likely to pass the preliminary phase (Veugelers 1997; Tether 2002). Companies that do not have specific personnel nor the specific knowledge will simply lack the mechanism to process the needs for intellectual capital production via UBC in R&D.

Part of a solution could be to set up a small in-house R&D department, which would then coordinate external R&D collaboration (Becker, Dietz 2004). Although the in-house department lacks resources to perform independent R&D, the driving force of intellectual capital production will still reside within the organisation. Such a strategy is not limited to small organisations. As discussed above, several large corporations (e.g. Cisco, GlaxoSmithKline, Novartis, IBM, etc) are opting for these strategies as well. The same applies for universities, which do not have to commercialise research on their own. Instead, during the preliminary phase (formation of the need for intellectual capital production), the most successful research by universities is driven in cases at which research departments are in contact with the external counterparts (Etzkowits, Leydesdorff 2000). Therefore, universities that enhance the absorptive capacity will be in a more favourable condition.

In conclusion, the success drivers within the preliminary phase were specified as follows:

- absorptive capacity of universities and businesses;
- earlier collaboration experience;
- rate of spill-overs.

Moving on to the input phase, despite the large potential stemming from university-business cooperation, the fundamental nature of these two institutions, and thus the motivation to cooperate, remains different. While businesses mostly aspire to generate profit, universities have a broader range of motivators. Aapaoja *et al* (2012) argue that the "firms' motivation is to gain a competitive advantage and addressing business growth, whereas universities want to create new research and offer education." At the same time, participating in research that has economic value, would be labelled as as a third mission of universities. (*Ibid*: 91)

Therefore, while considering the input phase of intellectual capital production via UBC in R&D, the business- and university-specific drivers should first be observed separately. For businesses, the input phase drivers mostly relate to a reasonable outlook to resolve the underlying need via UBC in R&D. Specifically, motivation relates to the firms' understanding of whether knowledge from universities could complement the firms' "technology portfolio" (Teixeira, Costa 2006: 25). Also, according to Cohen *et al* (2002), firm size and age could herein matter. Larger firms and start-ups are more likely to enter into UBC in R&D. Hence, economies that have a high concentration of either of the two should theoretically expect a higher rate of UBC projects in R&D.

From a slightly different angle, firms' ability to control outflows of knowledge could have a unique impact on businesses' motivation to enter into a contractual arrangement (Chun, Mun 2011). Thus, in order to proceed with UBC in R&D, it might be particularly relevant for some companies to understand, whether control over IPR will remain maintained. Specifically, since the input phase between universities and businesses has a semi-formal nature, the initiation of collaboration projects may vastly depend on the parties' trust against each-other. These kinds of informal contacts seem to be especially relevant in order to access tacit knowledge, which in many cases, stands for a decisive driver to proceed to the in-process phase (Arundel, Geuna 2004). Again, the latter relates back to the Triple Helix theory:

economies that are closer to Triple Helix III will have the closest connections between universities and businesses.

To specify the university-related drivers within the input phase, first, the "entrepreneurial led" and "classical" universities should be distinguished. The first kind of universities are such that have close connections with businesses, and that are therefore more prone to engage in UBC in R&D. The second kind is arguably more focused on base science, and has less interest in commercial applications. (Teixeira, Costa 2006: 26) A similar notion is also captured by the theories of Mode 1: the theoretical model; *versus* Mode 2 universities: the problem-oriented and trans-disciplinary model. Although it could be argued that Mode 1 as well as Mode 2 universities are needed for the sake of scientific advancement (Knuuttila 2012), it is clear that universities with Mode 2 characteristics will be more likely to complete the input phase of UBC in R&D.

At the same time, since the in-process phase stands for semi-formal university-business interactions, it should also be noted that several academics have a propensity to engage in informal collaboration. For example, Link *et al* (2006) have found that especially more tenured faculty tend to engage in knowledge transfer, joint publications with industry scientists, and consulting via informal collaboration. Out of such collaboration, a formal in-process phase of UBC in R&D might not follow. However, if trust between universities and businesses is high enough, the input phase could in theory be successful. The preference of such informal collaborations among some faculty could imply that there are alternative paths to contractual arrangements. Nevertheless, from the universities' stand point, regardless of whether the input phase results in a formal UBC in R&D, it is clear that academics are ought to be interested in the practical application of their research. Without such interest, they will most likely not seek connections with businesses, and will rather work in accordance to the Mode 1 framework.

In addition, some drivers to proceed from the Input phase are relevant across businesses and universities. Perhaps most importantly, the availability of public co-financing is clearly significant, especially within catching up economies. For example, Varblane *et al* (2012)

show that while clustering the European economies based on cooperation intensity, the countries with highest co-financing stand out in separate clusters from the countries with the lowest financing rates. The latter emphasises that within the catching up economies, in order to proceed from the input phase, it is clear that without public co-financing, there will likely not be sufficient funds to proceed with official collaboration projects.

This is also supported by comparing the collaboration patterns with the availability of EU structural funds. In Estonia, between 2004 – 2006 and 2007 – 2013 during which the structural funds were available to support UBC in R&D, collaboration levels became rapidly intensified (*Ibid*). At the same time, there were no UBC financing instruments solely supported by the private sector. Thus, in order to support the conditions for intellectual capital production via UBC in R&D, policies should continue with public co-financing mechanisms. The latter is especially important within the input phase, since without public co-financing, it will be difficult to motivate universities and businesses to proceed with official collaboration projects, assuming these are indeed driven by the aim to reach an impact stage (further analysed at the later part of the chapter)

In addition, research findings suggest that the input phase is more likely to be completed by companies from early stages of industries, or from industries that are under a rapid transformation- e.g. ICT and new materials (Campos 2010). Also, firms from knowledge-intensive sectors such as pharmaceuticals, chemistry and energy have a greater likelihood to enter into formal cooperation agreements with universities. This points to the tendency of firms seeking formal alliances mostly in case there is yet little idea of how, exactly, could knowledge eventually become commercialized. The latter is explained via the outlook of knowledge spill-overs: as the outlook improves, it could be expected that the rate of formally executed UBC in R&D will also increase. (Veuglers, Cassiman 2005)

In conclusion, the success drivers within the input phase can be specified as follows:

- ability to combine university-business interests;
- firm size and age;
- trust between universities and businesses;

- rate of entrepreneurial (Mode 2) universities;
- availability of public co-financing;
- industry belonging (are the firms related to industries that operate in early stages?).

Once UBC in R&D has entered the in-process phase, success drivers become foremost related to the low level relationship and business-related drivers (Davey *et al* 2011). The relationship drivers include mutual trust; commitment; a shared goal; understanding of common interest by different stakeholders; prior relations with the business partner; and cooperation as effective means to address societal challenges and issues. At the same time, the business drivers include employment by business of (former) Higher Education Institution (hereinafter HEI) staff and students; interest of business in accessing scientific knowledge; possibility of accessing funding / financial resources for working with business; short geographical distance of the HEI from the business partner; flexibility of business partner; access to business-sector research and development facilities; and commercial orientation of the HEI. Conclusively, the key drivers defined by the factor analyses of Davey *et al* (2011: 5) are outlined on the table 2 below.

Table 2. Types and grouping of drivers

Type of driver	**Explanation**
Relationship driver	Drivers that relate to the relationship between the academic / HEI and the business, and these include: • existence of mutual trust; • existence of mutual commitment; • having a shared goal; • understanding of common interest by different stakeholders (e.g. HEIs, business, individuals, students); • prior relation with the business partner; • cooperation as effective means to address societal challenges and issues.
Business drivers	Drivers that relate to the business factors that motivate UBC, and these include: • employment by business of (former) HEI staff and students; • interest of business in accessing scientific knowledge; • possibility of accessing funding / financial resources for working with business; • short geographical distance of the HEI from the business partner; • flexibility of business partner;

Type of driver	Explanation
	• access to business-sector research and development facilities; • commercial orientation of the HEI.

Source: Davey *et al* 2011

Although Davey et al have come up with a structured list, these still exclude several low-level, yet crucial In-process drivers for successful UBC in R&D. Specifically, they overlook project management, which is significant for any UBC project in R&D (Perkman *et al* 2011). A more detailed approach would also observe the roles of each member of the project team - e.g. the role of the Lead Researcher, whose capability to take responsibility for managing both the research work and the activities of the researchers could become an equally significant success driver (Barnes *et al* 2002).

Conclusively, Barnes *et al* (2002) identified eight categories of most significant success drivers (see following figure 4). While the first category (Universal factors) could apply for any phase of intellectual capital production via UBC in R&D, most of the other categories are mainly relevant within the In-process phase. Specifically, the success drivers were defined as follows: a) Universal drivers (trust, commitment, continuity of personnel, good personal relations); b) Choice of partners (no hidden agendas; prior collaborative experience, complementary aims, strategic importance past collaboration partner); c) Project manager (experienced project manager); d) Project management (clearly defined objectives, good progress monitoring, effective communications, clear responsibilities, good project planning, clear reporting & meeting structure); e) Ensuring equality (evident mutual benefit); f) Environmental factors (corporate stability); g) Outcomes (clear proprietary benefit, little proprietary benefit, tangible outcomes); h) cultural issues (agreed timescale, balanced priorities, student agenda, academic right to publish). (*Ibid*)

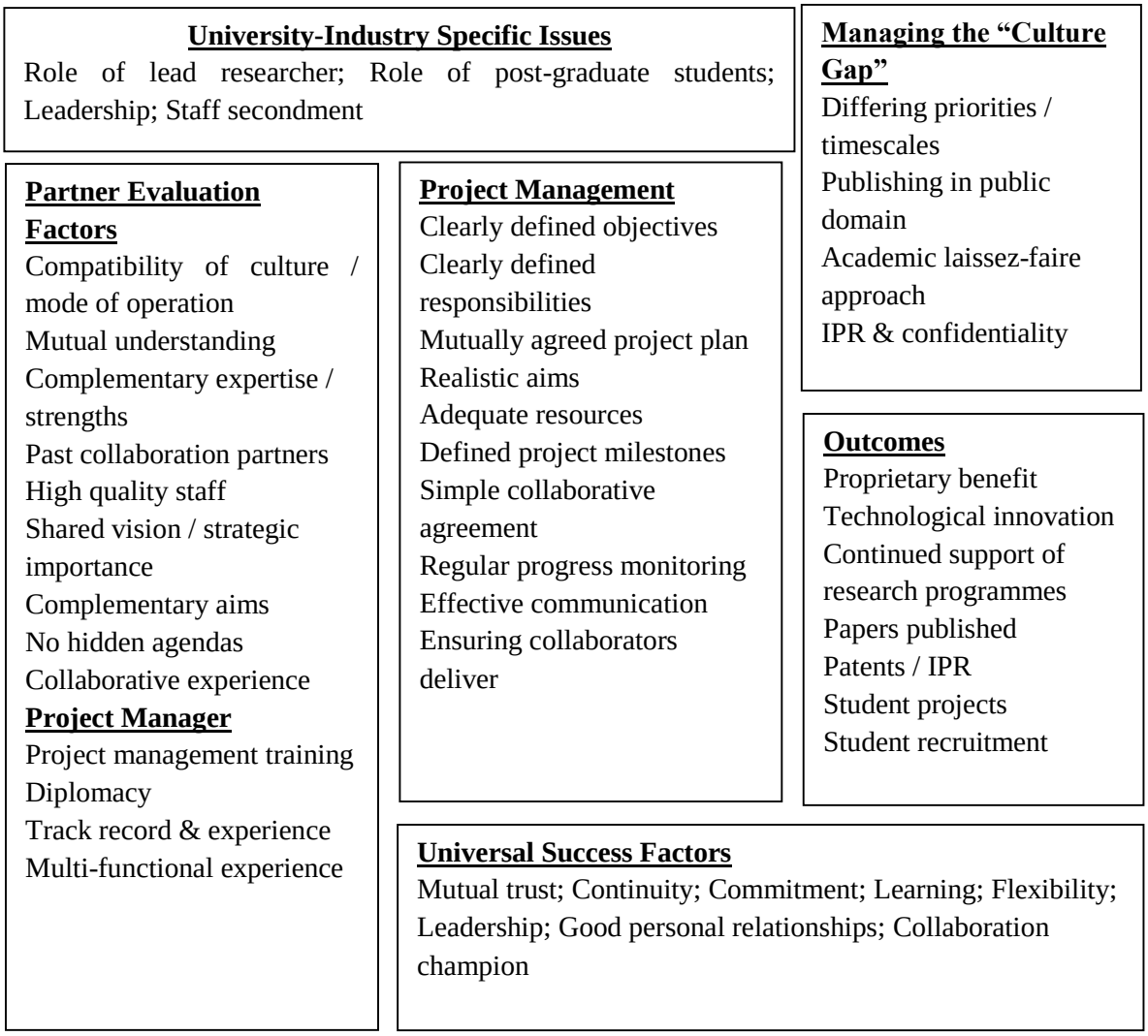


Figure 4. Key drivers for successful UBC in R&D (Source: Barnes *et al* 2002).

Also, during the in-process phase, the level of organisational involvement could become relevant for successful UBC in R&D. From the business' side, "without senior management influence, lower levels of management are unlikely to give a collaborative project the required degree of commitment, attention and priority" (Barnes *et al* 2002: 278). Moreover, from the universities' side, flexibility must be left for "academic rigour" in order to comply with the principles of academic integrity. Nevertheless, "clearly defined objectives and a structured approach to decision-making" are fundamental to any successful UBC project in R&D (*Ibid*: 208).

The output phase will mostly be reached by all of the UBC projects in R&D that already have ongoing contractual arrangements. This is true, since mostly universities and businesses will only enter contractual arrangements with confidence in their capability to meet the terms of the respective contract. Therefore, with respect to the particular drivers related to the Outcome phase, these are foremost related to the project-specific terms. Hence, the greatest incentives for reaching the outcome phase relate to the counterparties' motivation to avoid possible penalties in case of not fulfilling one's duties as well as the material benefits from completing specific tasks.

At the same time, the drivers related to the Impact phase are considerably more complex. On the one hand, this is the phase that often receives close to no attention (Seppo and Lilles 2012). On the other hand, as emphasised above, in order to reach commercial benefits, it is fundamental that UBC in R&D does indeed successfully complete the impact phase. Herein, the most critical success driver relates to commercialisation strategies and more specifically, to whether such strategies indeed exist for particular UBC projects in R&D. On behalf of businesses, an understanding of how and what to commercialise is likely more straightforward. Nevertheless, for universities, the significance of a systemic approach to knowledge commercialisation has only recently become recognised. (Toomla 2014)

For example, a relevant factor for the commercialisation strategy could be the existence of a clearly specified process for commercialising a UBC project in R&D. From the university's point of view, this starts with adopting a knowledge commercialisation mission next to the "traditional academic missions of teaching and scientific discover." (Meyer *et al* 2011: 179) Next, after recognising such a mission, the Valley of Death for transfer knowledge into a commercial application is ought to be crossed. One of the most successful methods is to have clearly defined processes along with critical resources and well-equipped partners for each respective phase of the commercialisation process. (*Ibid)*

As a result of the commercialisation process, successful spin-offs could be seen as the end-goal (Rasmussen *et al* 2013). Nevertheless, for UBC projects in R&D, the final objective could simply be a revenue and profit sharing agreement between the collaborating parties.

At the same time, the critical phases that need to be successfully completed to reach such results, could be the same phases of UBC in R&D as outlined by this respective thesis. In that case, the UBC projects that become to formulate agreements within the input phase, should already be defining commercialisation as the primary objective of collaboration.

Moreover, for UBC in R&D, the commercialisation strategies must account for the interest of both parties. Although the latter might seem rather straight-forward, it is in practice a difficult objective to be achieved. First of all, as shown above, universities and businesses themselves often find it difficult to draft strategies for a single organisation. Secondly, even if individual organisations manage to define their own interests with regard to R&D commercialisation, accounting for the interests of external organisations will introduce a dimension with much greater challenges. Therefore, with respect to the drivers that relate to the impact phase, the ability to formulate as well as execute joint commercialisation strategies will likely be the greatest determinant for indeed succeeding with UBC in R&D.

In conclusion, this chapter analysed the success drivers relevant for each of the phases within UBC in R&D. As shown above, each phase has certain critical drivers that contribute most to the successful completion of a cooperation project: absorptive capacity for the preliminary phase; ability to match university-business interests for the input phase; project management related for the in-process and output phases; and commercialisation strategy related drivers for the impact phase. At the same time, there are a number of success drivers equally relevant across phases. Herein, these drivers were categorised between high level (market demand for RDI; regulatory incentives; macroeconomic conditions) and low level ones (university-industry specific issues; partner evaluation factors; managing the "Culture Gap;" universal success factors; collaboration outcome perspectives). The following subchapter will analyse the possible methods to assess the current state of UBC in R&D at a state level.

1.3 Methods to assess university-business cooperation in research and development

This sub-chapter analyses methodologies to assess the current status of intellectual capital production via UBC in R&D. The goal is to specify, how to perform measurements so that the results could be used as basis for state level policy recommendations. Although the focus will be on assessment methods used by earlier studies, it must be noted that despite a wide literature on university-business interactions, "scholars have not developed any structure and commonly accepted systems of indicators aimed at measuring the results of these collaborations" (Piva, Rossi-Lamastra 2013: 40). Hence, since there are no widely accepted approaches, the beforehand sub-chapter must construct a theoretical understanding for what then constitutes a functional assessment methodology.

The lack of such a consensus is not unique to UBC, but rather inherent to any cooperation projects that include diverse "structural and institutional characteristics." University-business cooperation is simply "prototypical" to latter cases. (*Ibid*: 41) Moreover, only recently have UBC in R&D indicators become a significant research topic, although any quantitative and/or qualitative approach still poses substantial limitations. On the one hand, quantitative methods require simplifications prior to reaching any applicable inferences. On the other hand, qualitative methods risk substantial biases due to the subjectivity of evaluations.

Because the drivers of UBC in R&D are hardly ever numeric, the core focus of quantitative analysis has to rely on easily recorded output measures - e.g. number of patents or research expenditures (Autant-Bernard, LeSage 2011), number of financing mechanisms for UBC (Varblane *et al* 2012), number of collaboration initiatives, etc. Under a narrow framework, these indicators could indeed provide inferences. For example, Autant-Bernard and LeSage (2011) study the rate of knowledge spill-overs via spatial econometric models. For such a purpose, quantitative methods are surely. Also, Varblane *et al* (2012) have compared governmental support measures toward enhancing UBC in Europe. Because financing involves clear quantitative characteristics, it is also reasonable to employ quantitative assessment methods.

However, while assessing UBC in R&D at a state level, quantitative research could only observe the easily measurable nuances (as specified above, number of patents, number of financing mechanisms for UBC, number of collaboration initiatives, etc). A more complex alternative would be to derive proxies to successful UBC in R&D via subjective evaluations such as participants' satisfaction with the process and outcomes. E.g. Grimaldi and von Tunzelmann (2002) have constructed an indicator that builds on both direct and indirect (future) results of alliances, whereas a qualitative indicator observes "the potential for commercial exploitation of patents and scientific results and the possibilities of project follow-ups." (*Ibid*) Additionally, as Piva and Rossi-Lamastra (2013) pointed out, Grimaldi and von Tunzelamann introduced a third indicator: "the degree of correspondence between the initial objectives and the actual results achieved by the collaborative project." The latter indicator, too, requires qualitative assessment methods. (*Ibid*: 45)

At the same time, more recent research has derived even more complex proxies: e.g. Al-Ashab *et al* (2011) developed a Balanced Scorecard based on interviews with ten British firms operating in different industries. While focusing on businesses and universities that engage in Open Innovation practices (see also Chpt 1.2), their goal was to construct a mechanism that would allow to quantify the success of UBC in R&D. Inspired by the Balanced Scorecard methodology of Norton and Kaplan, the principles were adjusted and explicit KPIs for UBC in R&D were developed. Nevertheless, although their approach was proven instrumental for businesses, they provide little evidence on whether, in fact, the Balanced Scorecard could also assess collaboration from the perspective of universities.

A similar shortfall in Ashab *et al* (2011) methodology is noted by Piva and Rossi-Lamastra (2013), who alternatively argue, that the most significant contribution to generating evaluation mechanisms for UBC in R&D would be the Perkmann *et al* (2011) success map (see also Chapter 1.1). According to their approach, UBC in R&D may be assessed via the respective metrics for each phase (see also the figure 5 below - the upper part represents the success map; the lower part appropriate metrics).

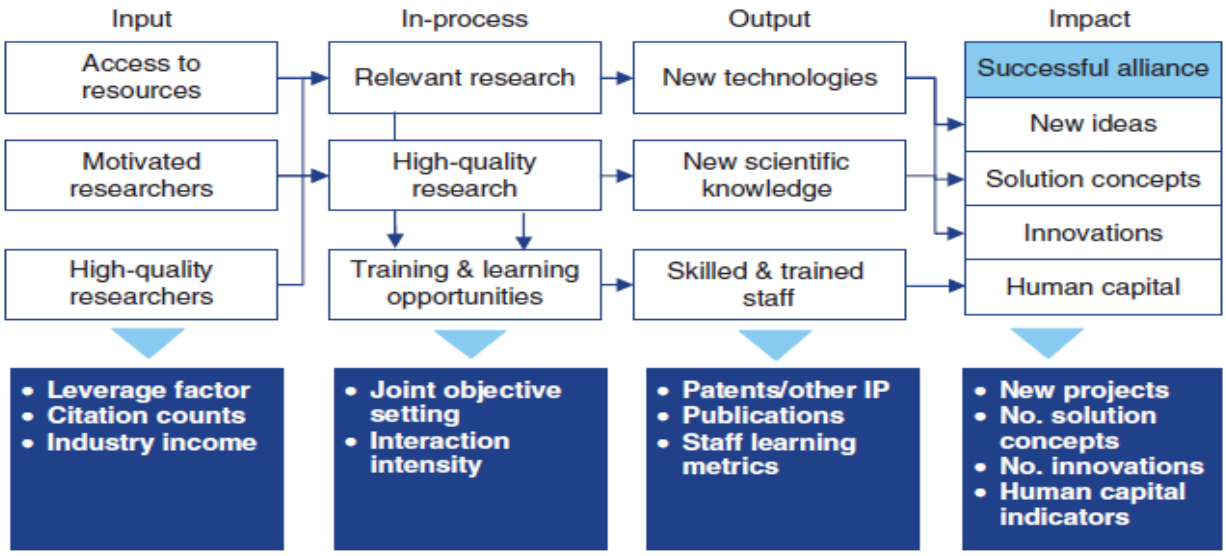


Figure 5. Success map of UBC in R&D with metrics (Source: Perkman *et al* 2011: 208).

Nevertheless, the metrics by Perkman *et al* (2011) still omit numerous drivers for UBC in R&D. First, as discussed in Chapter 1.1, their success map does not include the formation of a need for intellectual capital production; nor does it include the commercial impact as part of the process. Therefore, in order to assess UBC in R&D at a state level, a wider framework should be used with relevant drivers also observed for the latter two phases. Moreover, firms rarely "assess these relationships via hard performance measures" (*Ibid*: 203). Instead, qualitative nuances that are coupled with some quantitative metrics (e.g. number of partners that engage in cooperation throughout multiple projects) have a critical importance for assessing the success of UBC in R&D.

Also, while drafting a specific methodology for state level assessments, the specific nature of university-business interactions should be considered. Particularly, developed economies that already have trilateral networks and hybrid organisations- meaning that they have reached Triple Helix III (see also Chpt 1.1)- will be better prepared for the kind of quantitative performance analysis that Perkman *et al* (2011) have proposed. In Triple Helix III, university-business interactions are well established, which in turn means that the causes of the economies' poor and/or successful UBC in R&D are easier to be systematically traced.

For example, Fromhold-Esibith (2011) study UBC on the example of Eindhoven and Aachen Universities in the Nerherlands, which are both great example of academic institutions operating within a structured and intense network of privately established R&D units working side-by-side with academia. Both of the universities operate in clustered networks at which UBC in R&D can thrive. Also, since these networks have established concise forms of collaboration, it becomes much easier to model such collaboration with quantitative methods.

Yet, in the case of catching up economies (e.g. Estonia) that still lag in Triple Helix II (the *laissez fare* phase), the university-industry interactions are still arbitrary, which makes it difficult to assess collaboration via hard performance measures. Instead, since excess simplifications can be avoided, qualitative methods will likely provide greater instrumental value. This is due to quantitative approaches will rather observe the outcome in comparison to some other economies, and thus provide little options to pinpoint, how to enhance UBC in R&D.

The latter is supported by the earlier experience of science, technology and innovation (hereinafter STI) indicators, which have been under constant development starting from the 1950s. Nowadays, comparisons regarding the STI indicators between developed, catching up and other developed economies are still difficult to make (Freeman, Soete 2007). Moreover, for catching up economies in the Eastern Europe, collapsing of the Soviet Union embarked a rapid "implosion" of the research system, which subsequently lead to an "involuntary under-development of R&D activities" (*Ibid*: 8).

Therefore, in order to grasp the complexity of evolutionary innovation systems that lag in the earlier phases of Triple Helix, the collaboration patterns must simultaneously be observed from multiple perspectives, and often placed into contexts that standard indicators would not capture (Fromhold-Esibith 2011). To resolve such a challenge, Ramos-Vielba (2009), for example, observed university-industry linkages in Andalusia- a province of Spain- with the purpose of validating the UBC in R&D indicators for both academia as well as businesses.

While performing their research, they specified several overarching methodological short falls that most of the research on UBC tends to witness.

First, researchers tend to solely focus on either businesses or universities. Secondly, although most of the empirical research is conducted on either of the two parties, conclusions are often still drawn for both sides. For example, research focused on firms tends to entail the following limitations: projects are often aimed at industries closely related to research, e.g. biotechnology; studies with larger samples normally adopt data pools that are not explicitly designed for the purpose of UBC in R&D (e.g. the Community Innovation Surveys and there are notable problems with heterogeneity of sources that tend to be consistent among, for example, the European economies, but often even contradictory to the findings of North America. (Ramos-Vielba *et al* 2009: 652) Herein, the latter does not mean that research cannot be conducted on UBC in R&D with the above listed disadvantages. However, if specific recommendations are sought for enhancing the success of UBC in R&D, these disadvantages will weaken the ability to provide meaningful conclusions.

At the same time, research focusing on universities faces the short falls by traditional commercial indicators, which tend to be insufficient to measure "the wider spectrum of potentially productive contributions in universities." Furthermore, the procedures set up by universities to monitor the Third Mission activities (engagement in UBC in R&D) are rarely homogenous, and thus, difficult to evaluate from a narrow perspective. Also, as already noted above, there are considerable limitation to the data regarding the input-indicators (the STI) of universities' commercial R&D. (*Ibid*: 653)

Hence, in order to resolve such shortfalls within the assessment of UBC in R&D, the framework should be widened so that research would grasp both universities and businesses. Specifically, "the whole spectrum of possible knowledge exchanges between the two actors must be observed in order to capture the rationale behind university-industry relationships and to determine the role they play as sources of innovation." (Ramos-Vielba *et al* 2009: 654) This is also agreed by Davey *et al* (2011), who surveyed university and industry

representatives, and used factor analysis to detect the structure of inter-dependent relationships (*Ibid*: 651).

While observing some of the most recent studies, it is clear that the necessity to include both the university as well as business perspectives has become recognised. The above mentioned studies by Perkman *et al* (2011), Davey *et al* (2011), Ramos-Vielba (2009) as well as Vadi and Rajalo (2013) are such examples. In addition, recent studies analysing the most effective methods of assessing UBC in R&D tend to result in similar conclusions (e.g. Piva and Rossi-Lamastra 2013). Herein, perhaps the most instrumental studies are such that identify the possible indicators for assessing UBC in R&D.

For example, Masso *et al* (2013) have analysed possible indicators for assessing the success of UBC in R&D. Herein, although these indicators have been provided as part of a wider analysis on possible RDI indicators, their approach is in fact rather informative due to their assessment of respective indicators. They divide the cooperation process into three phases- input, activity, and output- whereas possible evaluation indicators are identified for each phase. As they consider the validity, economy of usage, and the quality of usage, they conclude that among the input indicators, the most effective could be to observe the R&D expenditures of HEIs, financed by enterprises. At the same time, for the output indicators, the most effective would be to observe the businesses' evaluation of the UBC in R&D. (*Ibid*: 103)

Along the same lines, Seppo and Lilles (2012) propose a similar cooperation process methodology. However, they argue that the focus of such indicators should be on the economic impact and relationship-based indicators. Specifically, they categorise the indicators into four groups: inputs, activities, outputs, and impacts. For the inputs, they define five sub-categories of key indicators (*Ibid*: 213):

- resources (e.g. R&D expenditures; university's governmental income; grants and contracts; industry funding; etc);
- researchers' capabilities (e.g. number of publications, citations, projects, patents in the past; etc);

- researchers' motivation (e.g. number of earlier contracts for UBC in R&D; number of strategies in the department for UBC in R&D; etc);
- firms' capabilities (e.g. number of quality certificates; previous UBC in R&D; number of scientists; etc);
- firms' motivation (e.g. number of previous contracts with universities; involvement with the university; etc).

In general, measuring the success at the input stage as defined by Seppo and Lilles (2012) relies mostly on relationship indicators. However, for the output and impact phases, assessing UBC in R&D relates mostly to hard numeric measures. Furthermore, explicitly with regard to the impact indicators, these are mostly on a macro level: e.g. GDP per capita; total factor productivity; number of share of high growth enterprises; share of inward FDI per GDP; knowledge intensity of production; etc. (*Ibid*: 213). While such indicators could indeed provide a general understanding of the current state of UBC in R&D, these will likely provide little explanation on the low-level impacts of specific UBC projects in R&D. A similar disadvantage relates to the indicators identified and validated by Masso *et al* (2013).

To resolve the latter, both the university and business perspectives could be included, while at the same time, observing the low- and high-level indicators related to the success of UBC in R&D. From a state level perspective, such a methodology could enable to assess both whether the primary conditions are favourable towards UBC in R&D, whereas the low level component could provide an explicit understanding of how to enhance successful cooperation at a project level. On larger scales, such a hybrid assessment methodology could perhaps not function. Nevertheless, within small economies, or at a regional level, cases like the UK's LINK scheme (Grimaldi and Tunzelmann, 2002), or the Triple Helix strategies in the smart cities (Lombardi *et al* 2011), such methodologies could certainly be considered.

In conclusion, there clearly is no commonly accepted methodology for assessing UBC in R&D. Therefore, a functional methodology will likely need a separate drafting by each economy. Nevertheless, as analysed in this sub-chapter, several principles are still universal for any assessment of UBC in R&D. First, depending on the exact level of economic

development as well as the stage of an economy's Triple Helix, the right combination of quantitative and qualitative methods is ought to be used. Secondly, it is clear that the cooperation process is ought to be divided into phases. Third, as shown by the sub-chapter 1.2, critical success drivers need to be supported in order to advance to the subsequent phases until eventually reaching the commercial benefits at the impact phase. Thus, an assessment of UBC in R&D would likely need to gear towards analysing the rate of success drivers present within a certain economy. The following chapter will outline the results of performing a similar assessment for the Estonian economy.

2. ESTONIAN UNIVERSITY-BUSINESS COOPERATION IN RESEARCH AND DEVELOPMENT

2.1 The status of research and development in Estonia and specification of the research methodology

The objective of empirical research is to find out, how to enhance the Estonian UBC in R&D. First, to define the broader context and the significance of UBC in R&D, the status of the Estonian RDI is discussed. Secondly, the empirical research methodology is specified along with a brief sample description. The following chapters will then describe the current state of the Estonian UBC in R&D, and provide policy recommendations on how to enhance UBC in R&D as an effective contributor to RDI.

As elaborated in earlier chapters, the Estonian research system has faced the need to evolve from the Soviet era stagnation in a complete separation of universities and businesses (Triple Helix I) towards complete tri-lateral networks and hybrid organisations (Triple Helix III). Nevertheless, for quite some time now, Estonia has remained in the *laissez-fare* phase (Triple Helix II), which is still characterised by a low absorptive capacity (Laine, Varblane 2010), and thus little uptake of UBC in R&D.

This is supported by the Europe 2020 Competitiveness Report (WEF 2012), which concludes that despite Estonia's exceptional convergence with the developed economies in terms of the competitiveness indicators, its success has not yet translated into an innovative business culture with a high UBC intensity (WEF 2012: 24). The latter is supported by Varblane *et al* (2012), who point out that the Estonia "has a small number of cooperation measures and the real cooperation from firms' side is also weaker." (Varblane *et al* 2012: 1) While comparing Estonia to other CEE countries, Serbănică and Drăgan (2012) also confirm that the Estonian firms collaboration with universities is remarkably low: only 14,5% of the firms that engage

in technological innovation have a collaborative engagement with universities (*Ibid*: 838). Additionally, Davey *et al* (2011) have reported that on average, 3,9 Estonian scientists out of 30 engage in collaboration with businesses (*Ibid*: 74). That clearly shows that Estonian UBC in R&D is currently performing poorly.

Fortunately, local innovation experts and policymakers are gradually noticing the problem. A most recent example is the Estonian Research and Innovation Policy Monitoring Programme (TIPS Programme) that has produced a series of reports on both Estonian RDI in general, as well as explicitly on the need to improve UBC. For example, within the Assessment of the Estonian Research and Development and Innovation Strategy 2007 – 2013 "Knowledge-Based Estonia" (hereinafter the Estonian RDI strategy) Kattel *et al* (2012) conclude that regarding basic science indicators, the Estonian universities have performed well, since most of the strategic goals have been achieved. Yet, the business-related goals are far from being achieved. (*Ibid*: 4)

At the same time, while compared to most of the other catching up economies of Eastern Europe, Estonia's innovation indicators are among the top improvers. For example, apart from other economies within the region that have remained "moderate innovators," Estonia has arguably achieved the status of an "innovation follower." Nevertheless, as depicted on the figure 6 below, Estonia is still a step behind of the "innovation leaders," who operate at the frontier of RDI. (Truve 2013: 13) Herein, the main indicators that still hold Estonia back from reaching the group of "innovation leaders" are directly related to a low level of UBC as well as ineffective knowledge transfer mechanisms (Kattel *et al* 2012).

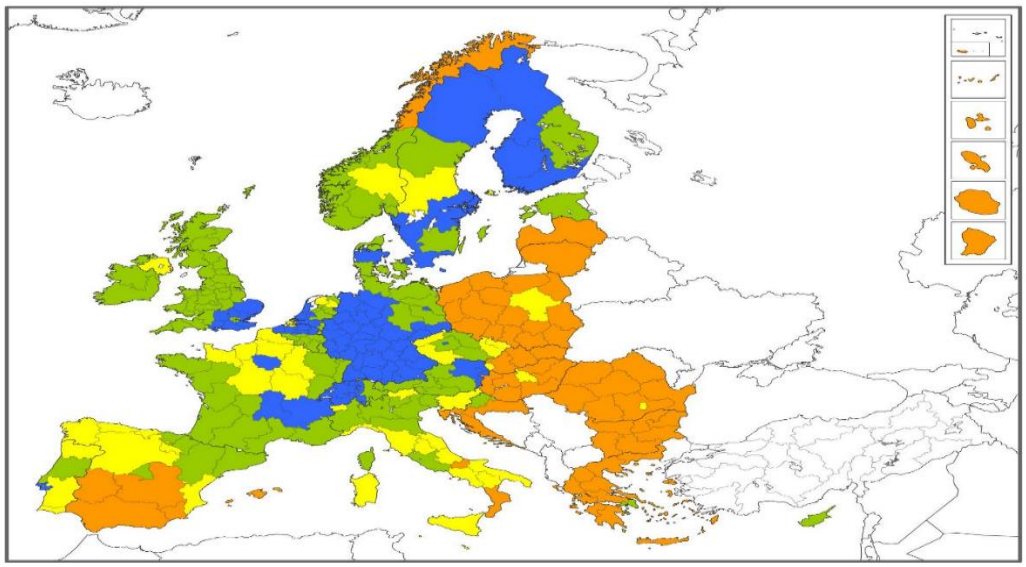


Figure 6. Innovation leaders (blue); innovation followers (green); moderate innovators (yellow); modest innovators (orange) (Source: Truve 2013)

Similar problems have been recognised by research conducted as part of the TIPS Programme. For example, the assessment of the Estonian RDI strategy for 2007 - 2013 argues that strong emphasis must be placed on cooperation between Estonian businesses, state institutions and universities. Conclusively, as shown on figure 7, the authors have outlined the targets for the Estonian 2014 – 2020 RDI, which explicitly places the economic effects of RDI at the central focus. As seen from the figure 7 below, one of the four strategic fields to achieve the latter goal, is "the coherency of academic, entrepreneurial and economic networks." (Kattel *et al* 2012: 4 - 5) This is tied closely to the need for enhancing UBC in R&D.

Yet, there are no commonly accepted methods to assess university-business interactions (see also Chapter 1.3), although as part of the TIPS Programme, efforts have been targeted towards developing such methods for the Estonian UBC in R&D. For example, Masso et al (2013) provide an elaborate discussion on which indicators should be used. In short, as also discussed in Chapter 1.3, there are three types of indicators: targets, inputs, and process indicators. The combination as well as a particular methodology for using these indicators depends on the individual research goals. At the same time, while they define specific indicators for different goals, they also point out that there are no functional indicators to

assess the success of UBC in R&D. Moreover, there are currently no research projects that would gather data on a national level to assess the success of UBC in R&D. As a potential solution, they argue that it could be instrumental to gather feedback from both collaborating parties on particular projects. (*Ibid*: 102)

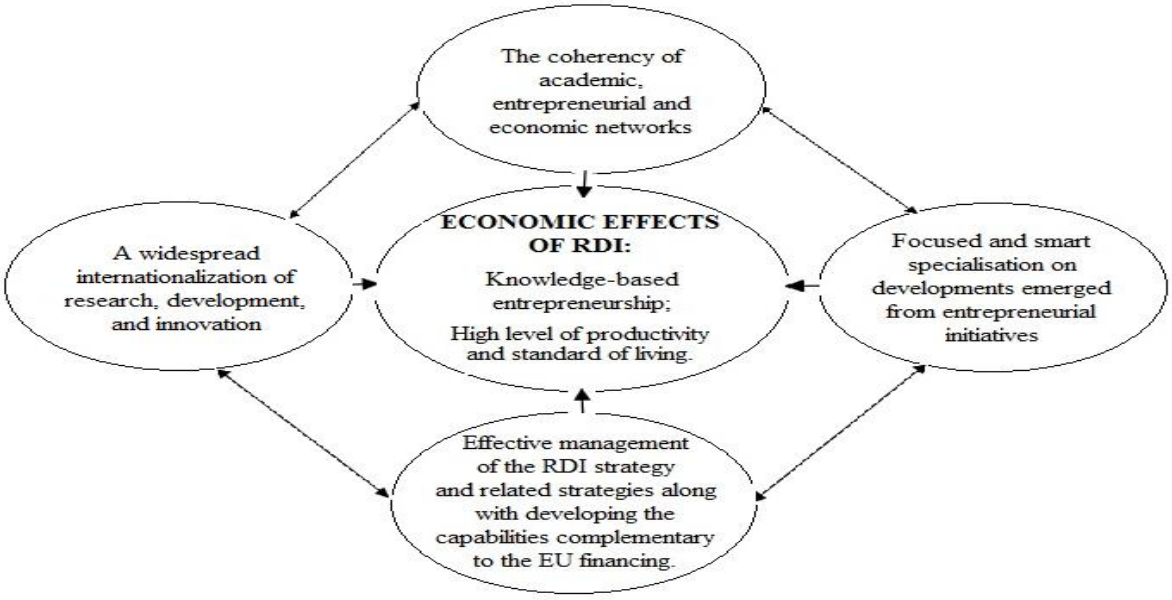


Figure 7. The recommended key goal for the Estonian RDI strategy 2014 – 2020 and related fields of development (Source: author's translation based on Kattel *et al* 2012: 5).

Thus, given that the goal of the beforehand thesis is to study, how to enhance the Estonian UBC in R&D, the research methodology focused on filling the above defined gap. Semi-structured interviews were performed with universities and businesses on project specific basis independently with both collaborating parties independently. A similar approach was used by Vadi and Rajalo (2013), who also conducted semi-structured interviews with business and university representatives as part of the TIPS Programme. Nevertheless, their approach did not involve both collaborating parties from the same projects, and they did not explicitly focus on success drivers for UBC in R&D. The following will provide further details on the explicit research methodology used by the author.

To detect and measure the concentration of drivers for successful UBC in Estonia, eight cooperation projects in R&D were closely investigated. As specified below, all of the observed cases represented different business verticals and if possible, different university

representatives so that a broad-based overview of the particular problems could be constructed. In addition, two companies were interviewed that were initially known to have performed UBC in R&D. Nevertheless, during the interviews, it was identified, that they do not have experience with R&D collaboration, but rather some other forms of collaboration that did not suit the definition. Among other results, their reasoning for not engaging in UBC in R&D is discussed in Chapter 2.2.

As already specified, for each project, semi-structured interviews were conducted separately with both the university and business representatives. All of the projects involved strictly two collaborating parties: one from the business' side, and the other from the university. To ensure that the perspective of all counterparties was included, cooperation projects with strictly two collaborating parties were investigated. The latter included two special cases. In one instance, the university representatives that participated within the project were from two different faculties. However, they operated as a joint team with shared responsibilities. Therefore, they still met the definition of a single collaborating partner. In another case, the collaboration project involved more than two parties. However, the specific focus of the interviews was at a sub-project level that was limited to the two interviewed parties.

Universities and businesses were interviewed for eight collaboration projects. In addition, two businesses were interviewed with an initial understanding that they both have earlier experience in collaborating with universities. Nevertheless, this turned out not to be the case (see the reasoning in Chapter 2.2). While constructing the research sample, the primary aim was to generate a horizontally diverse set of observations. On the one hand, it avoids sector-specific biases; on the other hand, a horizontally diverse sample provides an overview of the common denominators for any UBC projects in R&D. At the same time, the objective was also to study as many different Estonian R&D institutes and academic organisations as possible so that again, broader conclusions could be drawn on Estonian UBC in R&D.

Also, the idea was to foremost observe the cases that have reached commercial results and/or have a clear outlook for the latter. Although this was not achieved for all of the observed cases, the fact that three of the projects comply with the latter, enables to assess the entire

cycle of UBC in R&D up until the impact phase. Herein, Chapter 2.2 describes the respective findings. The table 3 below provides a brief overview of the sample.

Table 3. Overview of the research sample

Case	Organisation (related field for businesses)	Name of the interviewee(s) (Position)	UBC project
1.1	VTT-NTM OÜ (interferometers)	Maria Voznessenskaya (CMO)	PDI 2
1.2	Inst. of Physics, Univ. of Tartu	Arne Kasikov (Researcher)	
2.1	Üle OÜ (road maintenance)	Marek Koit (Member of Board)	IcePreventer
2.2	Keemilise ja Bioloogilise Füüsika Instituut	Kristian Sülluste (R&D coordinator)	
3.1	Tere AS (dairy production)	Mare Reiman (Head of product development)	ME-3 (probiotic lactic acid bacteria *Lactobacillus fermentum* ME-3")
3.2	Technology transfer office, Univ. of Tartu	Jane Saatre (Intellectual Property Manager)	
4.1	Quattromed HTI Laborid OÜ (biotechnology)	Kristian Ratnik (Laboratory specialist)	Happy Pregnancy
4.2	Instit. of Molecular and Cell Biology, Univ. of Tartu	Prof. Maris Laan (Professor of Human Molecular Genetics)	
5.1	Põltsamaa Felix AS (food manufacturing)	Karin Kustavus (Product Manager)	Survey of implicit associations
5.2	Faculty of Economics and Business Administration, Univ. of Tartu	Andero Uusberg (Researcher)	
6.1	JukuLab OÜ (ICT)	Andres Mellik (CEO)	Language robot
6.2	Estonian Academy of Security Sciences	Marek Link (Head of Innovative Learning Technology Center)	
7.1	Elektrilevi OÜ (energy)	Margus Sirel (Head of the Strategic Planning Department for Asset Management)	Smart grid network
7.2	Department of Electrical Power Engineering, Tallinn University of Technology	Prof. Juhan Valtin (Associate Professor)	
8.1	BoatArt OÜ (boating)	Richard Murutar (CEO)	Cumulus design
8.2	Estonian Academy of Arts	Tuuli Trei (Project Manager)	
9.1	Eolane Tallinn AS (electronics)	Emöke Sogenbits (CEO); Sixten Kerge (Quality Manager)	n/a
10.1	CrystalSpace OÜ (space satellite production)	Jaan Viru (CEO)	n/a

Source: Constructed by the author

With regard to the research methodology, since the goal of the thesis is to study the current state of the Estonian UBC in R&D and provide recommendations for enhancement, it is

important to first understand, what has driven the already occurring collaboration. Based on such understanding, it can be assessed, whether the current policy mechanisms facilitate favourable conditions to support these drivers. If not, the state level policies should be adjusted (see the discussion in Chpt 2.3) so that more projects could perform successful UBC in R&D. Specifically, each project was analysed in accordance with the phases of the process cycle of UBC in R&D (see also Chpt 1.1).

During face-to-face interviews, each of the phases of a particular cooperation project was walked through (see also figure 1). To map the companies' and universities' positioning for the preliminary phase, general questions were asked on their engagement in product and/or service development cooperation, and engagement in earlier UBC in product/service development. R&D was narrowed down to product/service development in order to achieve an explicit focus, and also to maintain a concise focus throughout the interview sessions. Additionally, for studying the other four phases of UBC in R&D (input, in-process, output, and impact phase), it was reasonable to pinpoint specific product/service development projects. For each phase, questions were designed to detect, whether the success drivers that could theoretically be relevant (see Chapter 1.2) were also present in the observed UBC projects in R&D. The same discussion was independently carried out both with the university as well as business representatives.

Apart from Vadi and Rajalo (2013), perhaps one of the closest methods has been used by Davey *et al* (2011), who observed HEI (Higher Education Institutes) and business representatives in order to study drivers as well as barriers to successful UBC in R&D. However, they performed a Europe-wide survey among businesses and HEI representatives. The considerably wider geographical scope also prescribed the usage of other methodologies than face-to-face interviews. Moreover, they observed both the drivers as well as barriers to successful collaboration. In the current case, the focus is drawn to only the drivers of successful UBC in R&D (see also Chapter 1.2 for the reasoning).

Also, neither of the latter studies performed face-to-face interviews with both collaborating parties explicitly from the same cooperation projects. This prevented these studies from

drawing in-depth conclusions on collaboration-related success drivers. Thus, this thesis observed eight specific cases among university and business representatives in the context of specific cooperation projects. In order to conduct the case-specific investigations, in depth face-to-face interviews were performed with both the university as well as business representatives for each case. Although this allows for a considerably smaller sample, and therefore potentially reduces validity, it also improves the level of specificity for analysing each cooperation project.

It is in alignment with Piva and Rossi-Lamastra (2013), who defined three problems in relation to assessing the success of UBC in R&D: (a) "Firms commonly pursue multiple goals when they establish alliances with universities." If both counterparties are interviewed, it is possible to detect the number of goals that firms have for each specific project, and based on these goals, it can be assessed, whether the respective projects have been successful; (b) "Alliances with universities pose specific problems" for businesses. These problems can best be identified, if both the university and business representatives have the opportunity to provide specific details of their cooperation projects; (c) "The outputs of university-industry alliances have both tangible and intangible nature," meaning that most of the output can be detected by an approach that again includes both counterparts, and that can best become grasped via face-to-face interviews. (*Ibid*: 2)

Secondly, since universities operate on fundamentally different foundations than businesses (see Chapter 1.2), their motivators to pursue UBC could in fact undermine the business' side drivers, and vice versa. Hence, the current approach allows to detect profile-related contradictory viewpoints for each specific UBC project, and subsequently assess, whether these contradictions could be extended to UBC in general. If so, a one-side perspective could produce biased conclusions on what in reality drives successful UBC in R&D.

Third, Estonia still operates in Triple Helix II (the *laissez fare* approach to UBC), which means that more flexible approaches to assessing UBC in R&D must be used in order to generate constructive inferences (see also Chapter 1.3). This is different from well-

established economies at which systemic interactions have been in place for a long time, and therefore, more quantifiable measures can be used for assessing UBC in R&D.

The questionnaire is divided between two sections. The first half focuses on the earlier defined phases of UBC in R&D, and follows the principles of open-ended content mapping (Ritchie and Lewis, 2003). Herein, the rationale is to collect information that in case of a predefined set of answers would most likely be overlooked. Moreover, in order to encourage the interviewee to elaborate, each of the open-ended questions uses a certain probing technique: either amplificatory, exploratory, explanatory, or clarificatory (*Ibid*: 150 - 153). Appendix 1 provides an overview of the questions with a specification on the probing type that the particular question has.

The second part of the interview uses structured questions. These are designed to cross-check and further specify the answers, and at the same time, provide a more concrete indication on whether the drivers for successful UBC in R&D are represented. All of the drivers outlined within the structured part of the interview script have been identified by earlier research as relevant drivers for successful UBC in R&D (see also chapter 1.2). Furthermore, while inspired by Barth *et al* (2002), the drivers were divided into six categories: university-industry specific issues; partner evaluation factors; project management; managing the "culture gap;" universal success factors; and outcome perspectives.

For the universities' side, the motivation for specific interview questions is rather the same as for businesses. There were only some slight adjustments to the questions so that the interview would be applicable to the perspective of university representatives. An overview of which questions have been modified within the universities' interview script, and which remained unchanged, is provided in Appendix 2.

In conclusion, this sub-chapter has shown that UBC in R&D will clearly have a central importance within the Estonian RDI strategy for 2020. Therefore, after providing an overview of the research sample and methodology, the following sub-chapter will analyse the currents state of the Estonian UBC in R&D based on the findings of empirical research.

After elaborating on the respective findings, the last sub-chapter will then provide policy recommendations to enhance UBC in R&D.

2.2 The current state of the Estonian university-business cooperation in research and development

The description of the Estonian UBC n R&D is built on analysing the current state of the drivers for successful UBC in R&D that were elaborated in Chapter 1.2. The logical sequence of the analysis follows the five process phases for UBC in R&D as they were defined in Chapter 1.1. While discussing each of the phases, a detailed overview becomes depicted on how the success drivers have functioned in the cases of the observed collaboration projects. Particularly, with regard to each phase, first the critical drivers are discussed (absorptive capacity, ability to match university-business interests, project management, and commercialisation, respectively). Then, the success drivers for all phases are observed.

First of all, out of the eight observed projects, three have reached some sort of an impact phase, meaning that the cooperation has yielded commercial results (ME-3 by Tere AS and the Institute of Microbiology and Institute of Biochemistry of the University of Tartu; the implicit associations test by Põltsamaa Felix AS and the Department of Economics of the University of Tartu; and the language robot development by JukuLab OÜ and the Estonian Academy of Security Sciences). Two projects have reached the output phase, but these have still not had commercial results (Smart grid network development by Elektrilevi OÜ and the Department of Electrical Power Engineering of the Tallinn University of Technology; and the 3D modelling of Cumulus by BoatArt OÜ and the Estonian Academy of Arts).

Two of the observed projects have ended in earlier phases: PDI2 by VTT-NTM OÜ and the Institute of Physics of the University of Tartu; and IcePreventer by Üle OÜ and KBFI. Happy Pregnancy project (or more specifically, the pregnancy marker test development on the Luminex platform) by Quattromed HTI Laborid OÜ and the Institute of Molecular and Cell Biology of the University of Tartu are still currently at the in-process phase.

In addition, there are two businesses observed (Eolane Tallinn AS and CrystalSapce OÜ) that were known to collaborate with universities. However, while conducting the interviews, it turned out that neither of the two companies have engaged in R&D cooperation with universities by using contractual arrangements. Their reasoning for not doing that is elaborated at the later part of the sub-chapter. In conclusion, the table below specifies the phases that each of the cases have reached.

Table 4. Specification of the phases that each of the projects lies in

Case	**Specification**	**Phase**
Case 1 (PDI 2)	PDI 2 development by VTT-NTM OÜ and the Institute of Physics at the University of Tartu.	Input
Case 2 (IcePreventer)	IcePreventer development by Üle OÜ and Keemilise ja Bioloogilise Füüsika Instituut.	Input
Case 3 (ME-3)	ME-3 industrial implementation by Tere AS and the Institute of Microbiology and Institute of Biochemistry, Univ. of Tartu.	Impact
Case 4 (HappyPregnancy)	HappyPregnancy development by Quattromed HTI Laborid OÜ and the Institute of Molecular and Cell Biology at the University of Tartu.	In-process
Case 5 (Implicit associations)	Implicit associations analysis by Põltsamaa Felix AS and the Faculty of Economics and Business Administration.	Impact
Case 6 (Language robot)	Language robot development by JukuLab OÜ and the Estonian Academy of Security Sciences.	Impact
Case 7 (Smart grid development)	Smart grid network development by Elektrilevi OÜ and the Department of Electrical Power Engineering, Tallinn University of Technology.	Output
Case 8 (3D-modelling)	3D-modelling of the Cumulus sailboat by BoatArt OÜ and the Estonian Academy of Arts.	Output
Case 9 (EMS)	Electronic Manufacturing Services development by Eolane Tallinn AS.	No collaboration
Case 10 (Satellite)	Space satellite development by CrystalSpace.	No collaboration

Source: Constructed by the author

With regard to the preliminary phase, the observed cases provided little additional information in comparison to what is currently known with regard to the Estonian UBC in R&D. This was expected, since the formation of the need for RDI occurs on a national level, and therefore, there are little case-specific drivers that could potentially affect the latter (see

Chapter 1.1 and Chapter 1.2). However, all of the observed UBC projects in R&D stem from some sort of market demand for better solutions. Moreover, all of the businesses reported that they would not have performed the project without the participation of the universities, which means that in order to meet the market demand for RDI that formulates in the preliminary phase, UBC in R&D is clearly needed.

Moving on to the input phase, as it was specified within Chapter 1.2, the most critical driver was absorptive capacity, followed by earlier experience, institutional resources, and spill-over rates. Since in minimum, all of the observed cases advanced from the preliminary phase to at least the input phase, it indicates that these organisations must have some level of absorptive capacity. Indeed, except Case 9 and Case 10 that did not have experience with UBC in R&D, all of the collaborating parties had specific employees that managed the R&D projects. Nevertheless, to save on cost, these employees were appointed on case-by-case basis, meaning that their daily work also included some other critical activities.

With regard to earlier experience as another driver for the input phase, most of the organisations had several ongoing cooperation projects. However, four out of the eight businesses, and respectively one out of the eight university representatives that engaged in UBC were not aware of the number of their earlier collaboration projects. Yet, all of the 16 interviewees responded that earlier results had created additional interest to engage in new collaboration. The latter was true even for the three cases that did not manage to proceed from the input phase. This clearly indicates that earlier collaboration is a significant driver of UBC in R&D, and it also supports the notion of cyclicality within UBC in R&D.

Out of the collaborating cases, only the UT's research group from Case 4 did not have earlier collaboration experience with businesses. This was apart from the two cases that were found not to have contractual arrangements as means of collaboration with universities. With regard to Case 9 (Eolane Tallinn AS), their contact with universities was explicitly related to Mechanism 1 (training of human resources) and Mechanism 2 (social networks and informal contacts). Regarding Mechanism 3 (contractual arrangements), which is in the scope of this particular thesis (see also Chapter 1.1), Eolane Tallinn had not engaged in such cooperation.

The latter is partly related to the fact that the company provides sub-contracting services, and this does not require R&D. At the same time, even if the company wanted to perform R&D in collaboration with local universities, it could not do it due to the lack of universities' expertise in electronics manufacturing. (Sogenbits 2014; Kerge 2014) Herein, also, the aim of this particular analysis was to assess the Estonian UBC in R&D. Thus, even if international collaboration could be considered possible in this case, it provides little input for this thesis.

Regarding Case 10 (CrystalSpace OÜ), the company is a young spin-off from the ESTCube-1 programme, established by three graduate students from the UT's Institute of Computer Science. They already have the skills as well as the informal access to all the academic resources (including the research laboratories and scientists). Thus, while they pursue most of their R&D in-house and occasionally consult with the faculty informally, they do not need UBC in R&D through contractual arrangements (Viru 2014). Therefore, Case 10 stands out as an example that confirms the tendency of some researchers and enterprises preferring informal collaboration, if the level of trust is high enough as well as if the central goal is to occasionally exchange ideas and discuss possible means for resolving challenges (see also Chpt 1.2). Moreover, the spin-offs from universities could stand as separate commercialisation cases for universities, which does not necessarily follow the pattern of UBC in R&D (see also the Chapter 1.2 analysis regarding commercialisation strategies at the impact phase).

While observing the motivation for starting the collaboration project, five of the eight cases pointed out that the business side initiated the cooperation. Two of the respective cases identified the university as the initiator. Most interestingly, within Case 3 (ME-3), both of the respondents identified themselves as the initiators of collaboration. Tere AS pointed out, that the company was actively looking for new solutions to differentiate their products from competitors (Reiman 2014). Similarly, the Department of Technology Transfer from the University of Tartu indicated that the university was seeking a commercial application for the newly discovered ME-3 bacteria (Saatre 2014). In a way, ME-3 represents a perfect match of university-business interests. Since ME-3 is one of the most successful examples of the UT's research commercialisation cases (Toomla 2014), it could also indicate that perhaps the

greatest success drivers are among the cases at which both parties are simultaneously seeking to initiate cooperation.

Next, six out of the eight observed cases reached the in-process phase, whereas three of the respective cases advanced to the impact phase, and two to the output phase. One project (HappyPregnancy) is still on-going with some mid-term results indicating that in minimum, the Output phase will be reached. Moreover, due to the high number of success drivers that have been identified for the HappyPregnancy project, it has favourable conditions to reach the impact phase. The latter is further elaborated towards the end of this chapter. Herein, the critical input phase drivers are further described.

Also, the importance of aligning university-business interests is emphasised within all of the six observed cases. Indeed, while asking the interviewees, what were the main drivers that allowed to achieve the expected results, all of the representatives from the respective six cases mentioned some drivers related to the alignment of university-business interests. For example, Uusberg (2014) brought out that while starting the project, the "scope and the expected outcomes were clearly agreed upon". Laan (2014) said that all of the collaborating parties "accounted for each-others' interests from the very beginning," and since most of the partners where acquainted, it was "easy to align our interests." Reiman (2014) emphasized the shared vision and shared goals. Both Link (2013) and Mellik (2014) identified flexibility with accounting for partners' interest. Flexibility was also mentioned by Voznessenskaya (2013) and Kasikov (2013) as well as Trei (2013) and Murutar (2013). This is in alignment with Chapter 1.2, which identifies that the ability to match univeristiy-business interests has a central importance within the input phase.

With respect to the in-process and output phases, as specified in Chapter 1.2, the most critical success drivers are related to project management. Herein, although some of the observed projects did not proceed from the input phase, they still carried out preliminary collaboration projects, which allowed them to assess also the project management related drivers. As shown on the figure 8 below, Case 3, Case 5, and Case 6 that have reached the impact phase, posted the highest number of success drivers related to project management. Moreover, the

latter cases had almost no discrepancy between the responses of universities and businesses. This indicates that both parties understood the project in a similar manner. Briefly, both respondents of Case 6 (Language robot) reported all of the observed 15 success drivers for project management. In Case 3 (ME-3), both respondents reported 14 success drivers. In Case 5 (Implicit associations), 13 drivers were identified by the business representative, and 14 drivers by the university representative.

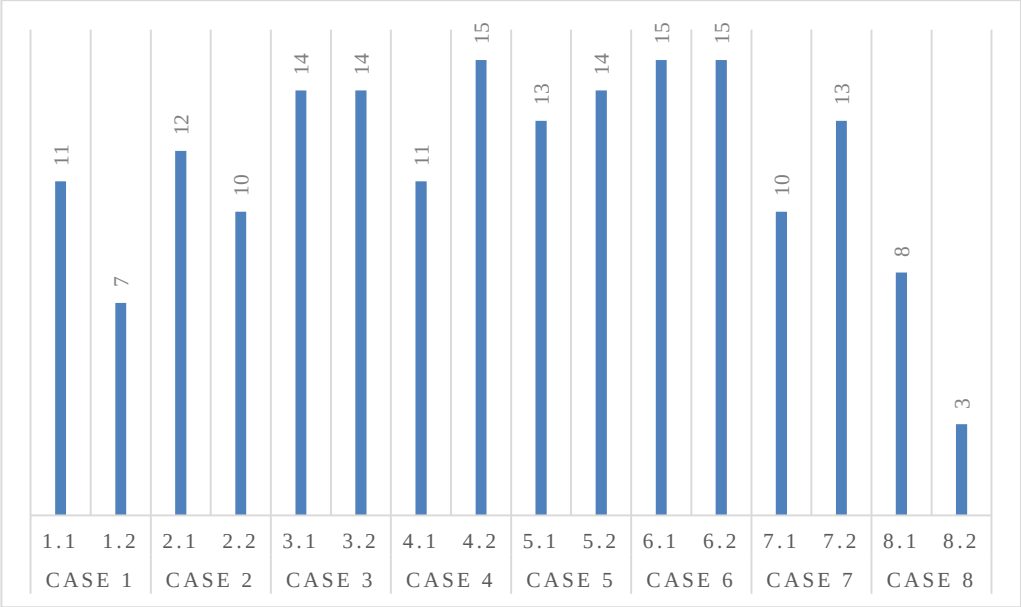


Figure 8. Number of identified project management related success drivers across cases out of 15 potential: the greatest number of success drivers represented in projects that have reached the impact phase. (Source: Constructed by the author).

With regard to the three impact phase cases, most of the respondents stated that cooperation was well managed: responsibilities were clearly defined, end goals and milestones were realistic and well understood, there were adequate resources to complete the project, progress monitoring was implemented regularly, collaborators delivered their tasks on time, and communication occurred constantly. For example, Saatre (2013) said that the ME-3 project was exceptional, since information was exchanged rapidly, and progress was monitored on regular basis. For Case 6 (Language robot), Link (2013) and Mellik (2014) both provided a similar reasoning, while also emphasizing that their project was successfully broken down to well-managed sub-tasks. Uusberg (2014) agreed for Case 5 (Implicit associations) that the

project scope was concise enough for successful management. While Kustavus (2014) agreed as well, she also pointed out that there were several issues related to insufficient resources for performing the expected tasks. Nevertheless, since information was exchanged on frequent basis, these issues were promptly identified, and hence quickly resolved.

At the same time, in cases that did not reach the impact phase, collaborators identified several weaknesses in project management. The lowest number as well as the greatest discrepancy of success drivers regarding project management was in Case 8 (3D modelling of Cumulus sailboat). The second lowest number of success drivers was in Case 1 (PDI 2). None of the latter cases reached the impact phase. For Case 8 that ended in the output phase, Trei (2013) emphasised the lack of sufficient communication with the business representatives. From the business perspective, Murutar (2013) pointed towards insufficient human resources to run a start-up, and simultaneously manage external cooperation. According to Murutar, the latter also caused their inability to manage cooperation on timely basis, which may indicate, that for start-ups, external resources would be needed to successfully manage collaboration projects.

Likewise, Sirel (2014) from Case 7 (Smart grid development) pointed towards insufficient human resources to proactively manage cooperation next to other duties. Moreover, Sirel suggested that the shortage of human resources was one of the primary reasons for why the particular project has not yielded explicit commercial benefits yet. At the same time, the university representative of Case 7 considered the cooperation successful, since new knowledge was created regarding the smart grid networks that among other aspects, has also contributed to up to date field-specific teaching materials for students (Valtin 2014). This again proves that universities and businesses have different definitions for a successful project (see also Chapter 1.2). In this specific case, while the smart grid development indeed yielded a contribution to the scientific understanding of smart grid networks, the results did not enable Elektrilevi to use the project output in commercial applications. Yet, this was the initial motivation for launching the smart grid project on behalf of Elektrilevi (Sirel 2014).

For Cases 1 and 2 that did not proceed from the input phase, the issues related to project management were not that significant, since the preliminary projects that were conducted as part of the input phase, involved a narrower scope. For example, according to Voznessenskaya (2013), "although the university representatives completed their work with high quality, the company has not managed to come up with a standardized product." Therefore, instead of seeking insufficiencies within project management, the company itself has not been successful in launching the R&D project for standardising the sub-components of PDI 2. Hence, although the university counterpart indeed emphasised that the communication has been insufficient (Kasikov 2013), the reasons are rather related to the lack of company's financing opportunities for launching a full-scale cooperation (Voznessenskaya 2013). This shows that poor project management is not always the primary reason for unsuccessful UBC in R&D.

Lacking a clear financing outlook was also mentioned in Case 2 as a primary reason for not entering into full-scale cooperation (Sülluste 2013). Nevertheless, the university and business counterparts have herein misunderstood each-other, since according to the company representative, there was a clear willingness to commit the necessary funding after the university proposed a clear budget and a project plan for IcePreventer's development (Koit 2013). However, the willingness to finance the project was not explicitly understood by the university counterpart. Instead, since KBFI assumed that there was not enough financial commitment by the company, they decided not to proceed with full-scale cooperation. Thus, although project management was not necessarily at the centre for Case 2, poor communication was indeed one of the reasons for not proceeding with the UBC project.

With respect to project management related drivers that would enable the projects to reach the output phase, the level of bureaucracy stemming from public financing was mentioned in several interviews. For example, Laan (2014) discussed that several critical project activities were postponed and/or cancelled due to the complexity of reporting requirements imposed by the grant authority (Archimedes). Moreover, Laan (2014) also emphasised that while conducting the project, the project manager needs to excessively focus on administrative reporting requirements, despite the fact that there is an enormous amount of research needed

to be done apart from dealing with financing. One option would be to employ another team member that is responsible for the reporting, but in their case, there was not enough budget for the latter. Moreover, certain reporting could only be conducted by team members with in-depth understanding of the project. The latter indicates that reporting requirements imposed by public grants force researchers to shift their focus from R&D to dealing with the excess bureaucracy. Similar issues were also identified by Saatre (2014), Reiman (2014), Sülluste (2013), Voznessenskaya (2013), and Link (2013).

Next, the UBC projects that have reached the impact phase should be considered to observe the drivers related to commercialisation. It goes beyond the scope of this thesis to observe the commercialisation strategies on a detailed level. For that, another thesis should be constructed (see, for example, Toomla 2014, who analysed the commercial strategy for the University of Tartu). Nevertheless, it can be noted that for all of the cases that reached the impact phase, the UBC agreements also included a strategy for commercialisation from the very beginning of the cooperation project. However, it must be noted that the causality could also be interpreted somewhat differently: it could have been, that the for these specific projects, there was a more specific outlook for commercialisation, and thus, the commercialisation strategy was defined in more explicitly.

Except for Case 8, the same cannot be noted for other UBC project in R&D that did not reach the impact phase. Also, with regard to most of the general success drivers that are relevant across the phases of UBC in R&D- university-industry specific issues; partner evaluation; 'culture gap' management; universal success drivers; and outcome perspective (see also Chpt 1.2) - the cases that have reached the impact phase have also most of the individual success drivers represented. For more details, see Appendix 3: breakdown of **i**dentified success drivers in specific categories relevant for all phases of UBC in R&D.

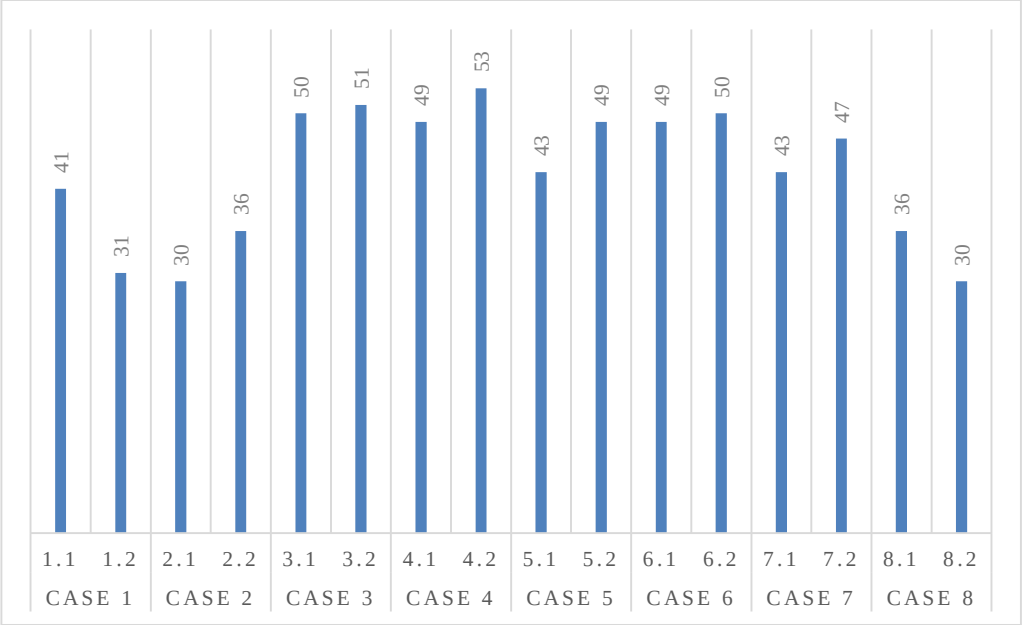


Figure 9. Total number of identified success drivers across the observed cooperation cases out of 56 potential drivers (Source: constructed by the author).

In general, as depicted on the figure above, projects that have reached the impact phase are closest to the maximum number of success drivers. Also, the discrepancy between the university-business responses of each specific case is greater for the cases that have not reached the impact phase, which indicates that contradictory viewpoints even with regard to some minor success drivers could risk the success of an UBC project in R&D. For example, in Case 1, which has reached the input phase, the business representative identified 41 success drivers, whereas the university representative identified 31. The lowest number of success drivers was identified within Case 8 at which 36 drivers were identified by the business representative, and respectively 30 by the university representative. Case 8 reached an output phase, whereas an impact phase is not likely to be reached.

At the same time, however, it must be noted that these assessments are based on qualitative methods. Therefore, while the tendencies of a greater number of success drivers seem to match with the UBC projects that indeed were successful, a more detailed interpretation would require that the cases are analysed in a more deeper level. This, however, can be done in later research building on the respective findings.

Lastly, as another overarching denominator, all of the cases, except Case 7 (Smart grid network), were co-financed by public grants. However, since Elektrilevi OÜ is a state owned enterprise, the latter case could be considered as partly state financed. Regardless, all in all, this supports the fact that Estonia currently does not have privately held R&D measures, nor will it likely develop such measures in the near-term future (Varblane *et al* 2012). While seeking the means to enhance Estonian UBC in R&D, it implies that state level policies will have a critical role in motivating universities and businesses towards further cooperation. Moreover, after the grant has been successfully used, and the impact phase has been reached, it is also more likely that the successful experience will incentives a continued cooperation based on privately funding (see also Chpt 1.1 and 1.2). All in all, the table below sums up the primary characteristics with respect to the observed UBC cases in R&D, and the related inferences for the Estonian UBC in R&D.

Table 5. Conclusive overview of the findings regarding success drivers from each case, and inferences for the current state of the Estonian UBC in R&D

Case	**Overview of key findings**	**Inferences for the Estonian UBC in R&D**
Case 1 (PDI 2, Input phase)	Cooperation has yielded preliminary results in terms of developing the needed components for PDI 2. However, lack of financing opportunities on behalf of the company holds back from entering full-scale cooperation. Has the third lowest number of success drivers reported by the university and the business representatives (31 and 41 out of 56, respectively).	Even if great applications could be developed, there is still a significant shortage of financing opportunities for entering into full-scale cooperation between universities and businesses. The primary shortfall is related to the gap between R&D and subsequent commercialisation: current financing schemes assume that the company instantly reaches a high volume of sales after completing the project. Moreover, self-financing rates assume that the company has considerable funds for investment. The latter, however, camnot the case in Case 1, since the sales of interferometers require long and complicated procedures with a high fixed cost margin.
Case 2 (Ice-Preventer,	Cooperation has not proceeded to the in-process phase despite the willingness of the	It was currently difficult to match university-business interests,

Case	Overview of key findings	Inferences for the Estonian UBC in R&D
Input phase)	company to finance the necessary development. Research institute has not seen an outlook for sufficient financing nor has the company's development idea directly been related to their research interests. Has one of the lowest number of success drivers with 36 reported by the university, and 30 reported by the business. The lowest category is partner evaluation related success drivers (only one out of nine drivers was detected by the business, and respectively six out of nine by the university- see also Appendix 3).	since the operating principles as well as the expectations of either parties were disconnected. Thus, clearly, the main weakness related to relationship drivers. The availability of experienced cooperation facilitators that could contribute on project specific basis could be a solution to drive similar R&D projects.
Case 3 (ME-3, Impact phase)	One of the most successful commercialisation cases for UT. The cooperation has yielded an economic impact on the university and the business. Both participants reported one of the highest number of success drivers: 50 and 51 out of 56, respectively.	ME-3 has a motivational impact, since proves that successful cooperation is indeed possible in Estonia.
Case 4 (Happy-Pregnancy, In-process phase)	Although the cooperation is still ongoing (the project is within the in-process phase), the achievement of some mid-term results indicates that the project has a high potential of reaching the impact phase. The latter is supported by the fact that cooperating parties also reported one of the highest number of success drivers in the sample: 53 and 49 out of 56 respectively by the university and the business.	Could serve as a best practice example for performing successful UBC in R&D. Although there are numerous barriers to conducting this respective project, the fact that the vast majority of success drivers are represented provides a mechanism to overcome these barriers.
Case 5 (Implicit associ-ations, Impact phase)	A successful case that has reached the impact phase. The cooperating parties reported a relatively high number of success drivers (49 by the university and 43 by the business out of 56). At the same time, it should be considered that the scope of this project was relatively smaller, which might imply that several major risk factors were avoided simply due to the smaller scale of cooperation. Also, it was conducted as a project for Master's thesis, which added an additional incentive for the project manager to complete the project successfully. Moreover, university representatives managed to develop a tool for future analysis in similar projects, which increased his	Collaboration projects will have a higher success rate, if there are additional incentives (e.g. earning a degree and/or developing tools for usage in other research projects) that drive the project managers. The latter can compensate for the lacking of otherwise critical success drivers.

Case	Overview of key findings	Inferences for the Estonian UBC in R&D
	motivation to succesfully finalise the Implicit associations test.	
Case 6 (Language robot, Impact phase)	A successful case that has reached the impact phase. The cooperating parties reported one of the highest number of success drivers (50 out of 56 by the university and 49 by the business). Currently, the Language robot trains border police and border patrol units in several European countries. From the business side, this has contributed to moving forward with developing similar cognitive learning technologies for the US market.	Could be used as another best practice example for conducting successful UBC in R&D.
Case 7 (Smart grid develop-ment, Output phase)	Reached the output phase, but likely not to proceed to the impact phase. Has been successful from the university perspective, since contributed to fundamental knowledge, and allowed to generate teaching materials. From the business perspective, only conceptually successful, but has not yielded practical applications, and thus no commercial results. University reported 47 out of 56 success drivers, the business 43. The indicated that there was a shortage of human resources to actively manage the project. Also, the initial task of the project was not explicit enough, which could be one of the key problems.	Without sufficient human resources, UBC in R&D cannot be actively managed, and thus, the results will often not relate to what was initially intended. This is especially relevant in cases at which the initial task for cooperation has not been explicitly defined, and becomes clarified while already performing the cooperation.
Case 8 (3D-modelling, Output phase)	Reached the output phase, but likely not to proceed to the impact phase. Has been successful from the university perspective, since the project manager performed the research as part of a Master's Thesis. The cooperating parties reported one of the lowest number of success drivers: 30 out of 56 by the university, 36 by the business.	Collaboration projects will have a higher success rate, if there are additional incentives (e.g. earning a degree). Nevertheless, for companies at a start-up phase, it will still be difficult to commercialise the outcome even if the university manages to complete its part.

Source: Constructed by the author.

To sum up, this sub-chapter has analysed the current state of the Estonian UBC in R&D by observing the respective collaboration cases. While using the findings of this sub-chapter as an input, and coupling it with a broader understanding of the Estonian RDI system from Chapter 2.1, the following sub-chapter elaborates on the findings from a state perspective.

Specifically, based on the current collaboration experience, policy recommendations are provided to enhance UBC in R&D as a significant contributor to the Estonian RDI.

2.3 Discussion and policy recommendations

By now it should be clear, that Estonia needs to rapidly enhance UBC in R&D. Yet, although the need has been recognised, Estonia misses a structured understanding for how to construct effective policy measures, and in which context does UBC in R&D particularly lie with respect to the broader RDI system. Also, there is little understanding of the extent to which universities should engage in UBC in R&D, and whether additional competences along with new personnel, and perhaps even new academic institutions should be created for UBC in R&D. Moreover, from the business perspective, there is little understanding to how and for what purposes could universities become engaged for joint R&D initiatives, and at which point will it exactly be reasonable to encourage UBC in R&D.

This thesis suggests that the cycle of UBC in R&D should be used as a basis for drafting these policy measures. Particularly, targeted policies should be drafted for each of the five phases of UBC in R&D (preliminary, input, in-process, output, and impact phases, respectively) with the final aim of driving most of the UBC projects in R&D towards the impact phase at which commercial benefits are achieved. Thus, this sub-chapter provides recommendations for designing policy measures to support UBC in R&D throughout these phases. While doing so, policy recommendations foremost relevant to individual phases will be outlined. Where applicable, general recommendations to enhance UBC in R&D are discussed as well.

First, before moving any further, perhaps most importantly, state level strategic objectives along with priorities must be defined to specify the extent to which Estonian universities need to engage in UBC. After this, a strategy to embrace certain entrepreneurial principles can objectively emerge for leading universities. Such state level strategic objectives are foremost important, since universities must also continue to teach as well as conduct base science at a top quality (see also Chapter 1.1). Thus, although targeted policy measures such as state level orders for UBC projects in R&D (further discussed below) could serve as clear-cut means

for indeed enforcing the phenomenon of entrepreneurial universities, this is ought to be performed with a clear understanding of what is eventually needed.

Without the latter, the state push towards entrepreneurial universities could in fact harm the ability of universities to perform their mission one- teaching- and mission two activities- research for base science (Knuuttila 2012), although so far, these risks have remained theoretical. Hence, after these priorities are defined, there will be a state level understanding of what to expect from UBC in R&D as a form of RDI. For example, this could be done in the form of an operational programme under the Estonian RDI strategy of 2014 – 2020, which has already identified university-business cooperation as one of the four critical means for achieving the 2020 objectives (see also Chapter 2.1).

Moreover, after defining the strategic objectives, the state level operational programme could target the five phases of UBC in R&D as they have been specified within this respective thesis (see Chapter 1.1). Herein, the strategic policy actions for each of the respective phases could aim to enhance the success drivers of UBC in R&D as defined in Chapter 1.2, and as they were confirmed to be represented in successful collaboration cases among the Estonian universities and businesses (see Chapter 2.2). While building on the findings of the case studies and the theoretical analysis performed as part of the beforehand thesis, the following will propose some of the policy objectives that a similar state level operational programme could include with respect to each of the five phases of UBC in R&D. At the end of the chapter, table 6 outlines the policy recommendations in a conclusive manner.

As described earlier, the preliminary phase is foremost related to the state level formation of the need for RDI (see Chapter 1.1). Thus, the Estonian policymakers first need to specify the means through which the state, universities and business can and should interact. An instrumental framework for such a specification could be the Triple Helix approach (Etzkowitz, Leydesdorff 2000). There are several examples of policy papers using the Triple Helix to specify innovation systems. For example, Lombardi *et al* (2011) proposed that the performance of smart cities could be assessed through an advanced Triple Helix model; Ranga *et al* (2008) used the Triple Helix framework to "enhance the innovation capacity of

small firms in the Northern Netherlands" (*Ibid:* 697); Fromhold-Eisebith (2011) has employed the Triple Helix approach to study the impact of UBC on a regional level within Eindhoven (The Netherlands), and Aachen (Germany).

Herein, as described in Chapter 1.2, the absorptive capacity of collaborating parties is a critical driver for transitioning UBC in R&D from the preliminary phase to the input phase. To successfully enhance the absorptive capacity, state level policies should first become to understand the formation of the need for RDI. This can be done through employing the Triple Helix framework, which enables to specify the conditions that are ought to be met in order to reach Triple Helix III (see also Chapter 1.1). More specifically, the explicit interconnections and linkages between the respective institutions are ought to be mapped so that current interconnections could become understood. From such an understanding, targeted measures can be taken to optimise the interconnections, and to facilitate new overlapping relationships between universities and businesses.

Depending on where exactly will the most critical shortages be identified, policy measures might include financing opportunities to build small in-house R&D departments for organisations that currently lack these features (would likely be a more costly measure than most of the other support schemes); or to generate support schemes for sub-contracting external R&D agents on case-by-case basis. This is supported by the findings from Chapter 2.2: the observed organisations had at least one employee whose responsibility was to coordinate R&D projects. Secondly, there were mostly also external agents employed to improve the capacity for managing collaboration. And thirdly, policies should be designed to exchange the experience of successful cooperation cases. More specifically, since the successful cooperation cases clearly included a greater number of success drivers, the best practices are ought to be exchanged particularly on how to include as many success drivers as possible on project specific basis.

Furthermore, state funded training opportunities are needed for organisations that do not have earlier experience with UBC in R&D. This is foremost relevant in order to increase the number of organisations that could enter the input phase. Currently, earlier collaboration

experience was found to be a significant driver of new cooperation projects. Yet, as elaborated in Chapter 2.1, only a handful of Estonian universities and businesses now have the cooperation experience: only an average of 3,9 Estonian scientists out of 30 engage in UBC (Davey *et al* 2011: 74). As discussed above, these numbers are not much greater in other countries (for example, the same indicator is 4,4 out of 30 for Finland as well as the Netherlands), it is still problematic while aiming to enhance UBC in R&D. Nevertheless, if adequate training was available, the number of potential organisations conducting UBC in R&D could increase much faster. Moreover, as discussed above, if Estonia was to resolve this challenge faster than the developed economies, a significant competitive advantage could be reached for enervating economic convergence.

Additionally, training should be coupled with networking opportunities to improve the informal ties that would both increase the pool of potential collaboration partners as well as to access tacit knowledge, which as discussed in Chapter 1.2, presumes that the potential partners are well acquainted. Only then can university-business interests become effectively matched, and subsequent inter-linkages inherent to Triple Helix III formulated. The latter was also proven by the case studies in which most of the successful projects had collaborating parties that previously knew each-other. Such acquaintances could be facilitating a series of state level matchmaking events with the clear purpose of introducing university and business representatives that operated within overlapping fields. For example, in the case of ME-3, the university and business representatives had their initial contact exactly in a similar event held at the University of Tartu.

Moreover, as described in Chapter 1.2, matching the universities and business is not solely relevant in terms of networking, but also in terms of reaching suitable contractual arrangements. As one of the most explicit policy measures, the state level R&D financing opportunities could require that the projects financed through public grants should also entail UBC. So far, most of the Estonian R&D initiatives have included a public financing component (Varblane *et al* 2012: 10). Since this trend is likely to continue, the state level policies could also draft the terms so that UBC in R&D would become a prerequisite to state level financing for any research that includes a component of applied science. This approach

would generate a necessary driving mechanism for matching the university-business interests, since without the latter, there would be no state level funding for R&D. In fact, similar incentives have already been employed by other states: for example, the Netherlands does not have a single R&D measure solely for companies. Instead, it has grant opportunities available for R&D that include both universities and businesses as joint applicants (Varblane *et al* 2012: 12).

An alternative would be to use tax incentives similarly to what has been discussed by Staehr *et al* (2010) as well as Kaarna (2010). However, any tax incentives would have to presume that first there is something to be taxed. They bring the example of income tax incentives for firms, which are only effective, if firms make a profit (*Ibid*: 3). Tax incentives to R&D should be viewed through a similar lens: since UBC in R&D is rarely exercised in Estonia, tax incentives will only have an effect on the organisations that already perform R&D. It will have little implications on driving additional organisations to enter into UBC in R&D. Moreover, since the Estonian companies are not taxed for reinvested profits, the potential benefits for using tax incentives will further lose justification.

Instead, next to public grants for R&D, since most of the Estonian HEIs are public institutions, the state could motivate HEIs through directly targeted policies that favour UBC in R&D. For example, similarly to state level orders placed for a certain number of students within each field, there could be state level orders defined for UBC in R&D within fields that have the highest priority for R&D. Since there are not many of such Estonian companies, the effects would also be rather small. Nevertheless, it could become an explicit policy mechanism next to other measures that motivates the creation of Mode 2 universities (Knuuttila 2012, Etzkowiz 2004), which as shown in Chapter 1.2, are instrumental to driving UBC in R&D. This would clearly increase the number of university representatives seeking to enter into contractual arrangements, and therefore, it could operate as a catalyst for indeed intensifying UBC in R&D.

Moving on to the in-process phase, policy measures for projects that already include contractual arrangements should foremost focus on the low level of success drivers. This can

be achieved by improving the project management skills of collaborating parties. Herein, the policies could aim to provide training for project management, and to exchange the best practices of projects that have successfully reached the impact phase. The latter need is supported by the case studies performed as part of this thesis: project management was generally found to be of high quality in the three cases that reached the impact phase. In other cases, at least one cooperating counterpart indicated that project management was rather poorly conducted (see also Chapter 2.2). However, if earlier training and experience sharing was more widespread, some of the mistakes could have been avoided.

In addition, the quality of project management could also be improved by subcontracting experienced project managers. This again may be supported by the state level financing mechanisms so that the collaborating parties could focus on performing the key R&D activities, and not be stopped by the nuances of project management. As outlined in several cases in Chapter 2.2, the latter was clearly significant in order to save the much needed time solely for research itself. Moreover, if the state grants supported the hiring of an external project manager, this could also enable to involve top level experts and thus significantly increase the chances of a successful cooperation.

Herein, although tax incentives, or some other regulatory measures might not be as effective for the preliminary nor the input phases of UBC in R&D, they could have a significant driving force for the in-process phase. With regard to tax opportunities particularly, as pointed by Staehr *et al* (2010), "R&D tax incentives can be regarded as effective as they entail some additionality, i.e. the incentives lead to *added* or increased R&D activity by the firms benefiting from the incentives." (*Ibid*: 4). It implies that for already ongoing collaborations, tax incentives could generate an additional driver to enervate cooperation.

From a slightly different perspective, a similar enabling mechanism can be achieved by minimizing the reporting requirements on public finances and improving the flexibility of the rules for using the grants while conducting R&D. As it was found for most of the observed cases, currently the bureaucracy related to public financing considerably restricts the flexibility of the R&D projects, and overly consumes the collaborators' time on reporting to

the grant administrators. In order to improve the success of UBC in R&D, policymakers should focus on improving the flexibility of public financing so that the time spent on the actual R&D could be maximized. For example, in Case 2 (IcePreventer), it was indicated that some of the miscommunication between the university and business counterparts was due to the fact that the contract negotiations were performed simultaneously to preparing a grant application to finance the respective development. This prevented the academics from focusing on the actual details of the potential development, and forced to deal with the numerous regulatory limitations and restrictions that the possible grant application would have included. Moreover, it was indicated that since the business seemed to show interest for the collaboration solely in order to apply for the grant in cooperation with the university, it was unclear, whether the business was indeed interested in performing a full-scale development. Problems stemming from the regulatory and bureaucratic requirements were also identified in Case 1 (PDI 2), Case 3 (ME-3), Case 4 (HappyPregnancy), and Case 6 (Language robot).

Concerning the output and impact phases, state policies should likely be viewed under a common framework. As soon as the projects start to provide results, supporting the commercialisation of UBC in R&D should become the primary focus. Herein, evaluation criteria that expect the commercial outcomes should become more explicit. Currently, in many cases, the commercialisation requirements are rather lax within the project applications as well as within the contractual arrangements between the collaborating bodies. This is problematic, especially given that the university counterparts do not necessarily seek explicit commercial benefits from a UBC project in R&D (see Chpt 1.3). If, however, commercialisation was required to be at the core of a state funded UBC project in R&D, as well as if it was a strategic objective for the universities, it would also define the explicit end-results in relation to the commercial goals.

For the impact phase, the sole objective should be commercialisation through training opportunities and functional commercialisation strategies. For instance, Toomla (2014) has provided a comprehensive set of recommendations for universities. Specifically, he proposes that first, there should be a framework constructed for each project, followed by the strategy

for selling the IPR, and subsequently conducting the sales as specified by the respective strategy (*Ibid*: 60). From the perspective of businesses, although there lacks a comparable study on Estonia, similar measures should be implemented. All in all, the table 6 below provides a conclusive overview of the proposed phase-specific policy recommendations to enhance UBC in R&D.

Table 6. Phase-specific policy recommendations to enhance UBC in R&D

Phase	**Recommendations**	
	Objective	**Proposed policy measures**
Preliminary phase	Define the state level strategic objectives and related priorities to enhance UBC in R&D	Generate an operational programme underneath the national RDI strategy for 2014 – 2020 in which university-business collaboration has been defined as one of the four key strategic channels for achieving the Estonian RDI objectives by 2020. Ensure that the operational programme includes clearly outline responsibilities, attributed resources, and deadlines for completing specific activities. Use the five phases of UBC in R&D as well as the critical success drivers for each phase as basis for defining the strategic objectives as well as guidelines for drafting the operational programme.
	Specify on a detailed level, how the state-university-industry interactions impact national innovation systems.	Employ the Triple Helix framework to specify major linkages and interconnections between the Estonian universities and businesses. Use the specification as an input for policies that would enhance the Estonian UBC in R&D.
	Based on the earlier specification, provide well-structured incentives to stimulate the formation of the underlying demand for RDI through UBC in R&D.	Initiate public-private partnerships and provide financing incentives for businesses and universities in order to draw attention to meeting the market demand through UBC in R&D.
Input phase	Improve the absorptive capacity of businesses and universities.	Modify RDI financing so that UBC in R&D would become a prerequisite to receiving state level grants.
		Provide financing to improve R&D capacity through external measures (e.g. sub-contracting on project-specific basis). Estonia should consider more elaborate bridge financing opportunities as well as the availability of external cooperation facilitators to drive R&D projects.

Phase	Recommendations	
	Objective	**Proposed policy measures**
		Provide access to training on R&D as well as collaboration management.
	Improve semi-formal connections between university and business representatives.	Initiate major networking events with the purpose of matching university and business representatives. Cooperation facilitators should be directed to review successful projects, and the ways that success drivers were ensured.
In-process phase	Match university-business interests.	Improve access to financing opportunities.
		Create state level incentives for UBC in R&D through HEI policies.
	Maximise collaboration efficiency.	Improve the project management capacity and skills: provide training for project management; exchange best practices.
		Provide tax incentives and minimize bureaucracy stemming from the reporting requirements for public financing.
Output phase	Increase the number of projects that reach the output phase, and at the same time, are likely to proceed to the impact phase.	Improve project management and draft evaluation criteria that assume the later stage commercialisation of the output. Also, define commercialisation as a strategic objective for universities along with a specific prioritisation and an accompanied operational programme for achieving these respective results.
Impact phase	Increase the share of commercialised projects.	Provide training opportunities on drafting commercialisation strategies.

Source: Constructed by the author.

In conclusion, this sub-chapter has provided policy recommendations for enhancing the Estonian UBC in R&D. As it was shown above, this includes a series of targeted steps that should be taken at a state level. First, the state level strategic objectives and priorities are ought to be defined in order to specific the expectations for the extent to which UBC in R&D is ought to be developed. This in turn will formulate the basis for drafting a state level operational programme. As discussed above, since the national RDI strategy 2014 – 2020 already identifies university-business cooperation as one of the four critical means of achieving the objectives by 2020, the operational program could be drafted under the framework of the respective strategies. Herein, as a structured basis of the operational programme, the five phases of UBC in R&D could be used as defined by the beforehand

thesis. Moreover, facilitating the emergence of the success drivers for UBC in R&D could be the central goal of most of the policy actions taken as such a programme. Also, the explicit recommendations for targeted policies to support each phase of UBC in R&D could be used as an input for drafting such a programme.

SUMMARY

Although UBC in R&D has a high potential for contributing to national RDI, and thereon to function as an internal growth driver, there is still little idea of how to enhance UBC in R&D, and what methods should exactly be used for assessing its current state. Thus, to specify the analysis, the theoretical part of the thesis captures the cooperation through five phases of collaboration: preliminary phase at which the need for RDI is being formulated; input phase, which stands for semi-formal university-business interactions; in-process phase that stands for the formal execution of UBC in R&D; output phase that represents the achievement of end results of UBC in R&D as defined in contractual arrangements; and the impact phase, which stands for the commercial benefits of respective collaboration. The reasoning was to capture UBC in R&D from a state perspective, and to subsequently define the key drivers that contribute to successful collaboration. After defining the key drivers, assessment methods were analysed.

Within the preliminary phase, the most functional method to analyse the asymmetries of an innovation system, and to understand the formation of the need for RDI, is to employ the Triple Helix theory. Particularly, the greater Triple Helix stage at which an economy lies, the greater are the interactions between the universities, state, and businesses. This in turn implies, that the need for intellectual capital production will be processed in a more effective manner, and the economy as a whole, will better manage to indeed satisfy the need of intellectual capital production. Thus, economies closer to Triple Heilx III, which stands for trilateral networks, and hybrid organisations, have the greatest likelihood of employing UBC in R&D for RDI.

At the input phase, partnerships are formulated to respond to the underlying need of intellectual capital production. Herein, this includes unofficial interactions as well as possible feasibility studies / pre-assessments prior to entering into full-scale cooperation. At this stage, again, the Triple Helix theory provides the best framework for analysing the level of interactions between universities and businesses. Briefly, economies at Triple Helix III have greater interconnections between the two parties, which also implies, that the input phase has a greater likelihood of being completed.

Moreover, states' level of economic development is ought to be considered, while analysing the input phase of UBC in R&D. In advanced countries, university-industry links are varied, which implies that the patterns of UBC in R&D are formalised, and thus, the input phase functions in a more systematic manner. However, in catching up economies, university-industry links have not been formalised, and therefore, the UBC in R&D occurs in a *laissez fare* manner. In turn, this implies that state level incentives are critical for enhancing the success of UBC in R&D, since without the latter, the input phase will not become completed.

Next, within the in-process phase, partnerships have already become formulated, and therefore, the cooperation occurs mostly under specified contractual arrangements. This is the phase at which formal execution of UBC in R&D occurs, and thus, most of its significant denominators are rather low level. Herein, the in-process phase is largely captured by the organisations' willingness to engage external counterparts for performing R&D. Such practices are widely spread in industries under rapid transformation, as well as in the small economies, that lack the internal resources to finance large scale in-house R&D. At the same time, it must also be noted, that similar strategies are acknowledged by numerous large corporations in ICT, engineering, pharmaceuticals, etc. In fact, it has largely been recognised, that the most effective R&D can be performed through UBC in R&D.

Projects that reach the output phase have mostly fulfilled the contractual obligations, and thus, a result of the cooperation can be reported. However, it does not necessarily mean that commercial benefits have been reached. Instead, projects in the output phase have rather develop new technologies, and/or the project team has achieved a new set of skills. For individual UBC projects in R&D, these outputs may indeed imply that cooperation has been successful. Nevertheless, from a state level perspective, toasssess the success of intellectual capital production via UBC in R&D; the commercial impact is also ought to be considered.

Thus, within the impact phase, clear-cut commercial impacts will be reached as a result of certain UBC projects in R&D. Such impacts may occur in the form of increased revenue or improved profitability of the firms and universities that are related to the cooperation. On the one hand, this might seem like elf-evident. Nevertheless, in cases where public financing is involved with UBC projects in R&D, the commercial benefits are not always granted. Often times, projects tend not to have explicit commercialisation goals linked to the cooperation agreements. Therefore, to avoid these risks, the impact phase should be separately scrutinized, and the drivers relevant for maximizing the commercial benefits of intellectual capital production via UBC in R&D should be better understood.

More specifically, with regard to the critical success drivers of UBC in R&D, these should be analysed in the context of the above specified cooperation phases. Indeed, there are some overarching success drivers that are relevant for all of the five cooperation phases: university-industry specific issues; partner evaluation factors; managing the "Culture Gap;" universal success factors; and collaboration outcome perspectives as the low-level drivers. Market demand for RDI; regulatory incentives; and macroeconomic conditions as the high-level drivers). However, the critical success drivers are foremost related to each of the respective phases.

First, for the preliminary phase, the critical success driver is the absorptive capacity for intellectual capital production. Specifically, companies with internal R&D departments, and universities have technology transfer units, or similar functions, are more likely to pass the preliminary phase as they are capable of processing the needs for RDI. Thus, part of a solution for enhancing the absorptive capacity could be to set up small in-house R&D departments, which would then coordinate external R&D collaboration. Although the in-house department would lack resources to perform independent R&D, the driving force of intellectual capital production would still reside within the organisation. As shown by this thesis, such a strategy is not solely limited to smaller organisations, but it could also be adapted by large multinationals, academic institutions as well as part of wider state level innovation systems.

Second, for proceeding from the input phase, the critical success driver is the ability to combine university-business interests. For businesses, the input phase drivers mostly relate to a reasonable outlook to resolve the underlying need via UBC in R&D. Specifically, motivation relates to the firms' understanding of whether knowledge from universities could complement the firms' business interests. From the universities' perspective, in order to understand the interest, a distinction should be drawn between the theoretical types of institutions (Mode 1) *versus* the entrepreneurial universities (Mode 2). Although both types of institutions are needed for the sake of scientific advancement, it is clear that Mode 2 universities will be more likely to contribute to matching the university-business interests, and thus complete the input phase.

Third, low-level relationship and project management drivers are critical for both the in-process as well as the output phase. These include mutual trust; commitment; a shared goal; understanding of common interest by different stakeholders; prior relations with the business partner; and cooperation as effective means to address societal challenges and issues. For business drivers, these include employment by business of (former) Higher Education Institution (hereinafter HEI) staff and

students; interest of business in accessing scientific knowledge; possibility of accessing funding / financial resources for working with business; short geographical distance of the HEI from the business partner; flexibility of business partner; access to business-sector research and development facilities; and commercial orientation of the HEI. The in-process and output phase include a similar set of critical success drivers, since mostly universities and businesses will only enter contractual arrangements with confidence in their capability to meet the terms of the respective contract. Therefore, with respect to the particular drivers related to the outcome phase, these are foremost related to the project-specific terms.

Fourth, with respect to the drivers related to the impact phase, these mostly relateto the viability of commercialisation strategies. For example, a relevant factor for the commercialisation strategy could be the existence of a clearly specified process for commercialising a UBC project in R&D. From the university's point of view, this starts with adopting a knowledge commercialisation mission next to the traditional academic missions of teaching and scientific discover. At the same time, for both the businesses as well as the universities, one of the most successful methods is to have clearly defined processes along with critical resources and well-equipped partners for each respective phase of the commercialisation process.

Next, with respect to the possible assessment methods, researchers on UBC in R&D have still not reached an agreement on commonly accepted methods. Nevertheless, at a state level assessment, the intensity as well as standardisation of university-business-industry interactions should first be determined. In developed economies, the interconnections are more standardised and straightforward, which enables to better employ quantitative assessment methods. In catching up economies, interconnections are yet to be formulated, which means that the qualitative approaches allow to draw inferences with greater explanatory power. In addition, the most recent research has become to recognise to view bot the perspectives of universities and businesses under a common framework. The latter is relevant in order to avoid potential biases from analysis on solely universities or businesses.

At the second chapter of the thesis, an assessment of the Estonian UBC in R&D was carried out. Specifically, the current state of the Estonian UBC in R&D was analysed in the context

of the broader RDI system as well as through eight case studies that observed specific collaboration cases. For the latter, in depth interviews were conducted both with university and business representatives from the observed cases. Based on the assessment, policy recommendations were provided for enhancing the Estonian UBC in R&D.

Although in the context of other catching up economies, the Estonian innovation system has been performing rather well, the economy is still an innovation follower rather than a leader. Moreover, the UBC in R&D has a low contribution to the Estonian RDI. Recently, this has become recognised by the leading Estonian scholars on innovation, who have also proposed that for the national RDI strategy of 2014 – 2020, UBC could be one of the means for achieving its strategic objectives. However, first, the rate of successful cooperation projects that result in commercial benefits is ought to be significantly increased. Therefore, while analysing the current state of the Estonian UBC in R&D via case studies, the relevant conclusions with regard to the observed success drivers are as follows:

- The Estonian UBC projects in R&D that have reached the impact phase have a high level of success drivers represented from both the university as well as the business perspectives. Therefore, to enhance UBC in R&D, focusing on the success drivers could be an effective approach. In total, earlier literature has identified approximately 56 separate drivers that could all potentially be relevant for a successful collaboration project;
- For projects that did not proceed from the input phase, either misalignments in communication or the shortage on financing opportunities was detected. At the same time, for most of the projects that proceeded from the input phase, the latter shortfalls were not detected. Thus, to match university-business interests within the input phase, this might imply that means for more targeted financing opportunities should be considered as well as opportunities to improve the semi-formal communication while preparing the full-scale cooperation;
- Projects that already entered the in-process phase, also reached at least the output phase. However, projects that did not proceed to the impact phase were missing a clear-cut commercialisation strategy. Also, a shortage of human resources along with

poor project management as well as a lack of conciseness within the initial task for UBC in R&D were identified. In turn, projects that did reach the impact phase, mostly reported that necessary resources were present, project management was performed successfully, and the tasks for each collaborating party were well understood. In addition, there were clear agreements on the commercialisation principles after the R&D has been completed. Herein, while aiming to enhance the Estonian UBC in R&D, the latter findings again support that the success drivers should receive the greatest prirority.

Briefly, based on the research findings, the following policy recommendations were provided to enhance the Estonian UBC in R&D:

- Generate an operational programme underneath the national RDI strategy for 2014 – 2020 in which university-business collaboration has been defined as one of the four key strategic channels for achieving the Estonian RDI objectives by 2020. Ensure that the operational programme includes clearly outline responsibilities, attributed resources, and deadlines for completing specific activities.
- Employ the Triple Helix framework to specify major linkages and interconnections between the Estonian universities and businesses. Use the specification as an input for policies that would enhance the Estonian UBC in R&D.
- Initiate public-private partnerships and provide financing incentives for businesses and universities in order to draw attention to meeting the market demand through UBC in R&D.
- Modify RDI financing so that UBC in R&D would become a prerequisite to receiving state level grants.
- Provide financing to improve R&D capacity through external measures (e.g. sub-contracting on project-specific basis). Estonia should consider more elaborate bridge financing opportunities as well as the availability of external cooperation facilitators to drive R&D projects.
- Provide access to training on R&D as well as collaboration management.

- Initiate major networking events with the purpose of matching university and business representatives.
- Create state level incentives for UBC in R&D through HEI policies.
- Improve the project management capacity and skills: provide training for project management; exchange best practices.
- Provide tax incentives and minimize bureaucracy stemming from the reporting requirements for public financing.
- Improve project management and draft evaluation criteria that assume the later stage commercialisation of the output. Define commercialisation as the strategic objective for businesses along with a specific prioritisation and an accompanied operational programme for achieving these respective results.
- Provide training opportunities and sharing of best practices on drafting commercialisation strategies.

LITERATURE CITED

1. **Aapaoja, A., Kujala, J., Pesonen, L. T. T.** Production of University Services. - International Journal of Synergy and Research, 2012, Vol. 1, No. 1, pp. 89 – 106.
2. **Al-Ashab, A., Flores, M., Doultsinou, A., Magyar, A.** A Balanced Scorecard for measuring the impact of industry-university collaboration. - Production Planning & Control: The Management of Operations, 2011, Vol. 22, No. 5/6, pp. 554 – 570.
3. **Ang, J., Madsen, J.** Can Second-Generation Endogenous Growth Models Explain The Productivity Trends and Knowledge Production In the Asian Miracle Economies? - MPRA Paper, 2009, Vol. 27.
4. **Arundel, A., Geuna, A.** Proximity and the use of public science by innovative European firms. - Economic Innovation New Technology, 2004, Vol. 13, No. 6, pp. 559 – 580.
5. **Audretsch, D. B., Feldman, M. P.** R&D Spillovers and the Geography of Innovation and Production. - The American Economic Review, 1996, Vol. 86, No. 3, pp. 630 – 640.
6. **Autant-Bernard, C., J., P. LeSage.** Quantifying Knowledge Spillovers using Spatial Econometric Models. – Journal of Regional Science, 2011, Vol. 51, No. 3, pp. 471 – 496.
7. **Baba, Y., Shichijo, N., Sedita, S. S.**. How do collaborations with universities affect firms' innovative performance? The role of „Pasteur scientists" in the advanced materials field. - Research Policy, 2009, Vol. 38, pp. 756 – 764.
8. **Barnes, T., I. Pashby, A. Gibbons.** Effective University – Industry Interactions: A Multi-case Evaluation of Collaborative R&D Projects. – European Management Journal, 2002, Vol. 20, No. 3, pp. 272 – 285.
9. **Becker, W.**, **Dietz, J.** R&D cooperation and innovation activities of firms – evidence for the German manufacturing industry. – Research Policy, 2004, Vol. 33, pp. 209 – 223.
10. **Beise, M., Stahl, H.** Public Research and Industrial Innovations in Germany. - Research Policy, 1999, Vol. 28, No. 4, pp. 397 – 422.

11. **Bekkers, R., Freitas, I. M. B**. Analysing knowledge transfer channels between universities and industry: To what degree do sectors also matter? - Research Policy, 2008, Vol. 37, pp. 1837 – 1853.
12. **Bergman, E**. Marshall's Dilemma and Commercialization of European Research. - IAREG, 2010, No. 1, Working Paper 1.3 e.
13. **Bergman, E.** Marshall's Dilemma: Intangible Assets and European Universities. - IAREG, 2009, Working paper. 1.3 e.
14. **Bruneel, J., D'Este, P., Salter, A.** Investigating the factors that diminish the barriers to university-industry collabortion. - Research Policy, 2010, Vol. 39, No. 7, pp. 858 – 868.
15. **Bush, V.** Science: The Endless Frontier. National Science Foundation, 1945 (reprinted 1960), Washington.
16. **Campos, A. L.** A review of the influence of long-term patterns in research and technological development (R&D) formalisation on university-industry links. - Revista Brasileia de Innovação, 2010, Vol. 9, No. 2, pp. 379 – 409.
17. **Chesbrough, H.** Open Innovation: A New Paradigm for Understanding Industrial Innovation. Oxford: Oxford University Press, 2006.
18. **Chun, H., Mun, S. B.** Determinants of R&D cooperation in small and medium-sized enterprises. - Small Business Economics, 2012, Vol. 39, pp. 419 – 436.
19. **Cohen, W. M., Levinthal, D. A.** Absorptive Capacity: A New Perspective on Learning and Innovation. - Administrative Scence Quarterly, 1990, Vol. 35, No. 1, pp. 128 – 152.
20. **Cohen, W. M., Nelson, R. R., Walsh, J. P.** Links and Impacts: The Influence of Public Research on industrial R&D. - Management Science, 2002, Vol. 48, No. 1, pp. 1 – 23.
21. **D'Este, P., Patel, P.** University-industry linkages in the UK: What are the factors underlying the variety of interactions with industry? - Research Policy, 2007, Vol. 36, No. 9, pp. 1295 – 1313.
22. **Davey, T., Baaken, T., Muros, V. G., Meerman, A**. The State of European University-Business Cooperation. Part of the DG Education and Culture Study on the Cooperation between Higher Education Institutions and Public and Private Organisations in Europe, 2011, 140 p. [http://www.ub-cooperation.eu/] 14.05.2014

23. **Eichengree, B., Park, D., Shin, K.** Growth slowdowns redux: New evidence of the middle-income trap. - NBER Working Paper Series, 2013. [http://www.nber.org/papers/w18673] 04.10.2013.
24. **Etzkowitz, H.** The triple helix and the rise of the entrepreneurial university. In G. Karln, N. Wormbs, & S. Widhalm (Eds.), The science-industry nexus: History, policy implications. Sagamora Beach, MA: Science History Publications, 2004, pp. 69 – 91.
25. **Etzkowitz, S., Leydesdorff, J.** The dynamics of innovation: From national systems and "Mode 2" to Triple Helix of university-industry-government relations. - Research Policy, 2000, Vol. 29, pp. 109 – 123.
26. **Fontana, R., Geuna, A., Matt, M.** Factors affecting university-industry R&D projects: The importance of searching, screening and signalling. - Research Policy, 2006, Vol. 35, pp. 309 – 323.
27. **Freeman, C., Soete, L.** Developing Science, Technology and Innovation Indicators: The Twenty-First Century Challenges. – Science, Technology and Innovation Indicators in a Changing World, OECD Publishing, 2011, pp. 271 – 284.
28. **Fromhold-Eisebith, M.** Towards a new generation of triple helix innovation policies: 'Campus' schemes and the examples of Eindhoven (The Netherlands) and Aachen (Germany). – 6th International Seminar on Regional Innovation Policies, 'Constructing Sustainable Advantages for European Regions,' 2011, Lund, Sweden**.**
29. **Fukugawa, N.** University spillovers into small technology-based firms: channel, mechanism, and geography. - The Journal of Technology Transfer, 2013, Vol. 38, No. 4, pp. 415 – 431.
30. **Geuna, A., Maria, B. F. I., Rossi, F.** The Governance of University-Industry Knowledge Transfer: Why small firms do (not) develop institutional collaborations? Bureau of Research in Innovation, Complexity and Knowledge, Collegio Carlo Alberto, 2010, Working Paper No. 13/2010.
31. **Goldstein, H., Bergman, E. M., Maier, G.** Comparing U.S. and European Views of University Involvement in Economic Development. ERSA conference papers, European Regional Science Association, 2011.

[http://www.ekf.vsb.cz/export/sites/ekf/projekty/cs/weby/esf-0116/databaze-prispevku/clanky_ERSA_2011/ERSA2011_paper_00301.pdf] 14.05.2014

32. **Grimaldi, R., Tunzelmann, N. von.** Assessing collaborative, pre-competitive R&D projects. The case of the UK LINK scheme. - R&D Management, 2002, Vol. 32, pp. 165 – 173.
33. **Kaarna, R.** Tax incentives and business enterprise research and development in Estonia. University of Tartu, Faculty of Economics and Business Administration, 2010, Master's Thesis.
34. **Kaiser, R., Kripp, M.** Demand-orientation in national systems of innovation: A critical review of current European innovation policy concepts. Druid Summer Conference, 2010. [http://www2.druid.dk/conferences/viewpaper.php?id=501953&cf=43] 04.10.2013.
35. **Kasikov, A.** (Researcher, Institute of Physics, University of Tartu). Interview by the author. Transcript. 06.12.2013.
36. **Kattel, R., Karo, E., Tõnurist, P., Looga, L., Varblane, U., Roolaht, T.** Lõppeva teadus- ja arendustegevuse ning innovatsioonistrateegia täitmise hindamine, 2012. [http://www.tips.ut.ee/index.php?module=32&op=1&id=3532]. 14.05.2014.
37. **Kerge, S.** (Quality Manager, Eolane Tallinn AS). Interview by the author. Transcript. 18.02.2014
38. **Knowledge based Estonia.** Estonian Research and Development and Innovation Strategy, 2006. [http://www.akadeemia.ee/_repository/File/ALUSDOKUD/Knowledge-based%20Estonia%20II.pdf] 03.11.2013.
39. **Knuuttila, T**. Science in a New Mode: Good Old (Theoretical) Science Versus brave New (Commodified) Knowledge Production? - Science & Education, 2012, DOI 10.1007/s11191-012-9498-9
40. **Koit, M**. (Member of Board, Üle OÜ). Interview by the author. Transcript. 03.12.2013.
41. **Kustavus, K**. (Product Manager, Põltsamaa Felix AS). Interview by the author. Transcript. 17.03.2014.

42. **Laine, A**., **Varblane, U.** Government supporting schemes enhancing university-industry knowledge transfer on the example of SPINNO program in Estonia. – Discussion on Estonian Economic Policy, 2010, Vol. 18, pp. 195 – 214.
43. **Laursen, K., Salter, A.** Searching high and low: what types of firms use universities as a source of innovation? - Research Policy, 2004, Vol. 33, pp. 1201 – 1215.
44. **Laursen, K**., **Salter, A.** Open for innovation: The role of openness in explaining innovation performance among the U.K. manufacturing firms. – Strategic Management Journal, 2006, Vol. 27, pp. 131 – 150.
45. **Link, A**. **N., D. S. Siegel, B. Bozeman.** An Empirical Analysis of the Propensity of Academics to Engage in Inforamal University Technology Transfer. - Rensselaer Working Papers, 2006, Number 0610, pp. 1 - 26.
46. **Link**, **M.** (Head of Innovative Learning Technologies, Estonian Academy of Security). Interview by the author. Transcript. 06.12.2013.
47. **Lombardi, P., Giordano, S., Caragliu, A., Bo, C. Del., Deakin, M., Nijkamp, P., Kourtit, K.** An advanced triple-helix network model for smart cities performance, 2011, Vrije Universiteit, Faculty of Economics and Business Administration, Department of Spatial Economics, 2011, Research Memorandum No. 45 (37 p.). [http://dare.ubvu.vu.nl/bitstream/handle/1871/24007/rm?sequence=1] 14.05.2014
48. **Masso, J**., **Liik, M., Ukrainski, K.** Teaduse-arendustegevuse ja innovatsiooni indikaatorid Eesti innovatsiooni- ja teaduspoliitikas: senine praktika ja poliitikasoovitused, 2013. [http://www.tips.ut.ee/index.php?module=32&op=1&id=3613]. 14.05.2014.
49. **Mellik, A**. (CEO, JukuLab OÜ). Interview by the author. Transcript. 31.01.2014.
50. **Mets, T.** Creating business model for commercialization of university research. - Management of Organizations: Systematic Research, 2009, No. 51.
51. **Meyer, A. D., Aten, K., Krause, A. J., Metzger, M. L.** Creating a university technology commercialisation programme: confronting conflicts between learning, discovery and commercialisation goals, 2011, Vol. 13, No. 2, pp. 179 – 198.

52. **Mohnen, P., Horeau, C**. What type of enterprise forges close links with university and government labs? Evidence from CIS 2. - Managerial and Decision Economics, 2003, Vol. 24, No. 2-3, pp. 133 – 145.
53. **Murutar, R**. (CEO, BoatArt OÜ). Interview by the author. Transcript. 04.12.2013.
54. **Perkmann, M., Neely, A., Walsh, K.** How should firms evaluate success in university-industry alliances? A performance measurement system. - R&D Management, 2011, Vol. 41, No. 2, pp. 202 – 216.
55. **Piva, E, Rossi-Lamastra, C.** Systems of indicators to evaluate the performance of university-industry alliances: a review of the litereature and directions for future research. - Measuring Business Excellence, 2013, Vol. 17, No. 3, pp. 40 – 54.
56. **Ramos-Vielba, I., Fernández-Esquinas, M.** Measuring university-industry collaboration in a regional innovation system. - Scientometrics, 2010, Vol. 84, pp. 649 – 667.
57. **Ranga, L. M., Miedema, J., Jorna, R.** Enhancing the innovative capacity of small firms through triple helix interactions: challenges and opportunities. – Technology Analysis & Strategic Management, 2008, Vol. 20, No. 6, pp. 697 – 716.
58. **Rasmussen, E., Benneworth, P., Gulbrandsen, M.** Developing University Innovation Capacity: How can innovation policy effectively harness universities? Capability to promote high-growth technology business, 2013. [http://druid8.sit.aau.dk/acc_papers/b61lyyb1a3yso09eea71tp1el96a.pdf] 14.05.2014.
59. **Ratnik, K.** (Laboratory specialist, Quattromed HTI Laborid OÜ). Interview by the author. Transcript. 10.01.2014.
60. **Reiman, M.** (Formed Head of Product Development manager, Tere AS). Interview by the author. Transcript. 11.02.2014.
61. **Riigikontroll.** Ülevaade riigi vara kasutamisest ja säilitamisest 2012. – 2013. aastal: Riigikontrolöri kokkuvõte Eesti riigi arengu ja majanduse probleemist. – Riigikontrolli aruanne Riigikogule, 2013.
62. **Ritchie, J., Lewis, J.** Qualitative Research Practice: A Guide for Social Science Students and Researchers. London: SAGE Publications Ltd, 2003. [196.29.172.66:8080/jspui/bitstream/123456789/1231/1/122.pdf] 14.05.2014

63. **Saatre, J.** (Intellectual Property Manager, University of Tartu). Interview by the author. Transcript. 15.01.2014.
64. **Schartinger, D., Schibany, A., Gassler, H.** Interactive Relations Between Universities and Firms: Empirical Evidence for Austria. – Journal of Technology Transfer, 2001, Vol. 26, pp. 255 – 268.
65. **Schumpeter, J.** The Theory of Economic Development. Cambridge: Harvard University Press, 1934.
66. **Seppo, M., Lilles, A.** Indicators Measuring University-Industry Cooperation. - Discussion on Estonia economic policy, 2012, Vol. 1, pp. 204 – 225.
67. **Seppo, M., Roolaht, T.** The Policy Suggestions Concerning Motivations and Barriers of University-Industry Cooperation. - Discussion on Estonian Economic Policy, 2012, Vol. 20, No. 1, pp. 226 – 246.
68. **Șerbănică, C., Drăgan, G.** University-industry cooperation in Central and Eastern Europe: A common past, a different future? – CES Working Papers, 2012, Vol. 4, pp. 837 – 852.
69. **Sisemajanduse koguprodukt 2013.** Statistikaamet, 21.03.2014. [http://www.stat.ee]. 15.05.2014.
70. **Sirel, M.** (Head of the Strategic Planning Department of Asset Management). Interview by the author. Transcript. 28.01.2014.
71. **Staehr, K.** An analysis of tax incentives to promote research and development in Estonia. Ministry of Economics and Communication, 2010. [http://www.mkm.ee/public/TA-Maksuuuring-2010-01.pdf]. 20.04.2014.
72. **Sülluste, K**. (Research and Development coordinator, Keemilise ja Bioloogilise Füüsika Instituut). Interview by the author. Transcript. 05.12.2013.
73. **Tether, B.** Who co-operates for innovation, and why. An empirical analysis. – Research Policy, 2002, Vol. 31, pp. 947 – 967.
74. **Toomla, S**. Kommertsialiseerimisstrateegiate arendamine Tartu Ülikooli näitel, Tartu Ülikool, Majandusteaduskond, 2012, 92 lk (Magistritöö).
75. **Trei, T**. (Project Manager, Estonian Academy of Arts). Interview by the author. Transcript. 04.12.2013.

76. **Tunzelmann, N., Malerba, F., Nightingale, P., Metcalfe, S.** Technological paradigms: past, present and future. - Industrial and Corporate Change, 2008, Vol. 17, No. 3, pp. 467 – 484.
77. **Ukrainski, K.** Sources of knowledge used in innovation: An example of Estonian wood industries – University of Tartu, Faculty of Economics and Business Administration, 2008, 264 p. (PhD Dissertation)
78. **Uusberg, A.** (Researcher, Institute of Psychology at the University of Tartu). Interview by the author. Transcript. 19.02.2014.
79. **Valtin, J.** (Associate Professor, Department of Electrical Power Engineering, Tallinn University of Technology). Interview by the author. 10.02.2014.
80. **Varblane, U., Seppo, M., Rõigas, K.** Benchmarking of Governmental Support Measures for University-Industry Cooperation. Discussions on Estonian Economic Policy. - Theory and Practice of Economic Policy, 2012, Vol. 20, No. 2, pp. 263 – 292.
81. **Veugelers, R.** Internal R&D expenditures and external technology sourcing. – Research Policy, 1997, Vol. 26, pp. 303 – 315.
82. **Veugelers, R., Mrak, M.** The Knowledge Economy and Catching-up Member States of the European Union. Report prepared for Commissioner's Ptocnik's Expert Group, "Knowledge for Growth", 2009. [http://ec.europa.eu/invest-in-research/pdf/download_en/kfg_report_no5.pdf]. 05.11.2012.
83. **Viru, J.** (CEO, CrystalSpace OÜ). Interview. Author's transcript. 20.03.2014.
84. **Voznessenskaya, M.** (CMO, VTT-NTM OÜ). Interview by the author. Transcript. 06.12.2013.
85. **World Economic Forum**. The Europe 2020 Competitiveness Report: Building a More Competitive Europe. *World Economic Forum*, 2012, Insight Report. [http://www3.weforum.org/docs/CSI/2012/Europe2020_Competitiveness_Report_2012.pdf] 14.05.2014

APPENDIXES

Appendix 1. The interview questionnaires

	Question	Type of question
Current situation		
1	How many product or service development projects has your company executed within the past five years?	Clarificatory probe (are they active within R&D at all?)
2	Within the past five years, have you done preparations to start (a) cooperation project(s) with universities? If yes, then how many?	Clarificatory probe (are there cooperation projects to talk about?)
3	If you answered "yes" to question nr. 2, then how many of the cooperation projects proceeded to the execution phase?	Clarificatory probe (is there actual experience with execution?)
4	If you answered "yes" to question nr. 2, then how many of the cooperation projects' results have a commercial potential?	Clarificatory probe (do some of the cooperation projects comply with the thesis' definition on productive UBC in R&D? See also chpt 1.1)
5	Who is involved in your company's R&D projects? Who is responsible for what?	Clarificatory probe (are there right people in charge of R&D?)
Preparing the cooperation project: Please select an example of a recent cooperation project that managed to reach commercial outcomes (positive example) / did not reach such outcomes (negative example)		
6	What was the motivation to start the cooperation project?	Explanatory probe (see, if the initial motivation is comparable across projects?)
7	Did you have previous connections with the university / faculty that you cooperated with?	Explanatory probe (test drivers: university-industry specific issues)
8	During the project preparation, who did you mainly communicate with from the university / faculty? Why exactly that person?	Exploratory probe (test drivers: university-industry specific issues)
9	Who initiated the cooperation? Your company or the university?	Clarificatory probe (see, if comparable across projects?)
10	What goals did you set for the cooperation project prior to starting?	Exploratory probe (test drivers: Project Management)
11	What division of roles did you agree upon between the university and company representatives?	Exploratory probe (test drivers: Project Management)
12	Did you also sign an agreement that specified the expected results of the cooperation project? Did you reach the expected results?	Exploratory probe (test drivers: Outcome perspectives)
13	If you answered 'yes' to question 12, then what were the main drivers from your company's side that indeed allowed to reach the results as agreed upon in the contract?	Amplifying probe (test drivers: could fall under any category)
14	If you answered 'yes' to question 12, then what were the main drivers from the university's side that indeed allowed to reach the results as agreed in the contract?	Amplifying probe (test drivers: could fall under any category)

15	Have the achieved results created additional interest in starting new cooperation projects with the same partner? If yes, then what projects?	Exploratory probe (test, if the cycle of UBC in R&D is driven by earlier positive results)	
16	Have the achieved results created additional interest in starting new cooperation projects with other partners? If yes, then in what projects?	Exploratory probe (test, if positive results induce other cooperation in R&D)	
Initiating and defining objectives for the cooperation project			
17	What was your initial interest to participate in the cooperation project?	Explanatory probe (test drivers: could fall under any category)	
18	What was universities' initial interest to participate in the cooperation project?	Explanatory probe (test drivers: could fall under any category)	
19	Please point out the positive aspects from the cooperation project	Amplificatory probe (test drivers: could fall under any category)	
20	Please point out the negative aspects from the cooperation project	Amplificatory probe (test drivers: could fall under any category)	
21	Had you initially known what you know now, would you still be interested in starting the cooperation? Please elaborate.	Amplificatory probe (test drivers: could fall under any category)	
22	If the university's representatives knew what they know now, what do you think, would they be interested in starting the cooperation? Please elaborate.	Amplificatory probe (test drivers: could fall under any category)	
23	What were the primary drivers for success (in case of a positive example) / causes of failure (in case of a negative example)	Amplificatory probe (test drivers: could fall under any category)	
Execution and results of the cooperation project			
24	Who lead the cooperation? Was it your company or the university?	Exploratory probe (test drivers: could fall under any category)	
25	How would you describe the role of your company throughout the cooperation process?	Amplificatory probe (test drivers: could fall under any category)	
26	How would you describe the role of the university throughout the cooperation process?	Amplificatory probe (test drivers: could fall under any category)	
27	Had you not cooperated with the university, would you have reached comparable results?	Explanatory probe (test, if UBC in R&D has been a unique path towards intellectual capital production)	
28	If you answered 'yes' to the previous question, then why did you still prefer to cooperate with the university?	Amplificatory probe (test, if UBC in R&D has been a unique path towards intellectual capital production)	
29	**The following lists a set of drivers that could potentially be significant for executing a successful cooperation project.** Please indicate, whether these drivers were represented at your cooperation project (Yes/No). Please elaborate, if needed.		
Nr	Driver	Represented?	Comment: pos / neutral / neg
University - industry specific issues			
1	Prior relation with the university representatives		
2	Role of Lead Researchers		
3	Involvement of post-graduate students		
4	Employment by business of (former) HEI staff and students		

5	Interest of business accessing scientific knowledge		
6	Interest of universities accessing business' scientific knowledge		
7	University's possibility of accessing funding / financial resources for working with business		
8	Possibility of business for accessing additional financing (e.g. state financing)		
9	Short geographical distance of the HEI from the business partner		
Partner evaluation factors		Represented?	Comment: pos / neutral / neg
10	Compability of culture / mode of operation		
11	Complementary expertise / strengths		
12	Past collaboration partners		
13	Partners' high quality of knowledge and skills		
14	Shared vision of the project's end-results		
15	Shared vision of the project's strategic importance		
16	Complementary aims		
17	No hidden agendas		
18	Partner's cooperation experience with companies		
Project Management		Represented?	Comment: pos / neutral / neg
19	Project management training		
20	Diplomacy		
21	Multifunctional experience		
22	Clearly defined objectives		
23	Clearly defined responsibilities		
24	Mutually agreed project plan		
25	Realistic end goals		
26	Realistic milestones		
27	Adequate Human Resources for achieving the milestones and end-goals		
28	Adequate financial resources for achieving the milestones and end-goals		
29	Other adequate resources		
30	Simple collaborative agreement		
31	Regular progress monitoring		
32	Effective communication		
33	Ensuring collaborators deliver		
Managing the "Culture Gap"		Represented?	Comment: pos / neutral / neg
34	Ability to match the differing priorities / timescales of academia and business		
35	Publishing in public domain		
36	Academic *laissez-faire* approach		
37	IPR and confidentiality		

Universal success factors		Represented?	Comment: pos / neutral / neg
38	Mutual trust		
39	Continuity		
40	Commitment		
41	Learning ability		
42	Flexibility of cooperation partners		
43	Business' Leadership		
44	University's Leadership		
45	Good personal relationships		
46	Image of a collaboration champion from the business' side		
47	Image of a collaboration champion from the university's side		
Outcome perspectives		Represented?	
48	Commercial benefit for the business		
49	Commercial benefit for the university		
50	Continued support for the business' related R&D programs		
51	Continued support for the university's related R&D programs		
52	Technological innovation		
53	Publishing opportunities		
54	Patents / IPR		
55	Compatibility with student projects		
56	Student recruitment		

Source: constructed by the author.

Overview of the modifications to the interview script for universities (as compared to the business' interview script)

	Not modified
	Modified

No	U	B	No	U	B	No	U	B	No	U	B	No	U	B	No	U	B
Unstructured questions						Structured questions											
1			16			1			16			31			46		
2			17			2			17			32			47		
3			18			3			18			33			48		
4			19			4			19			34			49		
5			20			5			20			35			50		
6			21			6			21			36			51		
7			22			7			22			37			52		
8			23			8			23			38			53		
9			24			9			24			39			54		
10			25			10			25			40			55		
11			26			11			26			41			56		

12			27			12			27			42			
13			28			13			28			43			
14			29			14			29			44			
15						15			30			45			

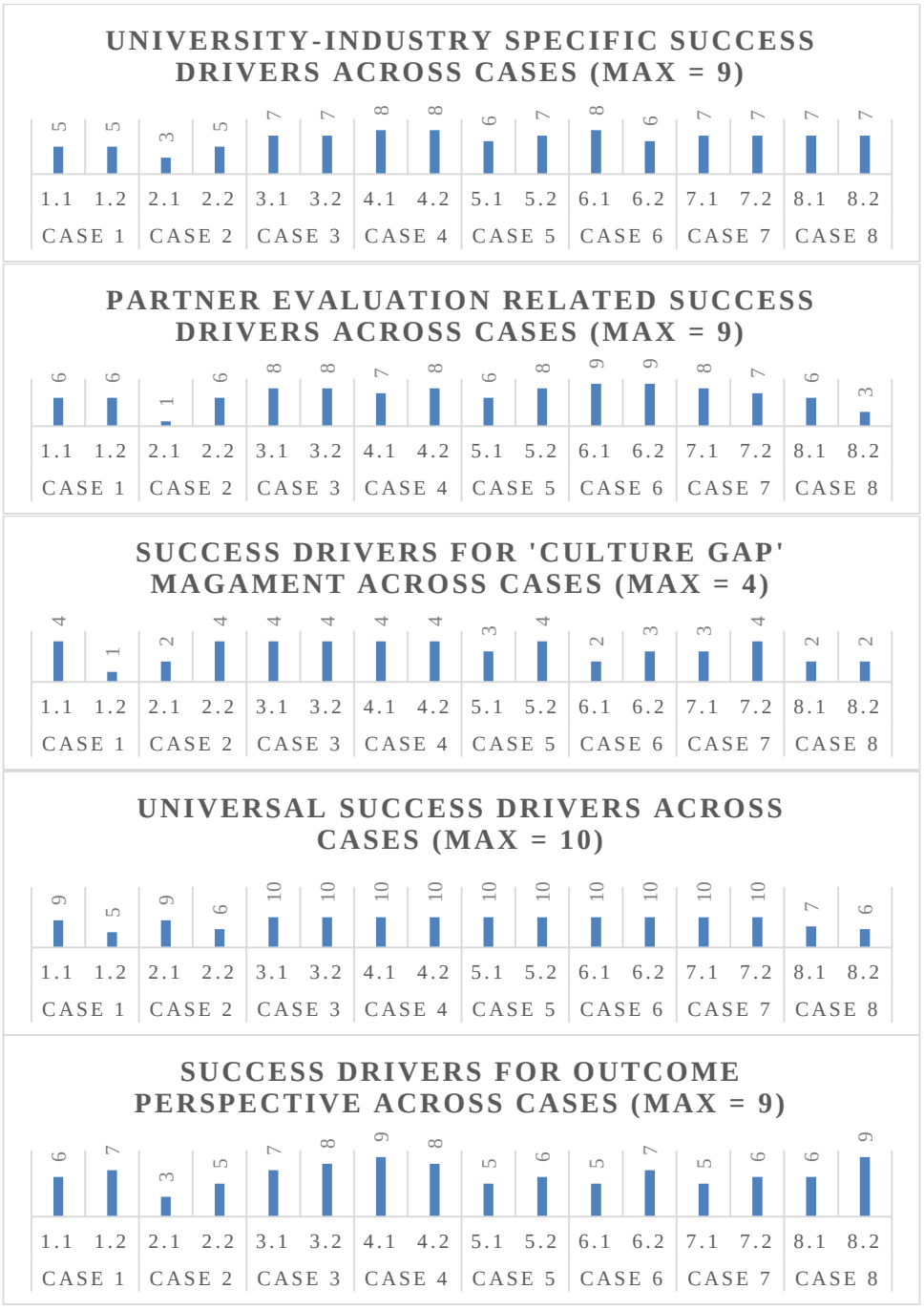
Source: Constructed by the author.

Appendix 2. List of interviewees

Number	Name (Position, Organisation)
1.1	Maria Voznessenskaya (CMO, VTT-NTM OÜ)
1.2	Arne Kasikov (Researcher; Institute of Physics, University of Tartu)
2.1	Marek Koit (Member of Board; Üle OÜ)
2.2	Kristian Sülluste (R&D coordinator; Keemilise ja Bioloogilise Füüsika Instituut)
3.1	Mare Reiman (Head of product development; Tere AS)
3.2	Jane Saatre (Intellectual Property Manager, University of Tartu)
4.1	Kristian Ratnik (Laboratory specialist; Quattromed HTI Laborid OÜ)
4.2	Prof. Maris Laan (Professor of Human Molecular Genetics; Institute of Molecular and Cell Biology, University of Tarty)
5.1	Karin Kustavus (Product Manager; Põltsamaa Felix AS)
5.2	Andero Uusberg (Researcher; Institute of Psychology, University of Tartu)
6.1	Andres Mellik (CEO; JukuLab OÜ)
6.2	Marek Link (Head of Innovative Learning Technology Center; Estonian Academy of Security Sciencies)
7.1	Margus Sirel (Head of the Strategic Planning Department for Asset Management; Elektrilevi OÜ)
7.2	Prof. Juhan Valtin (Associate Professor; Department of Electrical Power Engineering, Tallinn University of Technology)
8.1	Richard Murutar (CEO; BoatArt OÜ)
8.2	Tuuli Trei (Project Manager; Estonian Academy of Arts)
9.1	Emöke Sogenbits (CEO; Eolane Tallinn); Sixten Kerge (Quality Manager; Eolane Tallinn)
10.1	Jaan Viru (CEO, CrystalSpace)

Source: constructed by the author

Appendix 3. Break-down of identified success drivers in specific categories relevant for all phases of UBC in R&D.



RESÜMEE

Ülikoolide-ettevõtete koostöö teadus- ja arendustegevuses: Eesti majanduse kasutamata võimalus

Üks tõhusamaid mooduseid, teostamaks teadus- ja arendus- ning innovatsioonitegevust (edaspidi TAI-d) võiks olla läbi eduka ülikoolide-ettevõtete teadus- ja arenduskoostöö (edaspidi ÜEK TjaA). Viimane on eriti tõusnud päevakorda väikestes järgijõudvates majandustes nagu Eesti, mis peavad konvergentsi lõpetamiseks kasvama kiiremini kui arenenud majandused. Sellest hoolimata käsitletakse ÜEK TjaA-d endiselt tihti kitsa uurimisvaldkonnana, mille potentsiaali majanduskasvu edendamisele kiputakse alahindama.

Olgugi et mõned neoliberaalse majanduskoolkonna pooldajad võivad väita, et konvergents toimub vääramatu jõuna, on niisugune lähenemine siiski liiga lihtsustatud. Näiteks Schumpeteri poolendogeenne kasvumudel tõestab, et majanduskasv sõltub suuresti ka riigi enda võimekusest toota ja kommertsialiseerida intellektuaalset kapitali. Viimane omakorda sõltub riigi edukusest majanduskasvu saavutamisel läbi TAI rakendamise. Muu hulgas on vastav käsitlus järgijõudvatele majandustele oluline nt keskmise sissetuleku lõksu vältimiseks: nt Eestil on hetkel selge risk jääda sissetuleku lõksu juhul, kui ei suudeta rakendada sisemisi ressursse majanduskasvu kiirendamiseks. ÜEK TjaA-s võiks siinjuures olla üks võimalustest, mille kaudu võiks panustada Eesti TAI arendamisse ja seeläbi majanduskasvu kiirendamisse.

Sarnase väljakutsega seisvad silmitsi pea kõik riigid. Samas, lahendis tuleb igal riigil leida individuaalselt. Intellektuaalse kapitali loomet ega laiemat TAI rakendamisvõimekust ei saa riiki importida sarnaselt mõningate teiste majanduskasvu stiimulitega nagu nt välisinvesteeringute kaasamine, mujal arendatud tehnoloogiate rakendamine jne. Kuigi teiste

riikide praktikast saab õppida, siis ilmselgelt peab iga riik siiski iseseisvalt leidma parimad moodused nii TAI teostamiseks kui selle raames ka ÜEK TjaA edukuse tõstmiseks. Siinjuures, olgugi et vastav tõdemus on tänaseks laialt aktsepteeritud, puudub nii Eesti poliitikutel, ettevõtetel kui ka teadlastel selge nägemus, kuidas siiski edendada Eesti ÜEK TjaA-d. Seetõttu on käesoleva magistritöö eesmärk analüüsida hetkeolukorda Eesti ÜEK TjaA-s ning pakkuda poliitikasoovitusi koostöö tõhustamiseks. Täitmaks töö eesmärki, on autor sõnastanud järgmised uurimisülesanded:

- Analüüsida ülikoolide-ettevõtete TjaA koostöö võtmeprotsesse, lähtuvalt riigi tasandist;
- Analüüsida ülikoolide-ettevõtete TjaA koostöö peamisi edutegureid;
- Analüüsida, kuidas hinnata ülikoolide-ettevõtete TjaA koostööd;
- Analüüsida Eesti TAI süsteemi, kirjeldada uurimistöö valimit ning metoodikat;
- Hinnata Eesti ülikoolide-ettevõtete TjaA koostöö hetke olukorda,
- Pakkuda poliitikasoovitusi Eesti ülikoolide-ettevõtete TjaA koostöö tõhustamiseks.

Uurimustöö metoodika tugineb juhtumianalüüsidel, mis vaatlevad konkreetseid ÜEK TjaA projekte. Informatsiooni kogumine toimus poolstruktureeritud intervjuude käigus. Kokku vaatles autor kaheksat koostööjuhtumit. Iga juhtumi raames intervjueeris autor eraldi nii ettevõtte kui ka ülikooli esindajaid.

Töö teoreetiline baas tugines ÜEK TjaA protsessi analüüsimisel läbi viie etapi: koostöö esmane faas (TAI vajaduse formuleerumine); sisendfaas (poolametlik ÜEK); protsessi faas (ametlik ÜEK TjaA teostamine); väljundfaas (ÜEK TjaA tulemus); mõju faas (kommertsmõju). Iga faasi raames analüüsis autor esmalt kriitilise tähtsusega nüansse, mis on vajalikud koostöö olemuse mõistmiseks vastavates faasides. Seejärel analüüsis autor edutegureid, mis tagavad koostööprojektide liikumise eelnevast etapist järgmisesse. Viimasena analüüsis autor töö teoreetilises osas võimalikke ÜEK TjaA hindamismetoodikaid.

TAI vajaduse formuleerimise kirjeldamiseks esmases faasis kasutati Kolmikspiraali teooriat. Täpsemalt, vastav teooria loob funktsionaalse raamistiku riigi, ülikoolide ning ettevõtete

omavaheliste suhete kirjeldamiseks. Majandust, mis on Kolmikspiraali I astmes, iseloomustab ettevõtete-ülikoolide täielik eraldatus. Niisugune etapp on valdavalt esindatud autoritaarsetes ühiskondades ning vastavates oludes on tõenäosus ÜEK TjaA rakendamiseks suhteliselt madal. Kolmikspiraali II astmes on tegu *laissez fare* lähenemisega: ülikoolide-ettevõtete koostööks puuduvad otsesed takistused. Samas pole ka süsteemseid meetmeid, mis niisugust koostööd soodustaksid. Kolmikspiraali III aste on seevastu ülikoolide-ettevõtete koostööks oluliselt soodsam: organisatsioonide vahel eksisteerivad trilateraalsed võigustikud ning kattuvad juhtimisahelad. Majandustel, mis on lähemal kolmikspiraali III astmele, on suurim tõenäosus rakendada TAI teostamiseks ÜEK TjaA-d.

Järgmiseks, sisendfaas on partnerlussuhete kujunemise etapiks. Siinkohal võib koostöö toimida nii mitteametliku suhtluse kui ka esmaste tasuvus- ja eelanalüüside kaudu. Vastava etapi käsitlemiseks loob samuti parima raamistiku Kolmikspiraali teooria: taaskord, majandused, mis on lähemal Kolmikspiraali III astmele, omavad tugevaimaid seoseid ülikoolide ja ettevõtete vahel, mistõttu toimuvad vajalikud koostööd ettevalmistavad suhtlused oluliselt intensiivsemalt ja enamate organisatsioonide vahel. Veelgi enam, siinkohal tuleb eristada riikide majanduslikku arengutaset. Arenenud majandustes, kus on tihedad sidemeed ülikoolide-ettevõtete vahel, on vastavatel organisatsioonidel ühtlasi formeerunud täpsemad koostööpõhimõtted ja -praktikad. Seetõttu on oluliselt lihtsam jõuda koostöökokkulepeteni. Samas, järgijõudvates majandustes, mis on enamasti endiselt Kolmikspiraali II astmes (*laissez fare* lähenemine), on ülikoolide-ettevõtete sidemed oluliselt väiksemad. Seetõttu puuduvad ka väljakujunenud praktikad ÜEK TjaA teostamiseks. Niisugustel juhtudel on ühtlasi käesolevas töös näidatud, et vastavad sidemed ei tugevne iseenesest. Sestap on olulised riiklikul tasemel välja kujundatud poliitikameetmed, mis soodustaksid vastavate koostöösidemete väljakujunemist.

Protsessi faasis on partnerlussuhted täpsustunud ja koostööd tehakse enamasti ametlike lepingute alusel. Seega toimub antud faasis ametlik ÜEK TjaA elluviimine, mistõttu tuleb siinkohal eelkõige vaadelda ÜEK TjaA-d madalal projektide elluviimise tasemel. Protsessi faasi mõistmiseks tuleks eelkõige analüüsida, mis määratleb nii ülikoolide kui ka ettevõtete huvi koostöös osalemiseks. Siinjuures on üheks olulisimaks muutujaks organisatsioonide

valmidus teostada TjaA-d ühes teiste ettevõtete ja ülikoolidega. Niisugune valmidus on eelkõige täheldatav tööstusharudes, mis on läbi tegemas kiireid muutusi (nt IKT, nanotehnoloogia, biotehnoloogia jne), kuid nt ka väikestes majandustes, millel puuduvad sisemised ressursid TjaA teostamiseks ainult süsteemi siseselt. Samas tuleb rõhutada, et sarnast TjaA strateegiat rakendavad arvuakad rahvusvahelised korporatsioonid ja ka suured arenenud majandused. Viimane näitab, et avatud koostöö, sh ÜEK TjaA-s, on üks optimaalsemaid viise protsessifaasi läbimiseks.

Projektid, mis jõuavad väljundfaasi, on enamasti täitnud osapoolte vahel sõlmitud kokkulepped. Samas, nagu käesolevas töös välja toodud, siis viimane ei tähenda tingimata, et koostöökokkulepete täitmine tähendaks tingimata kommertsialiseeritavate tulemusteni jõudmist. Selle asemel võib ÜEK TjaA tulemusena olla nt välja arendatud uus tehnoloogia või koostöö osapooled võivad olla omandanud uusi teadmisi-oskusi. Üksikute koostööprojektide tasemel võib niisuguste tulemusteni jõudmist justkui käsitleda eduna. Samas, rahvamajanduse perspektiivist ei ole ÜEK TjaA edukas enne, kui ei ole jõutud kommertsialiseeritavate tulemusteni.

Seetõttu on autor käsitlenud väljundfaasi järgselt veel eraldi ka mõjufaasi kui etappi, kuhu jõuavad kommertsialiseeritud ÜEK projektid TjaA-s. Niisugune mõju võib nt tähendada, et ÜEK TjaA tulemusena on kasvanud märgatavalt koostööd teinud osapoolte müügitulu või on paranenud kasumlikkus. Üheltpoolt, niisugune käsitlus võib mõjuda ilmselge ja mõneti lihtsakoelisena. Samas, nagu autor on käesolevas töös näidanud, siis juhtudel, kus ÜEK TjaA-d viiakse ellu avaliku rahastuse kaasfinantseerimisel, ei ole kommertsialiseeritavate tulemusteni jõudmine alati eesmärgiks, sest koostöö tegemist peetakse juba iseenesest heaks tulemuseks. Sestap, vältimaks niisuguseid riske, tuleks mõjufaasi siiski käsitleda ÜEK TjaA osana ning eraldivõetuna väljundfaasist. Ühtlasi, vaadeldes kriitilisi tegureid, mis soodustavad eduka ÜEK TjaA teostamist, tuleks eelkõige käsitleda edutegureid, mis selgelt panustavad kommertsialiseeritavate tulemusteni jõudmisse.

Täpsemalt, autor on käesolevas töös analüüsinud kriitilisi edutegureid ÜEK TjaA teostamiseks vastavate eespool kirjeldatud koostööprotsessi etappide lõikes. Siinkohal,

eksisteerivad ka protsessietappide ülesed edutegurid. Nt koostööprojektide tasandil on käesolevas töös välja toodud partneri hinnangu faktorid; ülikoolide-ettevõtete profiilide eripärast tulenevad tegurid; toimetulek „kultuurilõhega;“ universaalsed edutegurid; ja koostöö tulemuste väljavaade. Ühtlasi, kõrgemal rahvamajanduse tasandil on faasiüleste eduteguritena välja toodud turu nõudlus TAI järgi; regulatiivsed tegurid; ning makromajanduslikud tingimused. Teisalt, kriitilised edutegurid on valdavalt siiski seotud konkreetsete koostööprotsessi etappidega, mistõttu tuleks neid käsitleda ka vastavas kontekstis.

Esmases faasis on kriitiliseks eduteguriks intellektuaalse kapitali absorbeerimisvõime. Täpsemalt, majandused, kus ettevõtetel on sisemised TjaA osakonnad ning ülikoolidel on väljakujunenud tehnoloogia ülekande praktikad, liiguvad suurema tõenäosusega esmasest koostöö faasist edasi sisendfaasi. Käesolevas töös on näidatud, et viimane on eelkõige tõsi, kuivõrd organisatsioonid on niisugustel juhtudel oluliselt võimekamad TAI vajaduste mõistmiseks ning vastavatele vajadusetele reageerimiseks. Seetõttu, tõhustamaks ÜEK TjaA-d, peaks esmalt keskenduma organisatsioonide absorbeerimisvõime kasvatamisele. Viimane ei tähenda siiski, et organisatsioonidesse peaks tekkima täiemahuline TjaA võimekus. Eelkõige on vajalik kriitilise võimekuse loomine, kuivõrd täiemahulise TjaA teostamine saab toimida organisatsioonide ülese koostööna. Nagu käesolevas töös näidatud, siis niisugune strateegia ei ole omane ainult väikestele organisatsioonidele. Vastupidi, suured rahvusvahelised korporatsioonid ning tugevad majandused on samuti selgelt liikumas organisatsioonide ülese koostöö, sh ÜEK TjaA, soodustamise kui tõhusaima TjaA elluviimise lahenduse suunas.

Teiseks, sisendfaasist edasiliikumiseks on käesolevas töös tuvastatud kriitilise edutegurina ülikoolide-ettevõtete huvide ühildamist. Ettevõtete perspektiivis on eelkõige oluline mõista, kuidas toetab ÜEK TjaA-s viimaste huve. Täpsemalt, eelkõige on ettevõtetele oluline, kas ülikoolide teadmised ja oskused võiks panustada viimaste ärihuvide edendamisse. Samas, ülikoolide perspektiivis on eelkõige oluline eristada teoreetilist tüüpi institutsioonide (Mood 1) ning ettevõtlikku tüüpi ülikoolide (Mood 2) vahel. Kuigi mõlemat tüüpi ülikoolid on

kahtlemata vajalikud teadusliku töö edendamiseks, on selge, et ülikoolide-ettevõtete huvide ühildamine saab edukalt toimuda eelkõige Mood 2 tüüpi ülikoolide kontekstis.

Kolmandaks, töö autor on tuvastanud, et protsessi ning väljundfaasides on kriitiliste eduteguritena eelkõige oluline projektijuhtimisega seonduv. Siinjuures on olulised märksõnad nagu koostööd tegevate osapoolte usaldus, pühendumine, jagatud eesmärgid ja huvid erinevate osapoolte vahel, eelnevad suhted koostööpartnerite vahel jne. Täiendavalt võivad olulised olla nt akadeemilise personali ja tudengite palkamisvõimalused, ettevõtete huvi ülikooli teadmiste vastu ning vastupidi, võimalus täiendavaks rahastuseks, väike geograafiline vahemaa, koostööpartnerite paindlikkus jne.

Neljandaks, mõjufaasiga seonduvad kriitilised edutegurid on eelkõige seotud ÜEK TjaA kommertsialiseerimisstrateegiate olemasolu ning jätkusuutlikkusega. Nagu eespoolt lühidalt kirjeldatud, siis ülikooli vaatenurgast algab see eelkõige Mood 2 tüüpi missiooni tähtsustamisest lisaks traditsioonilisele hariduse andmisele ning alusteaduse tegemisele. Samas, nii ülikooli kui ka ettevõtte kontekstis on siinkohal eelkõige oluline omada selgelt defineeritud ülevaadet kõigist koostööprotsessi etappidest kuni kommertsialiseerimiseni: sh oodatavad tulemused, seonduvad tegevused, vajalikud ressursid ning sobivad partnerid kommertsialiseerimisprotsessi elluviimiseks.

Täiendavalt, teadlaste hulgas puudub üldtunnustatud kokkulepe, millise metoodika alusel ÜEK T&A-d riiklikul tasemel hinnata. Siinjuures, autor on käesolevas magistritöös analüüsinud nii võimalikke kvalitatiivseid kui ka kvantitatiivseid uurimismeetodeid. Lühidalt, töös on välja toodud, et sobiva meetodi väljatöötamisel tuleb esmalt arvestada hinnatava majanduse arengutasemega: mida arenenum majandus, seda suurema tõenäosusega saab ÜEK-s täheldada standardiseeritud koostöösidemeid. Viimasel juhul võib olla põhjendatud kvantitatiivsete meetodite eelistamine. Samas, järgijõudvates majandustes, kus ÜEK koostööpraktikad ning sidemed organisatsioonide vahel on juhuslikud, saab kvalitatiivsete meetoditega olukorda täpsemalt hinnata. Ühtlasi, tagamaks objektiivsust, on hiljutised teadustööd järjest enam tähtsustanud üheaegselt nii ülikoolide kui ka ettevõtete analüüsimist.

Töö empiirilises osas teostas autor Eesti ÜEK TjaA hetke olukorra hindamise ning tõi välja poliitikasoovitused ÜEK TjaA tõhustamiseks. Siinjuures analüüsis autor esmalt Eesti ÜEK TjaA-d laiemalt, vaadeldes Eesti TAI strateegiat perioodiks 2014 – 2020 ning ÜEK TjaA rolli TAI süsteemi kontekstis. Seejärel analüüsis autor Eesti olukorda kitsamalt, teostades kaheksa juhtumianalüüsi. Vastavad analüüsid keskendusid konkreetsetele Eestis ellu viidud koostööprojektidele. Iga juhtumi raames teostati poolstruktureeritud süvaintervjuud eraldi nii ettevõtte kui ka ülikooli esindajatega. Seejärel, töö tulemuste baasilt töötati viimases osas välja politiikasoovitused Eesti ÜEK TjaA tõhustamiseks.

Lühidalt, kuigi teiste järgijõudvate majanduste võrdluses on Eesti innovatsioonisüsteem suhteliselt edasiarenenud tasemel, on riik siiski endiselt veel innovatsioonijärgijate kategoorias. Samas, enamus arenenud majandustest klassifitseeruvad innovatsiooniliidriteks, mis viitab, et vastavatele majandustele järgi jõudmiseks tuleks ka Eestil siiski saavutada innovatsiooniliidri staatus. Siinkohal, Eesti ÜEK TjaA-l on selgelt suurem potentsiaal Eesti TAI süsteemi panustamiseks, kui seni on suudetud ära kasutada. Seda on ka arvesse võetud Eesti TAI strateegia 2014 – 2020 koostamisel, kus ülikoolide-ettevõtete koostöö on toodud välja kui üks neljast strateegilisest kanalist majanduslike eesmärkide saavutamiseks. Viimase tõhustamiseks peaks esmalt suurendama kommertsialiseeritavate tulemusteni jõudvate koostööprojektide arvu. Sestap, kasutades juhtumianalüüsi Eesti ÜEK TjaA hetke olukorra analüüsimiseks, jõudis autor järgmiste tulemusteni:

- Eesti ÜEK TjaA projektides, mis on jõudnud mõjufaasi, on ühtlasi esindatud suurim arv käesolevas töös vaadeldud eduteguritest. Seetõttu kinnitavad edukad koostööprojektid, et tõhustamaks Eesti ÜEK TjaAd, tuleks eelkõige keskenduda edutegurite soodustamisele;
- Projektidel, mis ei jõudnud sisendfaasist edasi, oli probleeme eelkõige kommunikatsiooniga ettevõtete ning ülikoolide vahel ja/või sobivate rahastusvõimaluste leidmisega. Kuivõrd sisendfaasis on kriitiliseks eduteguriks ülikoolide-ettevõtete huvide ühildamine, siis on eespool loetletud takistused ootuspärased. Sestap, tagamaks koostööprojektide liikumist sisendfaasist protsessifaasi, tuleks eelkõige keskenduda just soodustada huvide lahendamist läbi

ettevõtete-ülikoolide kommunikatsiooni soodustamise ning suunatud rahastusmeetmete väljatöötamise;

- Sisendfaasi jõudnud projektid jõuavad valdavalt ka väljundfaasi. Samas, projektid, mis ei edenenud mõjufaasi, ei omanud konkreetset kommertsialiseerimisstrateegiat. Teisalt, mõjufaasi jõudnud projektidel võis täheldada nii kommertsialiseerimisega seonduvate väljavaadete kui ka täpsemate kokkulepete olemasolu. Ühtlasi, mitmetel projektidel oli probleemiks vähene inimressursi olemasolu ja/või ebamääraselt sõnastatud lähteülesanne koostööprojekti teostamiseks. Teisalt, projektid, mis jõudsid mõjufaasi, ühtlasi raporteerisid valdavalt, et esindatud oli nii piisavad inimressursid kui ka selgelt sõnastatud lähteülesanne. Ühtlasi, projektijuhtimine oli mõjufaasi jõudnud projektidel teostatud oskuslikult, samas kui väljundfaasis lõppenud koostööprojektide puhul oli projektijuhtimise edutegureid vähem esindatud. Niisiis, tõhustamaks ÜEK TjaA-d, on käesolev töö autori hinnangul kinnitanud, et edutegurite soodustamine võiks olla üks tulemuslikumaid lähenemisi.

Lühidalt, tuginedes käesoleva töö tulemustele, võiksid olla välja toodud järgmised poliitikasoovitused:

- Arvestades ÜEK TjaA tähtsust Eesti TAI 2014 – 2020 strateegia kontekstis, tuleks välja töötada ÜEK TjaA edendamise rakenduskava.
- Tuleks luua täpne ülevaade Eesti ülikoolide-ettevõtete praegustest koostöösidemest, andmaks võimalikult täpset sisendit ÜEK TjaA-d edendavate poliitikameetmete täpsemaks kujundamiseks. Siinjuures oleks soovituslik lähtuda Kolmikspiraali teooria poolt defineeritud raamistikust ettevõtete-ülikoolide-riigiasutuste vaheliste suhete kirjeldamiseks.
- Luua rahastusmeetmeid, mis motiveeriksid ülikoole ettevõtetega senisest enam koostööd tegema: üks võimalik lahendus oleks sarnaselt õppekohtade rahastamise süsteemile, siduda ülikoolide-ettevõtete koostöö riiklike tellimustega. Teisalt, ettevõtetele täiendavate võimaluste loomisel tuleks kaaluda võimalikke maksusoodustusi ning TjaA rahastusmeetmetid, mis eeldavad koostööd ülikoolidega.

- Luua ettevõtetele ja ülikoolidele täiendavaid koolitus- ja treeningvõimalusi TjaA koostöö teostamiseks. Ühtlasi oleks üheks võimaluseks luua võimalusi parimate praktikate vahetamiseks tänaseks juba mõjufaasi jõudnud koostööprojektide näitel.
- Tõhustada riiklikke toetusmeetmeid organisatsioonivälistе TjaA töötajate kaasamiseks. Ühtlasi, pakkuda projektijuhtimise koolitusi ning siduda riiklike rahastusmeetmete nõuded konkreetsemalt kommertsialiseerimisvõimekusega.

Kokkuvõttes, Eesti ülikoolide-ettevõtete koostöö potentsiaal TjaA-s on selgelt alarakendatud. Samas, kuivõrd Eesti on järgijõudev majandus, mis peab pidevalt kasvama kiiremini kui arenenud majandused, siis niisuguse võimaluse kasutamata jätmine ei ole põhjendatud. Sestap on antud töö tulemusena pakutud välja, et konstruktiivseim lähenemine oleks keskenduda ÜEK TjaA eduteguritele. Niisuguse tulemuse saavutamiseks peaks poliitikameetmed adresseerima igat koostööprotsessi etappi: vastavaid etappe puudutavad peamised poliitikasoovitused on käesoleva töö tulemusena ka välja toodud.

Non-exclusive licence to reproduce thesis and make thesis public

I, Mart Moora (born: 29th of June 1987)

1. herewith grant the University of Tartu a free permit (non-exclusive licence) to:

1.1. reproduce, for the purpose of preservation and making available to the public, including for addition to the DSpace digital archives until expiry of the term of validity of the copyright, and

1.2. make available to the public via the web environment of the University of Tartu, including via the DSpace digital archives until expiry of the term of validity of the copyright,

"University-business Cooperation in Research and Development: an Underused Opportunity for the Estonian Economy" supervised by Jaan Masso

2. I am aware of the fact that the author retains these rights.

3. I certify that granting the non-exclusive licence does not infringe the intellectual property rights or rights arising from the Personal Data Protection Act.

Tartu, 15.05.2014