NTNU – Trondheim
Norwegian University of
Science and Technology

Technology Transfer Offices: Addressing Imperfections in Entrepreneurial Ecosystems

The Norwegian Context

Janagan Balasingham
Andreas Hajanirina
Fiderana Olsen

NTNU School of Entrepreneurship
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Supervisor: Roger Sørheim, IØT

Norwegian University of Science and Technology
Department of Industrial Economics and Technology Management

NTNU
Det skapende universitet

MASTERKONTRAKT
- uttak av masteroppgave

1. Studentens personalia

Etternavn, fornavn **Balasingham, Janagan**	Fødselsdato **14. jun 1987**
E-post **balasing@stud.ntnu.no**	Telefon **45464051**

2. Studieopplysninger

Fakultet **Fakultet for samfunnsvitenskap og teknologiledelse**
Institutt **Institutt for industriell økonomi og teknologiledelse**
Studieprogram **NTNUs Entreprenørskole**

3. Masteroppgave

Oppstartsdato **31. jan 2014**	Innleveringsfrist **27. jun 2014**
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Oppgavetekst/Problembeskrivelse TTO-strategier og komponenter i entreprenørielle økosystem	
Hovedveileder ved institutt **Førsteamanuensis Roger Sørheim**	Medveileder(e) ved institutt
Merknader **1 uke ekstra p.g.a påske.**	

4. Underskrift

Student: Jeg erklærer herved at jeg har satt meg inn i gjeldende bestemmelser for mastergradsstudiet og at jeg oppfyller kravene for adgang til å påbegynne oppgaven, herunder eventuelle praksiskrav.

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Det skapende universitet

MASTERKONTRAKT
- uttak av masteroppgave

1. Studentens personalia

Etternavn, fornavn **Olsen, Andreas Hajanirina Fiderana**	Fødselsdato **24. jun 1989**
E-post **hajaniri@stud.ntnu.no**	Telefon **48294591**

2. Studieopplysninger

Fakultet **Fakultet for samfunnsvitenskap og teknologiledelse**
Institutt **Institutt for industriell økonomi og teknologiledelse**
Studieprogram **NTNUs Entreprenørskole**

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Trondheim, 21.05.2014
Sted og dato

Andreas H.F. Olsen
Student

Hovedveileder

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SAMARBEIDSKONTRAKT

1. Studenter i samarbeidsgruppen

Etternavn, fornavn **Balasingham, Janagan**	Fødselsdato **14. jun 1987**
Etternavn, fornavn **Olsen, Andreas Hajanirina Fiderana**	Fødselsdato **24. jun 1989**

2. Hovedveileder

Etternavn, fornavn **Sørheim, Roger**	Institutt **Institutt for industriell økonomi og teknologiledelse**

3. Masteroppgave

Oppgavens (foreløpige) tittel **Påvirkning fra entreprenørielle økosystemer på TTO kommersialiseringsstrategier for å løfte nyetableringer fra universitetet:** **Norsk kontekst**

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Trondheim
21/05-14
Sted og dato

Janagan Balasingham

Hovedveileder

Andreas H.F. Olsen
Andreas Hajanirina Fiderana Olsen

Originalen oppbevares på instituttet.

PREFACE

This written work is the result of the master thesis by the authors Janagan Balasingham and Andreas H.F. Olsen, as the final report in the author's master course TIØ4945 - Innovation and Entrepreneurship, Master Thesis. Using a resource based and resource dependence perspective, the research focus has been to map the different entrepreneurial ecosystems in Norway and to look at how the different technology transfer offices can address imperfections in the entrepreneurial ecosystems and thus make it easier for University Spin-offs to get access to important resources. The authors would like to thank their academic supervisors, Marius Tuft Mathisen and Roger Sørheim, for very insightful guidance and valuable comments during the work with the thesis. A big thank you also goes to Erik Wold (NTNU TTO), Karl Klingsheim (NTNU TTO), Mariann Ødegård (Kjeller Innovation), Anne Cathrin Østebø (Prekubator), Bård Hall (Norinnova), Anders Haugland (BTO), Anne Kristin Holmeide (NMBU TTO), Ole Kristian Hjelstuen (Inven2) and Daniel Ras-Vidal (FIN) who have made it possible for the authors to do a full-country research on technology transfer and entrepreneurial ecosystems, which probably is first of its kind.

The motivation behind the research has been sparked by our background, and our belief in the importance of, entrepreneurship. The research process has been demanding but very insightful for both authors, and we are happy to have gotten valuable insight in the research and commercialization community in Norway. We are both interested in starting our own companies one day, and through this research we have obtained a strong understanding of what resources that are important and which external factors that can induce or impede the success of new ventures. For this we are utterly grateful.

Trondheim, June 12th, 2014

Andreas H.F. Olsen

Janagan Balasingham

ABSTRACT

This research focuses on the creation and nurturing of University spin-offs and how the entrepreneurial ecosystem affects TTO's value creation process. We have conducted unstructured literature reviews on both TTOs and entrepreneurial ecosystems, ultimately resulting in a critique on Roberts and Malone's (1996) support-selectivity typology, where we argue that entrepreneurial ecosystems are complex and unique phenomenons, and that the handling of these important external factors cannot be easily generalized. Through the lense of Resource Based Theory and Resource Dependence Theory, we find that new ventures need to build a strong resource base to succeed, and USOs are especially dependent on resources, but because of liability of newness, it is difficult for them to get access to the resources they so desperately need. We further focus on the context of Norway and evaluate the different entrepreneurial ecosystems in Norway and look at how Norwegian TTOs can help USOs get access to important resources.

ABSTRACT IN NORWEGIAN (SAMMENDRAG PÅ NORSK)

Denne masteroppgaven ser på hvordan TTOer hanskes med svakheter i entreprenørielle økosystemer for å sikre at nyetableringer fra universitetene (USOer) får tilstrekkelig tilgang til ressurser. Entreprenørielle økosystemer er omgivelsene rundt universitetet hvor det er aktører som sitter på ressurser som USOer trenger. Vi har gjennomgått litteratur om TTOer og entreprenørielle økosystemer, og ved å bruke ressursbasert teori (RBT) og ressursavhengighetsteori (RDT) som rammeverk har vi kommet fram til at USOer ikke bare trenger ressurser for å overleve, men at de også er ekstra avhengige av ressurser sammenlignet med andre nyetableringer. I tillegg er det tydelig at TTOer kan ha mye å si for ressurstilgangen til USOer. Vi kritiserer Roberts and Malone (1996) som sier at for svake økosystemer så lønner det seg å gå for støttende og selektive TTO-strategier. Vi mener svake økosystemer er for komplekse fenomener til at man skal kunne generalisere en strategi for å løse alle typer svake økosystemer. Vi sier videre at TTOer må tilpasse sine strategier etter omgivelsene og at det er ulike verktøy (TTO-tools) som kan brukes for å hanskes med problemer i økosystemene. Vi har fokusert særskilt på økosystemkomponentene menneskelige ressurser, finansielle ressurser og tilgang til marked fordi det ser ut til å være en bred enighet blant både forskere og praktikanter at det er disse som er de viktigste komponentene i økosystemet og at det er disse som er de viktigste ressursene for USOer. Siste del av rapporten kommer til å ta for seg TTOer i Norge og vi kommer til å se hvordan TTOene går fram for å bedre på ressurstilgangen til deres USOer. Vi ender til slutt opp med en TTO-verktøykasse (TTO-toolbox) for norske TTOer.

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1. INTRODUCTION

Commercialization of university research results have become an important activity for several countries all around the world because of its expected positive effect on country's economic development (Sætre et al., 2006). One contributor to the growing focus on the commercialization of university research findings is the American Patent and Trademark Amendments Act from 1980, commonly known as the Bayh-Dole Act (Loewenberg, 2009; Shane, 2004). This amendment has been proven to be effective in facilitating university patenting and licensing, and has helped to accelerate US university technology transfer practices. The Bayh-Dole act requires university's faculty members, students or staff members who recognize or discover new technology and know-how to disclose this to the university (Loewenberg, 2009). Citing the New York Times, Loewenberg (2009) states that the number of patents have increased a hundredfold and more than 4500 for-profit US-firms have sprung up as a result of patents made under the Bayh-Dole act within its first 30 years. Based on the successful experience in the US, a number of countries, including Germany and Japan, adopted similar legislations to encourage universities participating in technology transfer in the late 1990s. Norway, the country of which this research will primarily focus on, implemented similar rules in 2003, aiming to increase commercialization of research and the establishment of organizations that could govern the commercialization processes within the university (Årdal et al., 2011).

As universities saw the value in nurturing the new technologies that emerged from their faculty, many of them chose to establish so-called Technology Transfer Offices (TTOs) which function as "technology intermediaries" that transmit the technology from the lab to industry, whether it is through licensing or by spinning off a company based on the technology. Traditionally, licensing has been the predominant transfer mechanism (Siegel et al., 2003). Other TTO tasks include fostering the university's interaction with industry and managing contracts for research (Friedman & Silberman, 2003).

Research on technology transfer follows the growth of the phenomenon in practice and put more and more emphasis on the creation of new innovative, technology-based university spin-offs (USOs) as a mean for economic development and job creation (O'Shea et al., 2007; Rasmussen & Borch, 2010; Shane, 2004; Steffensen et al., 2000). In 1997, the Bank of Boston performed research where they found 4000 MIT spin-offs that employed 1,1 million people, and generated $ 232 billion in worldwide sales. They also found, that since 1990, an average of 150 new firms have been spun out of MIT per year. It is however important to point out, that MIT is regarded as a very unique case in the context of technology transfer and entrepreneurial ecosystems. Shane (2004) indicates that the indirect effects of USOs might be even greater than the direct effects. He claims that they might include: regional development, attracting and retaining top-notch faculty, aiding the commercialization of high-risk projects, incentivizing more research activity, and training students. These are factors that he says are difficult to quantify, but are important nonetheless. It is however worth noticing that not all researchers agree on the importance of USOs. For example, the research of Harrison and Leitch (2010) concludes that most USOs start small and stay small because of founder aspirations, capabilities and resource endowments. Focusing on USOs from Northern Island,

they found that these are often technology lifestyle businesses rather than high-growth potential start-ups.

According to Sætre et al. (2006), Norway still has a lot to learn when it comes to the commercialization of research findings from universities. Still, there are growing incentives in Norwegian society to increase focus and interest in university technology transfer. Oil and natural gas, which have been Norway's main natural resources, are limited and will therefore come to an end at some point. This means that it would be both politically and economically wise for Norway to develop other industries before the country's natural resources deteriorate. Moreover, the average lifespan of people is increasing and manufacturing is being moved to low-cost countries. Fish and fish farming, which is Norway's second largest resource, are slowly being outpriced by other maritime nations (Sætre et al., 2006). All of these factors have led to the increase of focus towards entrepreneurship, innovation and commercialization of research findings from Norwegian universities (Sætre et al., 2006).

The research done by Breznitz et al. (2008) advocates that TTOs should consider the existing environmental conditions when implementing a strategy for transferring technology. Their research focuses mainly on the ecosystems at Yale and MIT, illustrating how two different strategies for technology transfer can both give positive outcomes. Being a university, which historically has focused on R&D, but not on commercialization, Yale experienced that the entrepreneurial culture and conditions around the university was not enabling new venture creation. The culture for entrepreneurship was weak (Breznitz et al., 2008). Because of this, the TTO at Yale decided to be very selective in what specific technologies to focus its commercialization resources on, and it decided to be very supportive, by taking part in the management teams and by making sure that the environment around the university became conducive for commercialization of university research. Inven2, the TTO from the capital of Norway and Norway's largest university, follows a similar strategy impacted by the strength of the University of Oslo's research on life science. At MIT however, because of the flourishing entrepreneurial ecosystem with several incubators around the city, high density of Venture capital and business angels, several successful start-ups, professional support actors who are entrepreneur friendly, a university with a culture for innovation and industry contact, a strong human capital within both technology and business, the ecosystem was in itself enabling new spin-offs, so the TTO did not need to be as supportive nor selective. Ultimately, Breznitz et al. (2008) concluded that the strategies set by the TTO should be very much aligned with the existing condition in the region. These "existing conditions" is commonly referred to as the entrepreneurial ecosystem, and is mentioned by several researchers as an essential factor in the business of new venture creation (Neck et al., 2004; Spilling, 1996; Van de Ven, 1993).

In cases where the entrepreneurial ecosystem is considered weak, the TTO's ability to use mechanisms to attract resources that the USOs need, can play a vital role in the economic development provided from the research arena. A lack of human capital has for example made some TTOs go after surrogate entrepreneurs, who are experienced entrepreneurs entering the management team as CEO or COO in a very early phase. These strong resources are said to provide a massive lift to promote USOs because of their management skills and

experience from former startups (Franklin et al., 2001). Based on the experience from US regions, most researchers agree that ecosystems consist of a set of different interconnected actors within a specific geographic area, which can highly influence the economic development in the region (Cohen, 2006; Isenberg, 2010; Neck et al., 2004; West Iii & Bamford, 2005). USOs are dependent on building a strong resource base in order to survive (Mustar et al., 2006). We will further argue that entrepreneurial ecosystems consist of different resources that USOs need, and that one purpose of TTOs is to make sure that the USOs get access to these resources, and, if this is not possible, conduct measures to ensure more autonomy.

Even though there have been a growing emphasis on TTOs and their strategies to promote new venture creations in both the US and Europe (Di Gregorio & Shane, 2003; Friedman & Silberman, 2003; Gilsing et al., 2010; Golob, 2006; Lockett et al., 2003; Markman et al., 2005; Shane, 2004), there is very little research about TTOs in the Nordic countries. It is important to have research in different context to see how the context shapes the findings for other parts and other cultures of the world, because, as we argue above, context and ecosystems matter. Traditionally, researcher's dominant way of typologizing the observed strategies of TTOs have been the use of Roberts and Malone (1996) Support-Selectivity typology which states that weak entrepreneurial ecosystems require high support and high selectivity, while strong ecosystems require low support and selectivity. There is however reason to believe that ecosystems are extremely complicated and unique, and that the support-selectivity typology might be too simple.

This research aims to answer the research question:

> *In the Norwegian context: How do TTOs address imperfections within weak entrepreneurial ecosystems, with respect to spinning off USOs?*

There is very little research on how technology transfer functions in a country as a whole, and for most countries, this would be very difficult because information is hard to obtain. In Norway however, the information is especially open due to high transparency in politics and society. Moreover, the fact that Norway is a relatively small country with only seven TTOs, it seems to be a well-suited country to conduct such a research. Norway implemented a similar version of the Bayh-Dole act in 2003 and the country may still be trying to find best practices in the context of technology transfer. This is supported by Mustar et al. (2008) who state that 1) it can take considerable time to develop transfer mechanisms that are needed to develop spin-offs that can achieve significant growth in international markets, and 2) it can take considerable time to develop networks between universities and industry. We will do qualitative interviews and conduct questionnaires with all Norwegian TTOs, assess their existing environments (entrepreneurial ecosystems), and we will find different measures that these TTOs do in order to address imperfections in their entrepreneurial environment, making sure that their USOs can get the resources they need to succeed.

We are of aware that there are internal factors within universities, such as technology focus, university eminence and university culture for entrepreneurship that could have influences on USOs and technology transfer, but for this research we choose only to focus on external TTO

factors. Many researchers have focused on internal factors (Di Gregorio & Shane, 2003; Siegel et al., 2003), but we believe that also focusing on external factors is important in order to get a full understanding of the area of technology transfer.

The following chapter will go through a literature review that will comprise our definition of University Spin-offs, theory on Resource Based Theory (RBT) as this can explain that USOs need resources and that they need to build a strong resource base in order to become competitive, and Resource Dependence Theory (RDT) to explain the strong resource dependence that USOs have in the beginning and that TTOs might play a very important role in decreasing this resource dependence. After that follows a literature review on entrepreneurial ecosystems, and a literature review of conventional TTO-strategies for commercialization of research findings. Chapter three is an elaboration of our research methodology. Chapter four presents Norway as the case country and chapter five will go through the analysis of the different case subjects (TTOs) in Norway. In chapter six we will present and discuss our findings and compare the different TTOs against one another. Lastly we will finish by stating our main research contributions, conclude, and present implications and recommendations for further research, as well as the limitations of our research.

2. THEORY AND LITERATURE REVIEW

The following will create the fundament for our discussion later on as we will now go through a definition of what a University Spin-offs is, we will present two theoretical frameworks which we believe can be useful in order to explain 1) that USOs need to build a strong resource base to become competitive (Resource Based Theory), and 2) USOs need help in order to do so (Resource Dependence Theory). After that follows two literature reviews where we first will review theory on entrepreneurial ecosystems and lastly, a review on technology transfer mechanisms.

2.1. UNIVERSITY SPIN-OFFS

Researchers suggest that USOs potentially are very important for industrialized countries, where spinning off-mechanism is considered the most efficient way to transfer new technological knowledge into businesses (Shane, 2004; Sternberg, 2014). Among instruments available for university entrepreneurship, spin-offs appear to be the one of which the recent literature exhibits the most understanding (Rothaermel et al., 2007). This is, according to Rothaermel et al. (2007), proven by the growth of studies illuminating this field in the last decade.

Research (e.g. Carayannis et al., 1998; Druilhe and Garnsey, 2004; Pirnay et al., 2003) has explored the various types of university spin-offs. Based on the university, some have tried to classify USOs in transferring "technology only," "technology and personnel," and "personnel only" (Carayannis, 1998; Nicolaou & Birley, 2003). The technology in which these spin-offs are based on can vary, but research shows a strong link between the university's research focus and USO technology (Degroof & Roberts, 2004). Several major employers in the San Francisco Bay Area that were spun out from a university include Sun Microsystems, Cisco Systems, Chiron and Genentec. These former USOs all have a strong link to their parent organization (Graft et al., 2002). USOs are hence normally reflected to include the technologies that the university has as its focus, covering areas such as material sciences, medical sciences, computer science, biotechnology, energy, electronics and many more. When it comes to which categories of transfer that may occur, Druilhe and Garnsey (2004) argue that this can be codified knowledge, tacit knowledge or both, based on USO business activities and resource requirements. Mentioned business areas are "consultancy," "intellectual property licensing," "software," "product," and "infrastructure creation".

There co-exist various definitions that are applicable in describing USOs. The variety of some definitions found in the literature is presented in Appendix 1. We can see that there are many different conceptualizations of university spin-offs, although a detailed examination gives some similarities (Pirnay et al., 2003). Pirnay et al. (2003) states that it exists many dimensions in characterizing USO, but lists up four dimensions that are often treated in the literature, (1) spin-off creation processes, (2) status of founders, (3) types of technological content, that is commonly used to develop the conceptualization of USOs and (4) if the USO were sponsored by the TTO or not.

With respect to spin-off creation process, many studies agree that to be a university spin-off, knowledge must be transferred from the university/research institution to the new firm (Shane, 2004). Described in another way, USOs are trying to commercialize research and innovations that has been developed within the university and/or research institutions. Many authors have a common understanding regarding the process of spin-off creations, but share different arguments concerning the status of the founders. Some authors define USOs as companies founded by the academic staff (Carayannis, 1998; Steffensen et al., 2000). While others, being less strict, include students as founders as well (Smilor et al., 1990). Others have not considered the status of the founders as long as the knowledge that is commercially exploited comes from the university (Klofsten, 2005; Roberts & Malone, 1996). According to (Siegel et al., 2004), the inventor can be involved in the spin-off in different ways; As a founder, in the board of directors, as a technical consultant or a passive inventor with equity stakes in the spin-off (Siegel et al., 2004). Furthermore, the establishments of spin-offs can be seen as a process in which founders will have to leave the university or research institute to manage their own firms (Carayannis, 1998; Steffensen et al., 2000), or the founders work at the university in parallel with the spin-off operations (Smilor et al., 1990). If we direct our focus at the types of technological content, (Steffensen et al., 2000) consider university spin-offs as companies with an objective to commercialize core technological ideas based on patents and licenses. Smilor et al. (1990) defining it more broadly do not only see the technology based on patents and license, but also on scientific know-how or non-patentable technology generated at the university/research institution. The degree of separation from the parent organization, and TTO, has also been an issue of debate (Howells & McKinlay, 1999). A sponsored spin-off is defined as a spin-off born out of the venturing activities of an established organization, where the parent organization has been actively involved in the development of the new firm (Wallin & Dahlstrand, 2006). This is normally operationalized by parent firms, where the university through TTO, is retaining partial ownership in the spin-off.

Our research defines a USO as a new company founded to exploit a piece of intellectual property created in an academic institution (Shane, 2004). In regards to background of the founder, USOs in this study are considered as firms established by faculty, students and TTO-staff. Individual companies from the industry, without any linkage to the university, interested in just buying or licensing the patents from the university are excluded. The academic researchers may in the establishments of the USOs remain at their academic position at the university, but at the same time also pursue the commercial opportunities in parallel. In the matter of knowledge commercialized, this is treated very broadly as; scientific or technical know-how, patented technology, technology-based ideas or research results acquired by the founder(s) during the academic activities. It is not necessary that such knowledge developed within the university is a core research focus of that particular academic institution. We also primarily regard sponsored spin-offs, because these are directly linked to TTOs. Student companies emerging from the university environment without any knowledge or assistance from TTOs or other university research are rarely affected by TTO-strategies. The conceptualization of USOs is determined as above because we do not want to exclude any possible spin-off formations that can emerge from university research. We treat

the USOs broadly because our specific unit of analysis is TTOs, and how they create value, not on which types of USOs they spin out.

2.2. RESOURCE BASED THEORY

The concept of resource based theory (RBT) has several highly influential contributors (Barney, 1991; Penrose, 1959; Wernerfelt, 1984). Edith Penrose introduced this way of thinking in her book "The theory of the growth of the firm" (1959) where she criticized existing theory of the firm and said that that this was inadequate to explain how firms grow. Penrose (1959) claimed that:

> *"There are important administrative restraints on the speed of the firm's growth. Human resources required for the management of change are tied to the individual firm and so are internally scarce. Expansion requires the recruitment of more such resources. New recruits cannot become fully effective overnight. The growth process is, therefore, dynamically constrained."*

Thus, Penrose (1959) put more emphasis on the importance of the firm's internal resources in order to achieve firm growth.

(Wernerfelt, 1984) managed to expand the theory by introducing a way of examining a firm looking at their resources rather than their products. However, it was not until Barney (1991) published his article Firm resources and sustained competitive advantage that it really started to gain strength and RBT has been a leading framework for examining venture growth and competitive advantage ever since (Mustar et al., 2006).

(Barney, 1991) notes that there are especially two assumptions that are elemental to his resource based view: (1) resources are distributed heterogeneously across firms, and (2) these resources cannot be transferred from firm to firm without cost. According to Priem and Butler (2001), several researchers have different perceptions on the underlying meanings of Barney (1991) resource based view, but because of its influence, and because of the lack of subsequent definitional work, we choose Barney (1991) as the baseline of our RBT-explanation.

RBT states that companies can be conceptualized as a grouping of resources, and these resources have the potential to give companies sustained competitive advantage if they are Valuable, rare, difficult or impossible to imitate and non-substitutable, or VRIN (Barney, 1991).

- Valuable resources make it possible for the company to improve its market position over its competitors
- Rare resources enables the firm to keep the competitive advantage over a longer period of time
- Resources that are difficult or impossible to imitate means resources that are immobile and costly to imitate for competitors
- Non-substitutable resources are resources that cannot be substituted by other resources in order to implement the same strategy

Exactly what resources are is challenging to comprehend because the definition of resources tends to be very inclusive (Priem & Butler, 2001). Intangible resources such as human know-how are for example hard to describe and value, while tangible resources such as financial resources are easy to describe and value.

Brush et al. (2001) write that resources can be characterized by their application and importance to the productive process ranging from utilitarian and instrumental, whereas utilitarian resources are applied directly to the productive process or combined to develop other resources (e.g. Office spaces), while instrumental resources are used specifically to gain access to other resources. Financial resources are considered instrumental because one can use financial resources to gain access to trucks, machines or even human resources. When the firm manages to combine resources well, these can become capabilities and thus enhance the firm's capacity to use resources to achieve positive effects. When capabilities are being used well, they become core competencies - things the firm does especially well that can lead to competitive advantage. Core competencies that are increasingly specialized and give the firm the ability to outperform its competitors will become strategic assets. Rare, Valuable, inimitable and nonsubstitutable strategic assets can give a substantial strategic advantage for the firm (Brush et al., 2001).

UTILIZING RBT ON NEW VENTURES

So, now we have established that firms can build competitive advantage by building a strong resource base. But what about new firms that do not have money, experience or anything other than the people who started the company?

> *"That strategy is based on resource strengths is obvious. The more important question to answer is, "What if you don't have any resource strengths?"*
>
> *- Birger Wernerfelt*

A limitation with Barney's (1991) article is that it is not well adjusted to entrepreneurial ventures. It cannot fully explain how entrepreneurs, with no special resources or experience could build sustained competitive advantage. For new ventures, these resources must first be assembled, and then they can build these and gain competitive advantage (Brush et al., 2001). Constructing an initial resource base is an exceptional challenge because the new venture may lack administrative history, a customer base, cannot point to it's reputation for performance, and may have no shared experience. This argument is supported by (Stinchcombe, 1965) who calls this phenomenon the "liability of newness". Every year, a great number of new ventures fail because of ineffective management, undercapitalization, human failings, or inability to attract and maintain qualified personnel. This is why new ventures are highly dependent on having the correct resources early on in their life cycles (Brush et al., 2001).

Mustar et al. (2006) states that scholars have defined resources rather broadly. A result of this is that a variety of alternative resource classification exists. Grant (1991) classifies resources as tangible, intangible and human resources. Tangible resources are financial and physical

assets, intangible resources are assets such as brand and reputation, and lastly human resources involve technical know-how and other knowledge resources. Barney (1991) classifies resources as physical capital, human capital and organizational capital resources

According to Brush et al. (2001), there are six different resources that are essential for new ventures; Technological, human, social, financial, physical and organizational resources. Mustar et al. (2006) uses a combination of Barney (1991) and Brush et al. (2001) and presents four specific resources that they believe to be most relevant for new ventures. Table 1 presents these.

Table 1 - Mustar et al.'s (2006) four important resources for new ventures

Resources	*Definition*
Technological resources	Defines the firm's products and technology (Borch et al., 1999). Typical factors that influence the technological resources for new ventures are the degree of innovation, scope of the technology, legitimacy of the firm's R&D, and where they are in the technology development cycle.
Social resources	Defines the firm's industry and financial contacts (Brush et al., 2001).
Human resources	Mustar et al. (2006) defines human capital as the size of the founding team, background of the founders, professional management experience, and organizational size.
Financial resources	Refers to the amount and type of financing of the firm (Mustar et al., 2006). Brush et al. (2001) emphasizes financial resources as instrumental because they are flexible and can give access to other important resources such as people or equipment. This means that, for USOs getting access to financial resources early on in their life cycle can be very important.

Other researchers, for example Ireland et al. (2003), agree with these critical resources for entrepreneurial ventures, saying that human capital, social capital and financial resources are essential factors for new ventures Ireland et al. (2003) makes a very important point citing (Michael et al., 2002):

> *"New ventures, especially those independent from on-going organizations, face adverse selection, meaning that they must be able to appropriately signal those from whom financial resources are sought that they possess the skills required to pursue opportunities and develop competitive advantages in order to create wealth."*

This means that the founder's human capital and their ability to convince people that they can create wealth is very important. Founders of USOs are often researchers, and these are traditionally not individuals with these kinds of abilities (Siegel et al., 2003; Wright et al., 2006). This illustrates one reason why it makes sense that universities have formed TTOs that can nurture these USOs and that can give them access to resources, which they so desperately need in order to succeed.

CONSTRUCTING A RESOURCE BASE

Brush et al. (2001) offers a resource plan of action for entrepreneurial ventures that addresses four specific challenges: 1) Identifying key resource needs and sources, 2) attracting and engaging resources, 3) combining resources and 4) transforming individual resources into organizational.

IDENTIFYING NEEDS AND RESOURCES

In order to obtain the correct resources, entrepreneurs need to go through two steps: 1) specify what resources are needed by first looking at the entrepreneurs and look at what resources he/she has before looking to the environment and seeing what resources can be obtained from themselves (financial, human, physical etc.), and 2) identify and target potential sources of suppliers of resources. USOs might have special needs for production facilities and supplies, and therefore it is important to identify where this can be found. USOs may also have special needs with respect to markets as it might have a technology which is especially suited for certain environments.

ATTRACTING AND ENGAGING RESOURCES

The entrepreneur's ability to sell a business idea through personal skills can be very important in order to interact with others but especially when attracting other resources such as financial and human resources. According to Brush et al. (2001), five social skills are important to the entrepreneur. Table 2 presents these.

Table 2 – Brush et al.'s (2001) five social skills for entrepreneurs

Skills	*Description*
Social perception	The accuracy with which the entrepreneur assesses the traits, intentions, and motives of others
Impression management	The way one induces positive reactions from others
Expressiveness	The ability to express emotions and feelings clearly and generate enthusiasm in others
Persuasiveness	The ability to change other's views or behaviors in face-to-face encounters
Social adaptability	The ability to adapt to, or feel comfortable in, a wide range of situations

COMBINING INITIAL RESOURCES

Resources are no good before before they are combined into unique resources in increasingly complex combinations, as mentioned above (capabilities). Resources can wear out, and entrepreneurs sometimes need to change some resources that are negative or non-productive. However, there are many entrepreneurs who are unwilling to separate from certain resources (e.g. partners, equipment). Continually assessing that the venture has the correct resources at

all times can help prevent resource weaknesses or inadequacies and should therefore be taken seriously by entrepreneurs.

TRANSFORMING PERSONAL RESOURCES INTO ORGANIZATIONAL RESOURCES

As the firm grows, it becomes more and more important that the special resources that are unique to the founder get transformed into organizational resources. Ventures that can not do this will be constrained in growth. In order to ensure the impact of this transition, the founders may need to engage in intense and frequent communication to other employees to develop a shared organizational understanding.

Although RBV traditionally was developed from studies of the for-profit sector, it could be a good framework to get a better understanding of phenomenons such as technology transfer within universities (Powers & McDougall, 2005). As Powers and McDougall (2005) state:

> *"Universities compete for research funds, star faculty, and for top-quality students, at least among institutions seeking to advance their reputations for excellence. The competition for these financial and human capital resources has become especially sharp in light of more institutions seeking limited federal research dollars, cannibalizing each other's top faculty, and increasingly relying on merit aid to attract the brightest students. Public universities also must compete more for a reduced pool of state funds."*

RBT might not be a sufficient theoretical framework for our research because this theory focuses on the firm's internal resources. This is not well suited for new ventures (Mustar et al., 2006) because new ventures do not have any resources except the founders. USOs are even worse off because traditionally, USOs are high-tech companies that have a tremendous need of resources (Clarysse & Bruneel, 2007) such as financial capital, human resources, suppliers, mentors, and this strong dependency of resources makes USOs very fragile entities as they are highly dependent on external factors in order to get access to these resources. As an example for USO's high need of financial resources, Clarysse and Bruneel (2007) write that high-tech, growth companies easily needs NOK 4 million to NOK 8 million in order to survive the early phase. We will therefore introduce another theoretical framework, Resource Dependence Theory, which will consider this resource dependence of USOs.

2.3. RESOURCE DEPENDENCE THEORY

Resource Dependence Theory (RDT) was developed by Salancik and Pfeffer (1974) who argued that organizations are highly affected by external resources such as labor, raw material, capital etc. In their book, they stated that: *"In order to understand the behavior of an organization, you must first understand the context of that behavior - that is, the ecology of the organization"*. Their basic arguments of the resource dependence perspective and interorganizational relations are as follows:

- The fundamental units for understanding intercorporate relations and society are organizations
- These organizations are not autonomous, but rather are constrained by a network of interdependencies with other organizations

- Interdependence, when coupled with uncertainty about what the actions will be of those with which the organization is interdependent, leads to a situation in which survival and continued success are uncertain
- Therefore, organizations take action to manage external interdependencies and to maximize their autonomy, although such actions are inevitably never successful and produce new patterns of dependence and interdependence

RDT recognizes that external factors have influence on an organization's behavior and, even though they might be constrained by their context, managers can act to reduce environmental uncertainty and dependence (Hillman et al., 2009). Central to the research on RDT is the concept of power, which means the control over vital resources. The basics behind this concept is that the control company A has over company B is the degree to which company B is dependent on the resources company A holds. According to Pfeffer and Salancik (2003) the problem about the RDT research is that the idea that organizations are constrained and affected by their environments and that they act to manage resource dependencies has become so widely accepted that it is not rigorously explored and tested. RDT has been used as theoretical framework in the context of several activities that firms do in order to manage resource dependencies (e.g. M&As, hiring board of directors, Joint ventures).

RDT AND USOS

In the previous chapter about RBT, we established that firms needs to build a strong resource base and combine these resources in a way that can give them competitive advantage. We also established that building a strong resource base could be very challenging for new ventures and especially for USOs. This is because:

- USOs often tend to be founded by scientists who do not have much business experience, network and the persuasiveness an entrepreneur needs (Siegel et al., 2003)
- USOs tend to be high-tech companies with a very high dependence on R&D in order to obtain proof of concept and might need a substantial amount of financial resources to do so (Clarysse & Bruneel, 2007)
- Being high-tech companies, USOs might be needing rare supplies from very special suppliers and thus have a strong dependence on suppliers

Taking into consideration what RDT says about power balance - that the power and the position a firm has in the industry is very much influenced by its dependence on other actor's resources. Because of "liability of newness" (Stinchcombe, 1965), the procurement of such resources might be a difficult task. TTOs can play a vital role in helping USOs to get access to and to procure the resources that they need in order to succeed. This aligns well with the arguments of Bauer and Flagg (2010) who state:

> *"Technology Transfer Intermediaries (TTIs) are the most diverse group of Resource Providers. They offer various assistances to the stakeholders associated with Technology Research, Product Development and Product Commercialization activities. Examples of TTIs include university TTOs, federal laboratory ORTAs, and other federally funded brokers such as the*

T2RERC. It is common for TTI to draw upon the capabilities of other resource providers."

TTO's importance for USOs is illustrated by figure 1, where the TTO can provide resources to USOs throughout their development stages. Other mechanisms, such as investors, and external grants are only available at certain times.

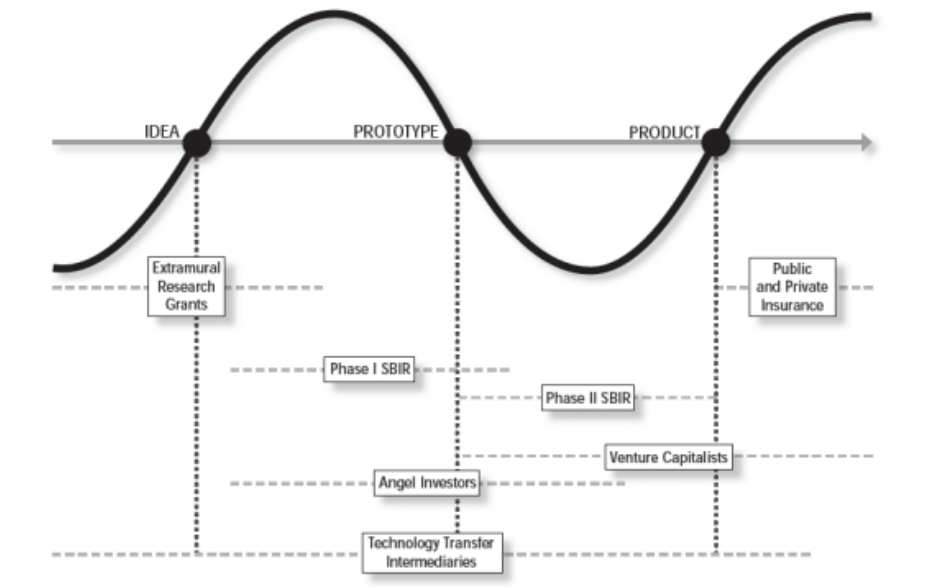

Figure 1 - Resource providers in different phases of the USO's life cycle

The liability of newness (Stinchcombe, 1965) puts USOs in an unfavourable position because they are very dependent on resources in order to succeed (Brush et al., 2001; Mustar et al., 2006). Resource dependence theory supports this by pointing at the very uneven power balance between USOs and resource holders as USOs need resources from them and they don't need anything from the USOs. TTOs, who might have been around for a longer time than USOs, could use their network and experience to help USOs get access to these resources, thus removing some of the liability of newness. It is however worth noticing that, as we mention in the introduction, building networks between university/TTO and industry might take considerable time (Mustar et al., 2008).

2.4. THE ENTREPRENEURIAL ECOSYSTEM

The entrepreneurial system, or the entrepreneurial environment, in one specific region is often referred to as an entrepreneurial ecosystem, and within these entrepreneurial ecosystems (EES), there are several actors that hold resources that USOs need in order to survive. This chapter will review previous research on EESs, which in our context will primarily be for technology-based firms.

Van de Ven (1993), citing other researchers (Constant, 1980; Jewkes et al., 1969; Usher, 1954), argues that entrepreneurship is not just about the individual entrepreneur. It is also a diverse set of interdependent actors within a geographic region that influence the formation and eventual trajectory of the entire group of actors and potentially the economy as a whole -

the entrepreneurial ecosystem (Iansiti & Levien, 2004; Spilling, 1996). Because of prospering entrepreneurial ecosystems such as Silicon Valley and the Boston-Cambridge region, several leaders and policy makers have tried to create the same environments for their own regions (Isenberg, 2010), hoping to obtain the same impressive socio economic impact these strong ecosystems have. Strong ecosystems for entrepreneurship attract talented people, high profiled and new companies, venture capitalists and business angels, consultants and other supporting actors, and all of these constitute a system which over time can develop into a strong entrepreneurial ecosystem that will contribute in the development of the region's economy (Isenberg, 2010).

2.4.1. COMPONENTS IN AN ENTREPRENEURIAL ECOSYSTEM

Van de Ven (1993) was one of the first to focus on the different components that constitute an entrepreneurial ecosystem. He divided these into three main groups:

- Resource endowments: He believes there are three fundamental resources that need to be present in order to develop a technology and industry; (1) basic research which gives the necessary foundation for new and innovative discoveries that might become commercial products, (2) financing mechanisms which are essential for the development and commercialization of an innovation, and (3) competent human resources who can develop and commercialize innovations.
- Institutional arrangements: Governmental regulations and institutional arrangements can facilitate and inhibit the emergence of new start-ups. This could be an increase or decrease in government funding, more permissive policies, and/or lowering of taxes which Wright et al. (2006) claims to be a good government policy to encourage more investments from investors
- Proprietary functions: Accessible markets and customers, access to innovation networks and technology development functions such as incubators and technology parks

Van de Ven (1993) believed, that with all of these components in place, and if they all coevolve in a sustainable manner, it is possible to obtain a strong entrepreneurial environment - an environment where necessary resources are readily available to new ventures with potential. Van de Ven (1993) did a good contribution in identifying the important factors in EES, but in order to create our model, we need more specific components in EESs. One of the first to create a specific set of components in EESs was Neck et al. (2004).

With background from researchers such as Van de Ven (1993) and Spilling (1996), Neck et al. (2004) developed a more specific set of components that collectively had an influence on the development of technology clusters in a region. They identified the components of the entrepreneurial ecosystem, which they believed led to the creation of a cluster of technology start-ups in their case-area. Table 3 illustrates all the interdependent components in an entrepreneurial ecosystem (Neck et al., 2004).

Table 3 - Components in an entrepreneurial ecosystem (Neck et al., 2004)

Component	*Definition*
Informal and formal network	Neck et al. (2004) found that the relationship between people and organizations in a region plays an important role in entrepreneurial ecosystems. Informal network is the ties between friends, family, colleagues and informal relations with similar companies. This component comprises the cultural aspect of the entrepreneurial ecosystem. Formal networks are a diverse group of actors in an economic community such as research university, government, professional and support services, capital sources, talent and large corporations. What Neck et al. (2004) defines as "formal network" is in other words similar to what Van de Ven (1993) would call the entrepreneurial system.
University	Research Universities can have a significant impact on the evolution of an ecosystem through research and education. In addition, universities generate talented young people who can come up with new technology or develop the skills to manage new ventures.
Government	Federal, regional and local governments foster or hinder the development of entrepreneurial ecosystems through tax rates and incentives, subsidies and grants. According to Cohen (2006), innovation can actually be compelled through proper policy application (e.g. mandating reduced vehicle emissions)
Professional and support services	Entrepreneurial tax and legal support, consultants and firms in the supply chain that provide inputs that may go into the finished product (Cohen, 2006)
Capital services	New ventures are often dependent on access to start-up capital such as venture capital, angel investors or government funding in order to achieve their goals
Talent pool	Access to a large number of qualified employees and students

New venture creation is a function of interdependencies between the different components (Neck et al., 2004; Van de Ven, 1993). A lack of investor interest would for example make it hard for some start-ups to succeed, as this would mean that they would not have the means necessary to conduct testing or other important tasks. This illustrates a strong resource dependence that must be dealt with, either by the organization itself, or by other actors. For the case of USOs, "other actors" could mean TTOs. An example of this is elaborated by Breznitz et al. (2008), where policy makers at Yale University really had to work hard to motivate investors to move to the area because they saw this as a crucial component for the success of their entrepreneurial ecosystem. TTOs often try to mitigate the dependencies that USOs have on the existing resources in entrepreneurial ecosystems. Exactly how TTOs operate will be further assessed in the next chapter.

According to Isenberg (2010), not all regional economies will have strong entrepreneurial ecosystems such as Silicon Valley or the Boston-Cambridge region. Governments often, and

should, play a decisive role to build entrepreneurial ecosystems within their country (Isenberg, 2010; Neck et al., 2004; Van de Ven, 1993). These researchers agree that governments can affect entrepreneurial activity by lowering taxes related to new ventures, subsidizing in lucrative business areas and creating government grants. World Economic Forum (WEF) reports that government and regulatory policies are viewed by entrepreneurs as both potential growth accelerators but also potential growth inhibitors. A research where (WEF, 2013) surveyed over 1000 entrepreneurs from around the globe revealed, that out of the 8 components (very similar to Neck et al. 2004) which were assessed, there are three which entrepreneurs consider to be the most important for the growth of their ventures; human capital, funding & finance and accessible markets (WEF, 2013). The WEF (2013)report is the first large-scale study of ecosystems that systematically examines which components of an ecosystem matters most to entrepreneurs when it comes to the growth of their companies, and the result from the research is listed below in Figure 2.

Pillar	US - Silicon Valley	US - Other Cities	North America	Europe	Aus/NZ	Asia	MEA	South/Central America and Mexico
Accessible Markets	92%	83%	85%	72%	69%	68%	68%	62%
Human Capital Workforce	93%	87%	90%	81%	81%	73%	50%	71%
Funding and Finance	91%	76%	82%	57%	69%	44%	55%	45%
Mentors/Advisers/ Support Systems	91%	72%	78%	52%	58%	38%	36%	35%
Regulatory Frame-work/Infrastructure	67%	57%	62%	54%	54%	39%	55%	42%
Education and Train-ing	80%	62%	70%	60%	38%	34%	32%	27%
Major Universities as Catalysts	88%	67%	75%	52%	42%	30%	23%	27%
Cultural Support	90%	64%	75%	33%	35%	26%	45%	16%
Average Score	86%	71%	77%	58%	56%	44%	45%	41%

Figure 2 - Entrepreneur's evaluation of the importance of different components in EESs (Source: WEF, 2013)

2.4.2. Critical components in Entrepreneurial Ecosystems

The fact that human capital, funding & finance and accessible markets were, according to WEF (2013), the most important components for new ventures is very much aligned with the findings of Mustar et al. (2006) (technical, human, financial and social capital). Moreover, findings from Pérez and Sánchez (2003) indicate that a small sized market and the lack of financial resources were the main obstacles to technology transfer during the first year of activity. Powers and McDougall (2005), who focus on identifying important resources for entrepreneurial activity, such as would occur with university technology transfer, identified resources such as expert knowledge and scientific capabilities, access to important personal, information and support structures. There seem to be an understanding among researchers that especially human resources, financial resources and social resources/accessible markets have the most influence on the value creation process of TTOs. Therefore, in order get a narrower scope; this research will focus on these three components.

HUMAN CAPITAL

Human capital is the knowledge and skill of the firm's entire work force (Ireland et al., 2003). Human capital in our context is the access to business educated students and graduates, quality of scientists in and around the university and access to experienced personnel with business and technological knowledge in the region that can manage USOs. Researchers agree (Cohen, 2006; Neck et al., 2004; Van de Ven, 1993), that a backbone of strong entrepreneurial ecosystems is the people that come up with the ideas and the people leading the new ventures. These people are attracted by other talents, and talented people attract companies, which again can hire these talented individuals (Neck et al., 2004).

Hitt et al. (2001) found human capital to be essential for a firm's performance with both direct and indirect effects. They found that as time goes by, human capital will increase and the value it creates exceeds the cost. A key element that positively affects a region's human capital is the presence of universities and research institutions (Shane, 2004; Siegel et al., 2007). Di Gregorio and Shane (2003) support this and add, that the more eminence the university has, the higher the chances of increased spin-off activity. Research by Marvel and Lumpkin (2007) confirms this as they found that people with formal education and especially people with technology-related knowledge were most likely to become innovative. Taking this into perspective, there seems to be some important factors that constitute human capital. These are 1) Education and 2) Experience (e.g. Technical, Financial, Industry, Management, and Business).

USOs and universities may lack sufficient internal resources to develop and manage the venture. This is why many need external resources. A central part of the findings of (Wright et al., 2004) is the identification of surrogate entrepreneurs as a mechanism to ensure quality human capital. Surrogate entrepreneurs are external, individual entrepreneurs who are hired by the university to take on technology-based USOs (Franklin et al., 2001). These surrogate entrepreneurs could be first-time entrepreneurs, coming from established firms in the region. This illustrates the other dimension that has influence on human capital - the region's industry structure.

The industry structure in the region is very important to build human capital (Neck et al., 2004). An existing industry is important, not just to build competence, but also to retain the best personnel. Looking at Silicon Valley, the cluster of highly profiled world-class companies such as Facebook, Apple and Google is a huge reason for why the best "techies" and best business developers leave their countries to work there (Isenberg, 2010). Some of these people might even start their own world-class company and thus attract other talents (Neck et al., 2004).

FUNDING AND FINANCING

Financial resources are critical for conducting research, especially the sciences from which many of the technologies being commercialized emerges. - Powers & McDougall (2005)

According to King and Levine (1993) research, better financial systems will lead to more successful innovation and thereby increase economic development. Entrepreneurs need investments in order to reach their goals and ideas, yet, according to Clarysse and Bruneel

(2007), most entrepreneurs do not have sufficient financial means to start up a business. Moreover, they state that the financial needs of USOs tend to be higher than other businesses due to necessary investments for technological developments, thus illustrating the especially strong resource dependence of USOs. One important thing about initial capital is that it buys the venture some time, while the entrepreneurs learn to overcome problems (Cooper et al., 1994). According to O'Shea et al. (2007), an important and necessary aspect of MIT's ability to create USOs is its ability to attract large financial resources to fund leading-edge science and engineering R&D. This is because of well-developed private investment systems (VCs, BAs, Angel-groups etc.). As mentioned in the section about RBT, financial sources are very important for new ventures because they can procure other important resources. Funding and finance in our context can be both public and private funding, which means that sources of funding could be government (Universities, grants, programs etc.), Business Angels and Venture Capitalists.

Venture capital is a valuable resource for USOs, not merely because of the financial capital provided, but also from the management or advisory expertise provided by venture capitalists (Powers & McDougall, 2005). However, the quantitative research that has been conducted on Venture Capital effect on university technology transfer has been conflicting. Di Gregorio and Shane (2003) found that accessibility to Venture Capital in a region did not predict USO-formations, while Shane and Stuart (2002) found that accessibility to Business Angels and Venture Capitalists most likely would lead to success. Qualitative research conducted on the matter have however been more affirming about the important role venture capital has on university technology transfer (Powell et al., 2002; Roberts & Malone, 1996), and have given substantial evidence to suggest that venture capital indeed is an important resource to generate more USOs.

Venture capital can fill some of the financial gap the entrepreneurs experience in the beginning of the venture's life cycle, but the problem is that VCs often are reluctant to invest early on because it is too high risk (Wright et al., 2006). This is especially critical for USOs given that they have high uncertainty on both the technical and market side. Because raising capital is a tremendous challenge for USOs in the pre-seed and seed-stage (see figure 3), USOs experience an equity gap which Van Osnabrugge and Robinson (2000) defines as:

> *"The absence of small amounts of risk capital from institutional sources for companies at the seed, start-up and early-growth stages, which arises because the fixed costs of investment appraisal and monitoring make it uneconomic for venture capital funds to make small investments, and also because of the reluctance of banks to make unsecured lending."*

Widding et al. (2009) claims that government grants and implementing university venture capital funds might be a way to fill the equity gap for USOs. According to Wright et al. (2006), private investors prefer to invest in USOs that have completed a good amount of development, which means that a critical point of time in a USO's life cycle is at the very beginning, where it needs to conduct a great deal of costly development, but it is not attractive enough for private investors because of the uncertainty.

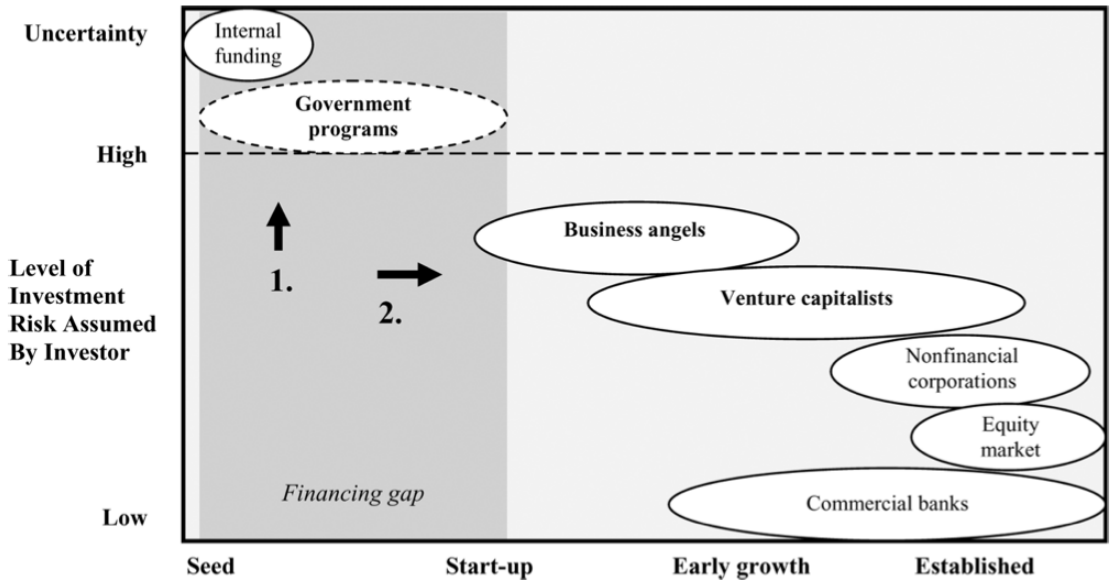

Figure 3 - Stage of development for USs and the financial gap (Widding et al., 2009)

The government can play a big role with respect to providing financial resources. In UK, a government initiative called University Challenge Fund provide incentives for investors to increase their exposure to USOs and hence to learn to engage with universities. The purpose of this fund is to help USOs achieve proof of concept so that they are more suitable for venture capital investors. In countries such as Sweden and Finland, the government provides pre-seed capital, networking and coaching to USOs as a part of a push strategy to start USOs with an optimal configuration (Wright et al., 2006). This implies that government funding is an important and very necessary initiative (Shane, 2004; Widding et al., 2009). However, pre-seed and seed capital is widely recognized as insufficient and also these programs are inadequate for high-tech capital-intensive USOs. It is of these reasons that Widding et al. (2009) claim that the use of University-affiliated Venture Capital funds (UVCs) is an alternative that could be considered in order to fill the previously mentioned equity gap of USOs. This claim is supported by Moray and Clarysse (2005) who state that UVCs could provide the necessary capital to give USOs the means to do prototypes and conduct market analysis and thus diminish the risk for private investors.

Another government mechanism to increase more financial resources is to make it more lucrative for investors to invest in startups by giving them tax-incentives. The Dutch "Tante Agaath" initiative guarantees individuals who invest over NOK 200 000 in a pre-revenue startup a yearly income tax deduction. This initiative has become so popular that the government had to put a limit on the number of applications per year (Wright et al., 2006).

Financial resources seem to be a very important resource for USOs, and there are many potential sources of finance. Private Equity can be very helpful, but these are hard to attract in the early stages. In this aspect, USOs need other types of funding to guide them through these critical stages, and TTOs can contribute by creating alternative funding mechanisms. Public funding initiatives might also be helpful, but the insufficientness of such funding

mechanisms mean that TTOs should influence the government to give more, or create mechanisms in order to obtain more autonomy, for example mechanisms such as UVCs.

ACCESSIBLE MARKETS

Based on the research of researchers such as Neck et al. (2004) and Spilling (1996), we look at accessible markets to be the collection of organizations, potential customers, suppliers and corporations in a region that USOs have access to and can extract benefits from. We assess the accessibility to markets to be as follows:

- If a university's USOs are focused around certain industries, then a strong accessibility to markets would be if there is a strong density of actors from these industries in the region

Neck et al. (2004) write that existing corporations can contribute in building a technology base in an area and thus be able to hire talented people, giving them incentives to stay in the region. Thus, accessible markets can contribute in retaining and subsequently increasing the human capital. O'Shea et al. (2007) write that spin-off activity is more likely to happen within a market that supports entrepreneurial behavior. Access to markets could also make it easier to get research funding, assistance and strategic partnerships from the industry, as mentioned above (O'Shea et al., 2007). According to Powers & McDougall (2005), industries are willing to invest in R&D into universities to for example have particular kind of research conducted.

Several researchers have shown that university-industry relations such as faculty consulting with industry, faculty involvement in new firms, industry funding research etc., have a positive effect on the number of USOs generated and exhibit more entrepreneurial activities (Cohen et al., 1998; Roberts & Malone, 1996). An example of this was shown by Colyvas et al. (2002) in an examination of 11 case studies from Columbia University and Stanford University, where they found that in all but one case, the researchers had involvements in networks including other researchers and industry professionals. The one case where this was not the case did not have technology transfer. The possibilities of finding good collaboration routines between university and the industry is there, but the university has to show the firms that it has something to offer them. According to Mustar et al. (2008), industry actors will be interested in working with a university if it has a good reputation for research and a critical mass in the area. This means that universities should focus on areas of expertise that the local firms will want to access.

WEF (2013) found seven key areas where productive relationships between new ventures and large industry actors are possible. Table 4 presents these.

Table 4 - Why accessible markets are important for USOs (WEF, 2013)

Key areas	*Important because*
Customer engagement	69% of all early-stage companies that WEF (2013) surveyed had large companies as customers, and early engagement from customers could accelerate growth to what Van de Ven (1993) would call the entrepreneurial system.

Credibility enhancement	By cooperating with large companies who want to be your customer, it is easier to build credibility
Strategic investors and financing partners	As mentioned above, industry-contacts could lead to funding and thus increase the firm's financial resource capacity
Mentorship and advice	Working along-side large industry actors will give the founders valuable industry insight
Go-to-market partners	The large companies can function as distributor or open doors to other important resellers
Operating capability enhancement	A collaboration with a large company could give the USOs access to production facilities, software, technology and know-how that would have taken years to develop on their own
Licensing leverage	The large company might be willing to license the USO's technology to enter a new market

This means that industry contacts could potentially be an extremely important resource for USOs. Moreover, Mustar et al. (2008) claims that USOs might find it hard to succeed in a market place because academics and business people speak different languages. Hence the importance of attracting and developing individuals who can act as intermediaries between these two areas, and thus create success stories that can be used to gain the industry's trust. It is important that both the university and the industry understand that both parties have something to gain on cooperation. An example from the interviews conducted by WEF (2013) is Galaxy (baking products) who said (illustrating mutual synergies between a new venture and an established actor):

> *"Building our croissant business with Williams-Sonoma has been great for both sides. They found the best croissants in the US, and we gained access to their millions of customers. In fact, Oprah discovered our croissants in the Williams-Sonoma catalog. We were fortunate that the orders from Oprah came through the Williams-Sonoma infrastructure (Call centre, website, order processing system, etc.). We would have a hard time handling all that volume ourselves."*

Accessible markets seem to be an important component for USOs because contact with industry actors can give them customers, industry insight, access to suppliers, technology facilities, access to know-how, and other industry factors that could accelerate the growth of the company.

2.5. UNIVERSITY TECHNOLOGY TRANSFER

Technology transfer from universities to industry has gained increased attention in recent years because knowledge produced in universities can foster business innovation and promote economic and social development in the region (Algieri et al., 2011). In addition to the traditional teachings and research activities, universities are pursuing higher interaction with society by pursuing more commercialization of research findings. The growing linkage

between science, technology and utilization had led to the term "entrepreneurial university" (Branscomb et al., 1999), and commercialization efforts has become the university's "third mission" of contributing to local economic development (Etzkowitz, 2003).

This chapter will emphasize the TTO role and how they support scientists through the stages of commercialization of the results of their study. We present the work process that is commonly used by the TTOs, defined as the traditional model of technology transfer. The resource dependence of USOs have been established to be of great importance, and we will present how TTOs go forward to nurture their sponsored USOs.

2.5.1. Traditional Technology Transfer Model

According to research, the most comprehensive theoretical version of university technology transfer process is seen as more or less a linear process (Siegel et al., 2004). Siegel et al. (2004) draws out a suggestion for a traditional model that follows a linear pattern, illustrated in figure 4. The design of the traditional model has been generated from various descriptions and interpretations of technology transfer processes found in recent literature (Siegel et al., 2004). It is important to note that the actual technology transfer processes and outcomes are dependent on both external and internal conditions. Internal conditions can for example be organizational practices that potentially change the motives, incentives, and organizational cultures of the players involved in this process. Resources of the TTOs are other conditions that may be involved in determining whether to establish a USO or not. Strong appropriability factors at the university, such as patents and technology secrecy, can give the university appropriate gains from the innovation, hence deciding the transfer mechanism (Cohen et al., 1998). Strengths of the ecosystem, i.e. with strong or weak accessible markets is an external factor that may play into whether there is a wish to license the technology to the industry or create a spin-off.

We are now going to elaborate on each stage of the traditional model in greater detail.

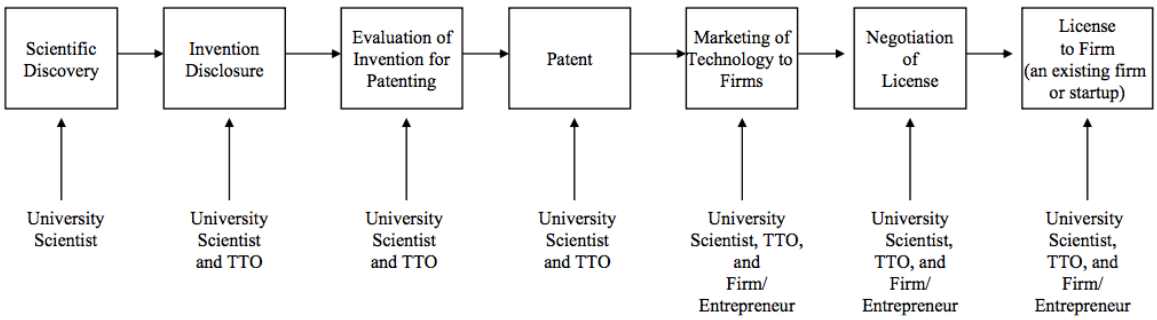

Figure 4 - Traditional linear model for technology transfer (Siegel et al., 2004)

Discovery made by a university scientist

According to Bozeman (2000), the catalyst for initiating the technology transfer process could come from research support of the federal government or industry. Most typically, the university scientist receives a federal research grant to conduct research in a specific field,

and purposely or serendipitously discovers new ideas that have market potential. Alternatively, an industry might conduct a partnership with a university in order to seek academic resources. This is called reverse linearity, where the university gets connected to external problems and sources of knowledge (Etzkowitz, 2003). Whether it is federal grants or funding from industry that originates the research, the traditional model of the technology transfer process starts with a discovery by the university scientist and moves forward in a linear path.

DISCLOSING THE INVENTION TO THE TTO

The size and importance of TTOs and the magnitude of their operations have increased steadily the past two decades. As stated in the Bayh-Dole Act, a federally funded faculty member who discovers new inventions that has commercial potential is required to disclose their inventions to the university TTOs. However, research show that invention disclosure rarely is committed, and it depends strongly on the incentive schemes found in the respective university (Debackere & Veugelers, 2005). Siegel et al. (2003) further state that personnel within TTO must dedicate an extra effort in order to get scientific researchers to disclose their inventions, and the number of disclosures, which then can influence the number of spin-offs are strongly linked to faculty quality. The alternative to disclosing the inventions is not being considered in the traditional model, but that would simply mean not disclosing, or that the faculty members bypass the TTOs, starting a company on his/her own. One of the main reasons behind this act may be due to TTO's sometimes perceived conflict of interest, as they first and foremost look out for the university's interest. This implies a tendency to delay projects in wait for the highest deal, resulting in less promising projects to be dragged along for some time before its dropped (Mosey & Wright, 2007).

TTO-EVALUATION – DECIDING ON WHETHER TO PATENT OR NOT

TTO has a role to facilitate knowledge transfer by licensing the inventions to the industry or through other forms of intellectual property that has emerged from the university research (Siegel et al., 2004). In general, the faculty staff that makes the discovery must delegate all rights to the university to negotiate licenses on their behalf (Litan et al., 2007), even though only a fraction of the inventions will move forward to the patent stage. Interest in the technology from the industry often provides sufficient justification for filing a patent. In order to decide whether to patent or not, TTOs normally evaluates the inventions on different aspects. These are revenue potential, licensing potential, academic field of the invention, competitiveness and extensibility. A detailed walkthrough of these aspects can be found in Appendix 2. However, these parameters place too much emphasis on the importance of patents as the primary output in the technology transfer process, overlooking other mechanisms for profitability and commercialization. Moreover, we believe that this model should be revised regularly as new alternatives for commercialization emerges.

MARKET THE TECHNOLOGY TO ENTREPRENEURS/FIRMS

An important role of the TTO is to connect inventions to firms that want to utilize them, whether it is to existing firms in the industry or spin-offs. The strategic choice on where TTOs choose to market the technology is mainly dependent on the ecosystem, and if there is

an accessible market to offer the technology. TTOs can therefore be seen as an educator to academic entrepreneurs and information brokers to investors (Lerner, 2004), which is a direct mechanism that TTOs can do in order to decrease USO's resource dependence. Siegel et al. (2003) state that the primary motive is to safeguard the intellectual property that belongs to the university, while marketing the intellectual property to private firms.

NEGOTIATE LICENSING AGREEMENTS

Since the university owns the intellectual property rights to the invention, it can license the patented technology to a suitable organization or an entrepreneur (Friedman & Silberman, 2003). Thursby et al. (2001) note that it is quite normal for multiple firms to examine the university's technology, but that it is considerably fewer firms that actually become involved in the licensing discussion, illustrating a "thin" market for early-stage technology. If there is a licensing agreement, TTO must determine whether to include royalty agreements, where the firms that use the technology must pay a percentage earned from the usage of the technology to the university, or include an equity stake in the new venture based on the licensed technology. Licensing with equity is becoming more common because if even one of the firms in the TTOs portfolio goes public, the returns for the university could be significantly large (Powers & McDougall, 2005).

LICENSE THE TECHNOLOGY VS. SPIN-OFF COMPANIES

According to the traditional model, the technology is commercialized when the technology is transferred. The dominant way in which technology has been traditionally transferred from universities to the private sector is through licensing (Siegel et al., 2003). In a licensing agreement to an existing company, the university may charge a company an initial payment and then receive royalty payments, for the right to use a particular part of the intellectual property. This process has the advantage that the researcher and the university is able to capitalize on the technology, and that the researcher is able to pursue his or hers research without committing large amount of time for commercial matters. But in the same time, we believe that the downside is twofold: First, the nature of the invention may not be easily patentable and transferred through a license agreement. For example, the inventor or researcher may possess tacit knowledge that is not easy transferable. The literature on licensing states clearly that licensing agreements should only be conducted when the assets can be protected by intellectual property and easily be stipulated in the form of a contract (Shane, 2004). Secondly, universities may have difficulties with catching the full value of their technology through a licensing agreement, thus seek a more direct involvement in the commercialization (Franklin et al., 2001). A result of this involvement can be spinning out a company.

Creating a spin-off, around the actual technology, gives the academic researcher another road to commercialize the research, thus become an academic entrepreneur. The types of reward systems in place in universities can also greatly facilitate or impede faculty involvement in technology transfer activities. The spin-off creation can be established due to the difficulties TTOs experience in licensing the technology to large companies or external entrepreneurs (Lowe, 2002). This can be caused by the fact that the technology is seen as too high-risk for

any investors to invest in the technology. Sometimes, spin-offs can be the only option for the TTOs to develop the technology further, or else the technology may not be commercialized at all (Shane, 2004).

2.6. TTO RESPONSE TO FACTORS IN THE ENTREPRENEURIAL ECOSYSTEM

Up until now, traditional literature with the focus on how TTOs address entrepreneurial ecosystems with respects to spin-off strategies has mainly been inspired by Roberts and Malone's (1996) Support-Selectivity typology. We will, in the following section, review this typology and assess how these different mechanisms can handle the complexities of entrepreneurial ecosystems. Henceforth, we will refer to these mechanisms as TTO-modes.

Roberts and Malone (1996) argue that there are two key-dimensions to analyze spin-off strategies: (1) level of support and (2) level of selectivity from the TTOs.

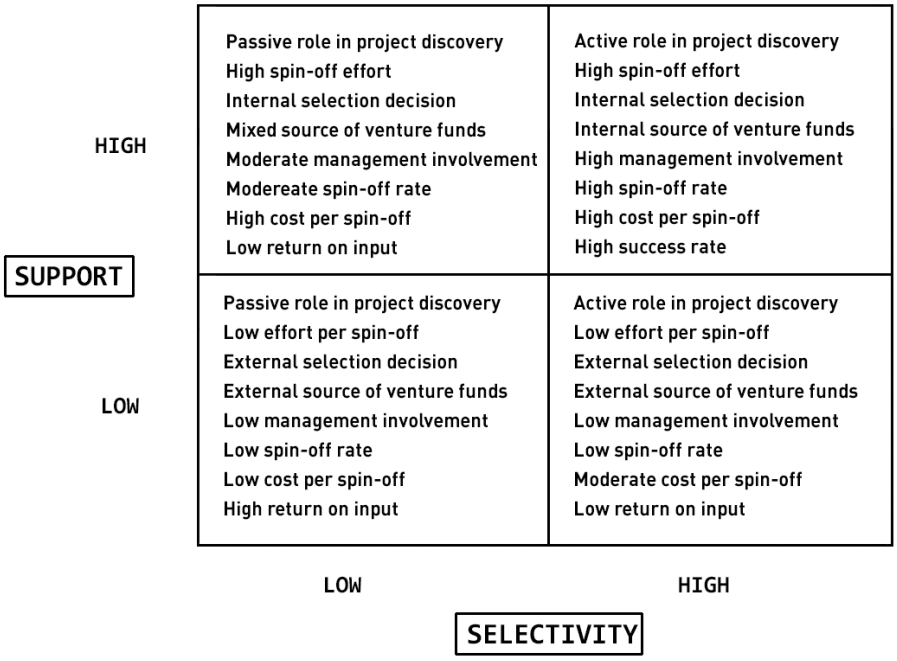

Figure 5 - Support-Selectivity typology (Roberts and Malone, 1996)

Roberts and Malone (1996) further state that only two of the quadrants are viable as course of action. Either high support and selectivity mode, or low support and selectivity mode. Hereafter follows an elaboration on these.

If we look at the two modes separately; the low support-low selectivity concerns aiming for many spin-offs, because of the low selection in technologies to spin out, with little support. This mode could be beneficial under certain conditions, because it is cost effective and the number of spin-offs makes it possible to invest in several technological areas. Choice is left to external agencies (such as venture capital funds) that are generally known to have greater experience and expertise in 'picking winners' and less potential for conflicting objectives than the R&D organization (Roberts and Malone, 1996). The authors argue that this mode is best suited for well-developed entrepreneurial ecosystems. Examples from Boston and

Silicon Valley (section 2.4), show that with a strong entrepreneurial environment, the projects are pushed forward into success by the strong resourceful environment, and the TTOs can undertake a passive role in support and selection of technologies. In such environments, licensing of technology is very common, as these environments would have firms who can use the technologies.

The high support-high selectivity TTO-mode on the other side means a few numbers of highly supported spin-offs. This mode seeks out to pick potential winners, and maximize the support to these spin-offs to increase their chances of success. This mode is, according to Roberts and Malone (1996), more efficient in less developed entrepreneurial ecosystems. If resources such as advisors, financial, managerial and connection to industry are not available in the external environment and there are likely few geographically like firms with whom to network, the TTO itself needs to assume this role (Powers & McDougall, 2005). However, (Wright et al., 2008) stresses that high selectivity and high support must be seen as an ideal and not a "must" because implementing such a TTO-mode in a weak entrepreneurial ecosystem could be very costly and resource demanding.

The other two alternatives presented in the matrix are characterized as non-sustainable strategies (Degroof & Roberts, 2004). Where the low support-high selectivity TTO-mode can cause a rather slim spin-off portfolio with the possibility to not achieve any returns on the few investments made, because of limited follow-up and support. The other alternative, with a high support - low selectivity TTO-mode seems very lucrative as this would mean many spin-offs and high support, but in reality this would require a substantial amount of resources and therefore this is not a viable alternative.

Ultimately, Roberts and Malone (1996), and all of their advocators, look at TTO strategies to handle external factors in the way that is illustrated by figure 6.

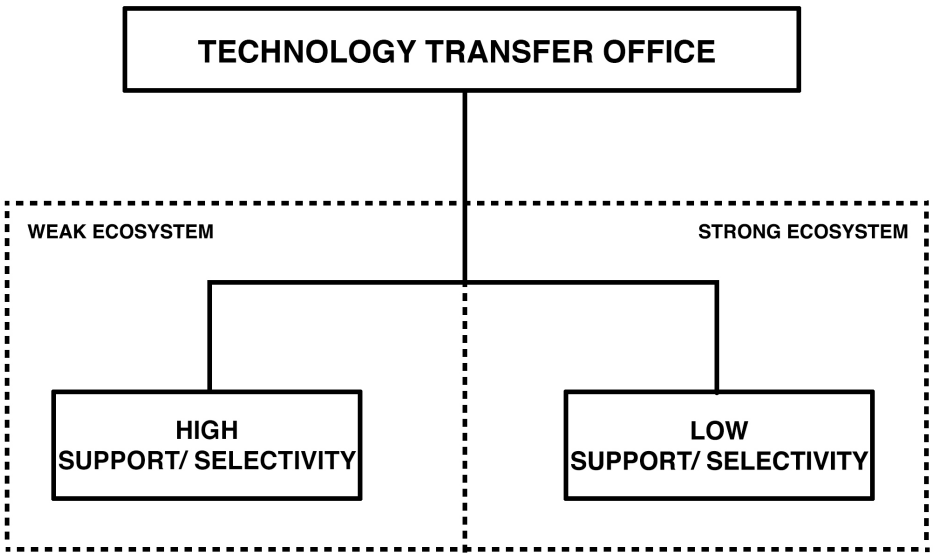

Figure 6 - Traditional theory on TTO-strategies to address external factors

The selectiveness of TTOs in the high support/selectivity TTO-mode mentioned above seems to be selective in regards of what projects to work with rather than being selective on what industries to focus on, which was the case for Yale University (Breznitz et al., 2008). It is of this reason that we want to define two dimensions of selectiveness (given weak entrepreneurial ecosystems):

INDUSTRY SELECTIVENESS

Universities who are spinning of ventures who are linked to mainly the same industry, such as Yale University in regards to Biotech (Breznitz et al., 2008), might find it a better use of resources to focus all their commercialization efforts towards the ideas that could be linked to the specific industry. The strong focus on specific industries could be a result from internal factors within the university, or it could be that the region is very dominated by a specific industry.

CASE SELECTIVENESS

Universities who do not have any specific focus on any industries might not experience the same positive effects by choosing an industry selective mode because this could cause a decrease in deal-flow, as one would have to say no to several potentially strong ideas. For TTOs in such regions, it might be a better use of resources to choose potential winners, regardless of industry or technology (Roberts and Malone, 1996).

Our literature review on entrepreneurial ecosystems shows that there are several different factors within these systems that make them very complex phenomenon. Until now, research on TTO-strategies to handle external factors have focused on either being highly selective and supportive if the entrepreneurial ecosystem is weak, or having low selectiveness and supportiveness if the entrepreneurial ecosystem is strong (Roberts and Malone, 1996; Breznitz et al., 2008). For benchmark areas such as Silicon Valley or the Boston-Cambridge region, where the entrepreneurial ecosystem itself is creating the institutions and support actors needed to nurture innovation and USOs, a low selectivity and support might be viable. However, there are very few such entrepreneurial ecosystems (Isenberg, 2010), and even these areas might have small imperfections. This means, that also for strong entrepreneurial ecosystems, simply arguing for a low support and low selectivity might be far too generalizing.

For weak entrepreneurial ecosystems, the TTO can play an important role in nurturing and promoting new ventures (Roberts and Malone, 1996; Powers & McDougall, 2005). The challenge with weaker ecosystems is that they are complex phenomenon because being a "weak entrepreneurial ecosystem" is not a fixed condition. The absence of important elements in an entrepreneurial ecosystem, such as a lack of human capital, lack of market, and/or financial capital, could be very negative for a region (Isenberg, 2010; Neck et al., 2004; Van de Ven, 1993). Since weak entrepreneurial ecosystems might comprise very different features, and since this is never a fixed condition, it is challenging to generalize a TTO-mode that can address weak ecosystems. In addition, simply turning to the support-selectivity typology gives little operational guidance to TTOs. For example, given a

supportive mode, what would they be supportive on? Well, that would depend on factors in the entrepreneurial ecosystem and factors within the university.

2.6.1. CLOSING WORDS ON EES, TTOS AND USO DEPENDENCY OF RESOURCES

This research suggests that simply turning to either high or low supportiveness/selectiveness is far too general strategies in order to fully handle the complexity of entrepreneurial ecosystems, especially weak ecosystems. Moreover, we believe, that within the broad strategy of high supportiveness/selectiveness, there are several different "TTO-tools" to address imperfections in the TTO's respective EESs. We define TTO-tools to be measures conducted by TTOs in order to make important resources more available for USOs. Examples of TTO-tools are:

- The use of surrogate entrepreneurs in order to increase the human capital of USOs
- Promoting the implementation of UVCs in order to fill the financial gap that USOs experience in pre-seed and seed-stage
- Arranging network-meetings in order to enhance university-industry relations

We have found, in section 2.2 - 2.5, that the most important environmental factors for USOs and subsequently technology transfer are Human resources, Financing and funding and accessible markets.

Human capital is, according to RBT researchers an essential resource for USOs because these resources give way for other resources. Strong EESs often tend to have a large pool of resourceful people who have knowledge and experience in business, technology and entrepreneurship. However, if this is not the case, research shows that TTOs can play an important role in making sure that USOs get access to the correct people to take the venture onwards to success.

Financial capital is another very important resource for new ventures because 1) it can procure other resources such as human capital, and 2) it is highly necessary in order to make it possible for USOs to conduct testing and achieve proof of concept in the pre-seed and seed-stage. Strong EESs have a large pool of VCs, business angels, and other sources of funding sources, which make financial sources readily available for promising USOs. However, if this is not the case, research shows that TTOs can play an important role in filling the financial gap that USOs experience before they are ready for private investors.

Accessible markets can give USOs access to human capital, financial resources and even customers. Strong EESs tend to have an abundance of large corporations and actors that can support new ventures. However, if this is not the case, research shows that TTOs can play the role as the mediator and make sure that USOs get access to industry actors.

Most USOs have a weak resource base and may have a strong need to get access to resources in order to obtain competitive advantage. This resource dependence puts USOs in a very unfavorable position, as shown in figure 7.

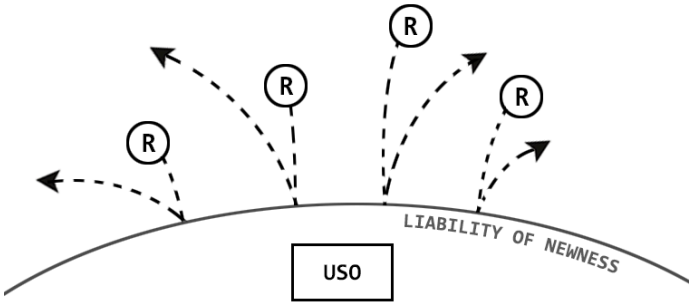

Figure 7 - The resource dependence of USOs

The liability of newness (Stinchcombe, 1965), which we introduce in section 2.3, makes it especially tough for USOs because they cannot point to earlier successes or experiences. TTOs however might not have this liability, given that they may have been around for a while and that they during this time has build a network of industry actors, investors and important personnel. By representing USOs, TTOs could alter the power balance between the USOs and the different stakeholders in the EES and thus make it easier for USOs to get access to resources. An optimal situation would then look like the situation shown in figure 8.

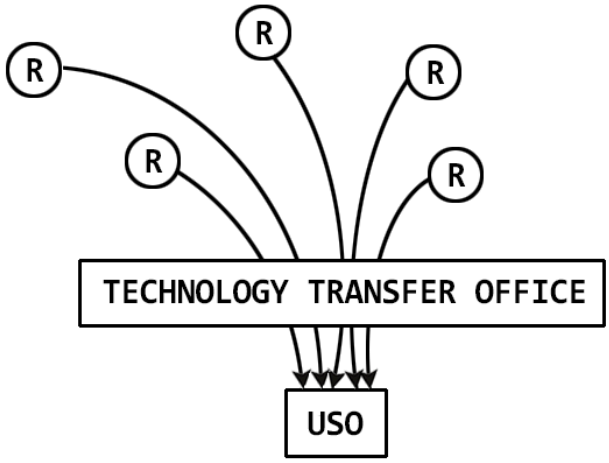

Figure 8 - TTOs ensuring USOs better access to important resources

Further on, we will start our analysis on technology transfer in Norway, and assess whether these abstractions are true for the Norwegian context.

3. RESEARCH METHODOLOGY

The research method is what constitutes the relationship between the theory and the research (Bryman, 2008). This chapter considers the research methodology of this research. It presents the rationale and procedures applied in the search for literature and empirical part of the study, and explains how data has been obtained and analyzed. First, a thorough *literature review* was conducted. Second, an *exploratory multiple case case study combined with a survey* was performed in order to add insight to USOs as a commercial mean for technology transfer from universities in Norway. This way of mixing both the qualitative and the quantitative approaches will be explained in greater detail later. This is then followed by a criticism of the research methodology where the study's validity and reliability is accounted for and discussed.

Our point of departure for this master thesis was a pre-study conducted in autumn 2013. The pre-study consisted mainly of a thorough literature review based on the research question:

> *How does components within an entrepreneurial ecosystem affect TTO-strategies?*

The pre-study also contained a limited case study of NTNU TTO, the Technology Transfer Office at the prestigious Norwegian University of Science and Technology (NTNU) in Trondheim. This case subject was chosen because of our close proximity to the source. The limited case study provided us with additional insight into, and new perspectives on, TTO mechanisms. Based on these observations a conceptual model was constructed to show TTO responses to weak entrepreneurial ecosystems (See Appendix 3). This groundwork laid the foundation for this master thesis.

In this master thesis, we conducted an iteration of the research question to fit the Norwegian context, and revised the final literature from the project thesis in accordance with the new research question. The unit of analysis, TTO is examined with the research question:

> *In the Norwegian context: How do TTOs address imperfections within weak entrepreneurial ecosystems, with respect to spinning of USOs?*

The empirical study was then formed based on the final literature. We created an interview guide (Appendix 4) and a complementary survey (Appendix 5) that was based on the elements which was perceived as important by the scholars. The case subjects, the entire TTO-population in Norway were selected to map out a comparative understanding of their processes and strategies. While developing the case study, we once again uncovered new perspectives, which in turn paved the way for a revision of the interview guide. The literature review and data from the case study were thereafter used to analyze and discuss the TTOs comparatively in regards of their respective entrepreneurial ecosystems, resulting in a TTO-Toolbox as our research finding.

The work process of the research methodology explained above is illustrated by figure 9.

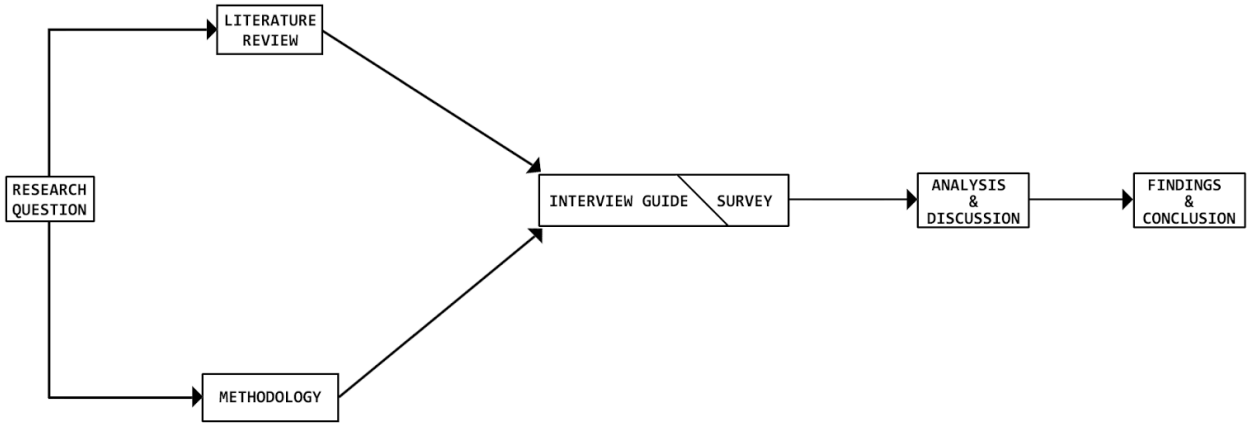

Figure 9 - Research methodology path

We have to emphasize the importance of initiating relations to all the TTOs in Norway. The TTOs examined represents different regions and research environments. In addition, they also have different owner structures. The advantage of a nationwide examination gives the ability to compare the exact elements in various TTOs and regions, and therefore more correctly analyze and compare how they react to imperfections in the ecosystem. The focus to include the entire TTO-"population" has given us a remarkable insight in different TTO practices nationally.

3.1. LITERATURE REVIEW

3.1.1. UNSTRUCTURED LITERATURE SEARCH

In order to get a general overview of the topics surrounding spin-off processes, we started off by reading articles, books and literature reviews, which were given to us as a literature package by our teaching supervisors early on. This was our starting point for our further literature search. We chose to do an unstructured literature search because of the broad and dispersed amount of literature around university entrepreneurship, TTO-strategies and entrepreneurial ecosystems, in addition to the fact that these topics have been covered from many literature traditions. Because our research looks at two separate phenomenon; TTOs and entrepreneurial ecosystems, we had to do a twofold unstructured literature search. In regards of TTOs, we found relevant literature by searching in Google Scholar, ISI Web of Knowledge, Science Direct and Scopus. Since we were focusing on university spin-offs (USOs), we used search words such as "university technology transfer" or "academic technology transfer", and secondly "university spin-offs" or "academic spin-offs". This resulted in a number of researchers, such as Rasmussen et al., (2008), Clarysse and Bruneel (2007), Bozeman (2000), Breznitz et al., (2008), Wright et al., (2007), Mustar et al, (2006), and Roberts and Malone (1996) to name a few, who have made significant contributions within the field of university technology transfer. We chose to focus our search terms around USOs because we wanted to analyze how TTOs ensure resource access to the new ventures from universities. In regards of entrepreneurial ecosystems, we did the same thing using search words such as "Entrepreneurial ecosystems", "Entrepreneurial infrastructure",

"Entrepreneurship systems" and "Entrepreneurial ecosystem components". This resulted in some very interesting contributions from authors such as Van de Ven (1993), Spilling (1996) and Neck et al. (2004) to name a few. In addition, we used search words in a more narrow scope after learning about the phenomenon surrounding entrepreneurial ecosystems. These can be viewed in Appendix 6. We also found other very useful articles by using Jalali and Wohlin's (2012) reverse snowballing method, looking at the sources that the author have used and read the articles from the source as well.

The unstructured literature search generated many articles, some of which were relevant and some were not. We had to create some selection criteria in order to choose the ones we wanted to examine further and use in our research. The selection criteria we used were that the literature had to include:

- Spin-offs and USOs, because we are focusing on USOs as a transferring mechanism, and not licensing
- External factors that can influence TTO-modes, to get an understanding of what constitutes an entrepreneurial ecosystem
- Supportive TTO strategies, because we are focusing on Norwegian entrepreneurial ecosystems which we assumed to be weaker entrepreneurial ecosystems and thus needing more supportive TTO strategies

In addition to research articles, there were also retrieved data from web pages and unpublished articles, primarily from Norwegian sources (Appendix 6). This data was extracted solely to complement our contextual facts about the different entrepreneurial regions and legislation in Norway.

3.1.2. LIMITATIONS OF LITERATURE REVIEW

When we conducted the literature review, we were uncritical in regards of the source, as long as the content of the articles consisted of spin-off phenomenon and TTOs. This may lead to a weakness in quality assurance of the literature, as some articles, in example the unpublished ones that we found are weighted equally as the published articles. In addition, we chose to do an unstructured literature review. Here we did not use systematic procedures to search for, and this may provide a variety of ways the literature was retrieved and selected for inclusion in this research. An unstructured literature review does not necessarily search narrower than systematic literature review. In fact, a non-systematic literature review could consult a wider range of sources compared to a structured search, which may be the case in this research, but because the search, selection and appraisal criteria are neither systematic nor replicable, the conclusions are generally considered more subjective and less valid than those of structured reviews. We have in this master thesis found relevant literature that has matched our research question, thus used them selectively in order to illustrate key findings and recommendations. We have because of our unstructured way of gathering data, selected references that support our recommendations. A structured review, on the other hand, would have applied a series of strategies to the process of gathering, evaluating, analyzing, and presenting the evidence that is designed to minimize bias.

3.2. MULTIPLE CASE STUDY SUPPORTED BY A QUESTIONNAIRE

> *"Conducting research with a multiple case study supported by a questionnaire, is the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the purpose of breadth and depth of understanding and corroboration"*
>
> *- Johnson et al., (2007).*

Outlined by Johnson et al.'s (2007) definition, a multiple case study supported by a questionnaire, hereafter denoted as a mixed methods research involves both collecting and analyzing qualitative and quantitative data. Our case study is based on several data sources: (1) qualitative data from semi-structured open-ended interviews with CEOs at TTOs, (2) e-mails to follow up interviews and ensure that we understood the accounts given correctly, (3) close-ended quantitative questionnaires to TTO-staff and (4) archival data, including press clippings, company web sites and discussion forums.

By mixing the data, we were provided a better understanding of the problem as we can converge the different datasets by analyzing them individually. The main purpose of using the mixed methods research in our research is to examine the agreements and disagreements between the CEO of the particular TTO, and its staff. Since the CEO may possess more insight into some parts of the TTO-strategy than the rest of the staff may not know of, there is a chance for information asymmetry internally within the TTO. Because there was more resource demanding conducting interviews with TTO-staff, we chose to do a quantitative survey in order to measure their response, and compare it with the in-depth answers given by the CEO. In a mixed methods study the researcher can give the same priority, weight or status to the quantitative and qualitative aspects, or alternatively give greater weight to one of them (Creswell, 1999). This research aims to utilize a qualitative priority where the quantitative method is used in a secondary role. The greater emphasis on the qualitative method is a more appropriate choice given the nature of the research question. By asking follow-up questions and digging into the elements that we thought was appropriate for the respective TTO along with the interview process, we experienced that the collected data was more straight forward to understand, compared to the received data from the survey. Especially when the latter data was estimated to contain higher levels of interpretation errors.

When attempting to combine these findings, some researchers call this process triangulation (Creswell et al., 2006). The term triangulation can be confusing because it has two meanings. It can be used to describe corroboration between two sets of findings or to describe a process of studying a problem using different methods to gain a more complete picture. The latter is the meaning used in this master thesis.

These two viewpoints, prioritizing and triangulating are very much aligned with the *convergent parallel design* within mixed methods design models in the literature.

3.2.1. Research design: The convergent parallel design

In the search to answer a research question, there exists a need to choose a research design in addition to the research strategy. The research design is the framework for collecting and analyzing the data, where the specific chosen design relates to the criteria for evaluating the research (Bryman, 2008).

The most well known approach to mixing methods is the convergent design (Creswell, 1999). The purpose of the convergent design is "to obtain different but complementary data on the same topic" (Morse, 1991) to best understand the research problem. This design is used when the researcher wants to triangulate the methods by directly comparing and contrasting quantitative results with qualitative findings for validation purposes. We had a clean focus on codification and analyzing the data individually, and extracting relevant data separately. We then sat down together when analyzing through all the data to find interesting key points to discuss further. The approach by coding the data separately gives this research robustness compared to coding the data in collaboration within the research team. Within the convergent parallel design, we consider both case study design and survey design as our way of viewing the data. These approaches are explained in the following subchapters.

3.2.2. Qualitative data collection: Case study research

In order to determine whether the preliminary findings from the literature review were applicable in real life experiences, we decided to conduct a multiple comparative case study. Thomas (2011) defines that "Case studies are analyzes of persons, events, decisions, periods, projects, policies, institutions, or other systems that are studied holistically by one or more methods". Yin (2009) describes further that a case study is study method where "why" and "how" questions are asked, and where the researcher has little control over events and the focus in on a contemporary phenomenon in a real-life context. Because our research question is an exploratory "how"-question, the suggested approach suits this research. With this in mind and considering the time and resource limits with a master thesis, we decided to proceed with a descriptive embedded case study. In this context embedded refers to our wish to know the TTO-organization in-depth, and not just as a holistic entity. We wished to study the concrete actions and efforts in the different approaches in fostering USOs, but also how the lack of resources in the region affected TTOs.

We started with a pilot interview with Head of Venture at NTNU TTO, who had considerable practical experience with the management of TTOs. This interview helped us to form the interview guide. In addition, it made sure that we as interviewers were well prepared before entering into the next phase of the study. We conducted 10 interviews with our key informants. However, only 7 of them, consisting of TTOs were used in the primary analysis of the data. The other 3 was conducted to get a holistic and objective measurement of the TTO landscape. These were Union for innovation companies in Norway (FIN), Coventure and Sogn og Fjordane Science Park.

Table 5 - Key informants from the multiple case study

Key areas	*Important because*	*Interview length*
NTNU TTO	CEO	10:32
NTNU TTO	Head of Venture	55:30
Kjeller Innovation	CEO	37:57
Prekubator	CEO	39:17
NMBU	CEO	45:03
Inven2	CEO	52:34
Norinnova	CEO	34:10
BTO	CEO	32:08
FIN	CEO	1:08:03
Coventure	CEO	31:05
Sogn og Fjordane science park	Business developer	57:04

The interviews varied in length from 30 to 70 minutes, and followed the aforementioned interview guide. The interviews followed a "courtroom" procedure, with the interviewers emphasizing the need to focus on facts and events rather than on interpretations, which is in alignment with the lessons from Eisenhardt (1989). We always began the interviews by asking the respondents to elaborate on the background of the TTO and other contextual data about the region, followed by a more in-depth focus on the different components in their entrepreneurial ecosystem. Lastly, in order to answer our research question, we asked about their strategies and measures to increase the access important resources. As mentioned, we followed up the interviews with e-mails asking clarifying questions on an as-needed basis. Interviews with Norwegian informants were conducted in Norwegian, and translated into English by the authors. We strived to ensure that nothing was lost in translation. When possible, we took steps to minimize informant biases, and always held the data provided in the interviews up against the archival data collected from secondary sources, in order to ensure that we were not suffering from being fed biased information. Being CEOs or people in leadership positions, our informants was all highly knowledgeable and influential with regards to TTO strategies, both nationally and internationally. Such informants are the most reliable as they possess greater insight into their specific field and are able to have a comparative view (Huber & Power, 1985; Seidler, 1974). Further, we emphasized during the interviews that we were interested in case-specific facts and events. Thus, the information provided is less likely to be subject to cognitive biases and impression management (Huber & Power, 1985; Seidler, 1974).

3.2.3. QUANTITATIVE DATA COLLECTION: QUESTIONNAIRE RESEARCH

To associate more certainty to the qualitative data, we sent out questionnaires to the TTO-staff. The main purpose of this additional data collection was to evaluate the employees' perception of available resources, and to investigate the consistency within each TTO. By comparing the in-depth responses from CEOs with the quantitative close-ended data from the TTO-staff, we could, based on the correlation in the answers, draw conclusions of where there was consistency and where there was a major gap in understanding of the complexity of the entrepreneurial ecosystem. We built the questionnaire in Questback Ask & Act. The main build-up was somewhat similar to build-up of the interview guide, which was two-fold. First, the respondents were asked to characterize the different resources for their USOs in their region. The help text explained the respondents what the different components meant in our context. They were given the option to rate every component in a 7-folded-Likert scale like shown in the example below:

How do you characterize human capital in your region?

Human capital is about having experienced entrepreneurs and/or strong technology experts in the region that can manage USOs.

1	2	3	4	5	6	7
Very poor						**Very strong**

Secondly, the respondents were asked to rate the importance of the different resources for their USOs in their region. In a similar way, they were asked to dimension their answers in a 5-folded-Likert scale. The respondents were asked to rate these components based on how they perceived the importance for successfully establishing USOs in the region. The rationale behind having different Likert scale ranges for the characterization-questions and importance-questions is because the characterization-questions are more important to map out in order to understand how the different regions see themselves, and where different tools are applicable. The importance-questions are something that may vary based on the strategies that TTOs have, and that can be discussed within the TTOs in order to implement various tools in the future. The questionnaire also contained input fields where the respondents could fill in other thoughts about the entrepreneurial ecosystem. In example, we asked for concrete actions of what they did, and what they could do in order to increase the access to resources. This is interesting, because it is not always the case that the management and the rest of the staff have the same perception of the challenges. This gives opportunities for highlighting better solutions that may be hidden within a TTO, and that potentially never become a reality.

The procedure for collecting of the data started with us receiving the email addresses of the respondents after asking the CEOs if there was possible to conduct this questionnaire. The employee mailing lists provided by the CEOs of the different TTOs were combined to survey the total of 7 different TTOs in Norway.

Table 6 - Questionnaire-respondents from the multiple case study

TTO	Number of respondents	Number of employees	Response rate
NTNU TTO	14	23	60,87 %
Kjeller Innovation	6	14	42,86 %
Prekubator	5	8	62,50 %
Inven2	14	27	51,85 %
NMBU	3	4	75,00 %
Norinnova TTO	3	18	16,67 %
BTO	9	16	56,25 %
Total	**54**	**110**	**52,29 %***

*Mean value

After about two-three rounds of personal phone calls to the CEOs, 54 of 110 TTO-employees returned their questionnaires, resulting in a response rate of 52.3 %. Because the survey was sent to the entire employee base at every TTO, we have to remark the possibility of not receiving answers from personnel that works with internal tasks within the TTO, without specific knowledge about the region around the university. This means that the above-mentioned response rate in reality might be better than 52.3 %.

3.2.4. DATA ANALYSIS

Based on the triangulation of data from our different sources, rich and reliable cases of each of the TTOs could be built (Jick, 1979). Thereafter, within-case and cross-case analyses were performed. The analysis started by looking closer at each case on a stand-alone basis. Following the stand-alone analysis of all cases, cross-case analysis was performed. This process was highly iterative, with the researchers stepping back and forth between data and analysis many times. Further, a significant amount of time was set aside for discussion both within the team and with external researchers in order to ensure the validity of the emergent constructs. Finally, as the findings from the study were ready for presentation, a sanity check was performed. All informants were contacted and asked to correct any final misunderstandings.

3.2.5. STRENGTHS AND WEAKNESSES IN THE MIXED METHOD RESEARCH

The convergent design has a number of strengths and advantages. The design makes intuitive sense. Researchers new to mixed methods often choose this design, and it has become a popular approach in mixing qualitative and quantitative data. It is an efficient design, in which both types of data are collected during one phase of the research at roughly the same time. Each type of data can be collected and analyzed separately and independently, using the techniques traditionally associated with each data type. At the same time, researchers need to consider the consequences of having different samples and different sample sizes when

merging the two data sets. Different sample sizes may arise because the quantitative and qualitative data are usually collected for different purposes. This means generalization vs. in-depth description, respectively. Researchers may also face the question of what to do if the quantitative and qualitative results do not agree. Contradictions may provide new insights into the topic, but these differences can be difficult to resolve and may require the collection of additional data. The question then develops as to what type of additional data to collect or to re-analyze: quantitative data, qualitative data, or both? The weighting of the different data sets was in this case a clear solution to cope with the gap in the data. In addition, there is a finding in itself if there is a clear gap, meaning that the respective TTO internally are not coherent.

The authors are both students at NTNU School of Entrepreneurship. Because of the close relation and cooperation with NTNU TTO, this may have led to a subjective bias when conducting the interviews and when treating the data afterwards. NTNU School of Entrepreneurship meets NTNU TTO in various venues in the innovation environment in Trondheim. The detailed knowledge about NTNU TTO, compared to other distant TTOs has the chance to skew the investigations in subjective manner. We have taken measures to prevent this by having a focus on being extra consistent when conducting the interviews with NTNU TTO and analyzing data afterwards.

Due to the sensitivity there are chances that the different TTOs may have been selective in regards to the types of information they wanted to share with us and withhold from us. Because of our strong relation to NTNU TTO, TTOs in other parts of Norway may have been reluctant to share every aspect of their thoughts and strategy. In order to encourage the interviewees to share freely, all the TTOs and interview candidates were told that this was solely a descriptive analysis to map out the differences in TTO strategies, and that everyone could learn from each other's spin-off processes. In addition, emphasizing to the TTOs that the work we are doing is for learning purposes made them more cooperative and willing to share information.

Questionnaire research is probably the best method to use when one hopes to gain a representative picture of the attitudes and characteristics of a large group (Ilieva et al., 2002). However, validity can be a problem with this type of data collection. The questions have to be standardized for all TTOs, thus it can be difficult to ask anything other than very general questions. Because of this, the results may not be as valid as results obtained from other data methods. Using questionnaires, there is also an aspect of inflexibility. Once the survey has been distributed and we detect an error, it might be difficult to send out a new one, because the responses are already coming in. To resolve this challenge, we iterated the question set with our supervisor a few times, and tested it on each other before sending it out. The responses from the questionnaire showed that some TTOs responded more thoroughly than others. In addition, for TTOs with few employees, the number of responses can make a huge difference in the analysis and end results. We have tried to solve this by commenting on the uncertainties in the analysis, to give the reader an understanding of this particular weakness when receiving the responses.

4. THE NORWEGIAN CONTEXT

This chapter will comprise important aspects of the Norwegian context in regards to entrepreneurship and policies to induce innovation. We will first briefly elaborate on the legislation that came in 2003 and the effects that this had on Norwegian universities and their efforts in commercialization. After that follow brief descriptions of important institutions that do entrepreneurship inducing work in Norway. Finally, we will present an overview of the different regions as a transition to the next chapter where we will present all of our case subjects.

4.1. OVERVIEW: NORWEGIAN COMMERCIALIZATION POLICIES

The commercialization of research has gotten more and more attention, and this has also been the case in Norway who implemented a similar version of the Bayh-Dole act, which is what the US IPR legislation is commonly referred as, in 2003 (Rasmussen et al., 2007). This was done because Norwegian policy makers were interested in achieving the same positive economic effects that they had been seeing in other countries that had implemented similar legislations. This legislation came as a result of the work of Bernt-Utvalget who concluded that Norwegian research institutions should look at commercialization of research findings as a part of their mission in the future (Spilling et al., 2006). Through the legislation, scientists were required to report to the university in cases of research results that could have potential for commercialization. Bernt-Utvalget proposed that the revenues from the commercialization should be shared between the inventor and the research institution (one third to the inventor and the rest to the institution). A result of this new legislation was that most of the larger education institutes in Norway established TTOs (Rasmussen et al., 2007).

There are a total of 6 TTOs in Norway that have connection to education institutes, but this research will add a seventh TTO (Kjeller Innovation) because of its important role of commercialization of research in its region. According to Branstad (2009), an important objective of these TTOs is to find innovations within the research institutes and gather resources in order to license the technology or spin off a new venture. Further, he states that Norwegian TTOs primarily focus on intellectual property, assessment of ideas, establishing companies, licensing, and early-stage funding. Their main competence lies within technology and business.

Researching Norwegian entrepreneurial ecosystems and commercialization processes, Rasmussen (2008) found that:

1. Commercialization activities should have stronger linkages to the research institutions.
2. Commercialization and the work around industry relations should be better coordinated.
3. Norwegian research institutions should increase their competence about commercialization.
4. The will to develop commercial concepts from research findings should be enhanced.
5. Financial resources should be channelized to where the need is highest

6. There is a need for better ties between research institutions and investors/industry during the early stages of spin-off development.
7. Commercialization actors, especially TTOs, need clearer and more defined roles.
8. The relations between the different components in entrepreneurial ecosystems should be clarified.

It is interesting that the findings of Rasmussen (2008) is very aligned with what we have found from theory to be very important when focusing on technology transfer. For example, point number six is a clear example of the need for better access to markets as this will increase the access to customers, suppliers, mentors, talents, etc. Another example is point number five who touches the importance of financial resources. As these findings are results of a research conducted before 2008, it will be interesting to see whether this is still the case after six years.

4.2. Inducing research based entrepreneurship in Norway

We will now present some of the most prominent actors that contribute in inducing research-based entrepreneurship in Norway. This is merely a brief overview, which means that there are several actors that could be mentioned, but we have focused on the most prominent ones.

4.2.1. Public mechanisms and funding landscape

According to Rasmussen (2008), it is expected a new invention per 12 - 15 million NOK invested in research, and 30-50% out of these inventions will result in a patent or a license. They further state that the reluctance of investors to invest in pre-seed and seed-stage because of the high-perceived risk is also the case in Norway. Therefore, Rasmussen (2008) state that it is important for the Norwegian government to make sure that promising projects get the necessary financial resources to conduct testing and ultimately achieve proof of concept so that they may wake the interest of investors. The most important financial means to support R&D and commercialization processes at Universities are governed by the Norwegian Research Council, and according to their websites, the Norwegian government allocates NOK 24 billion to R&D in Norway per year, while only NOK 107 million is allocated to the commercialization of research.

The Norwegian Research Council

The Norwegian research council (NRC) is a strategic unit that points out focus areas for research, provides funds for, and evaluates, the research being done. The council's purpose is to be the government's main advisor in research political questions and to function as the main meeting place for Norwegian research (Rasmussen, 2008). The FORNY2020 program is the most important financial mechanism to support the commercialization of research.

The main goal for FORNY2020, which will last until 2020, is to bring research findings from publicly funded research institutions out to the marked. The program provides financial support to USOs and commercialization actors (e.g. TTOs). The program does not give financial support to research, but supports activities that lead to the commercialization of the research. This could be (FORNY2020, 2014):

- Proof of concept of the technology
- Transferring of the technology
- Finding investors

The FORNY-program, which was preceded by FORNY2020, was the main financing source for TTOs. According to Branstad (2009), the FORNY-program contributed in the establishment of 231 spin-offs from Norwegian research environments during the years 1995-2004. In 2006, FORNY started a new and larger initiative on the verification of technology projects, where the goal was to meet the financial needs linked to obtaining proof of concept. Thus it was allocated NOK 45,7 million to this purpose in 2007 (Branstad, 2009).

SIVA

SIVA, The Industrial Development Corporation of Norway, was founded in 1968 and functions as the developer of strong regional and local industry clusters. SIVA does this through ownership in infrastructure, through investments and the creation of knowledge and innovation networks (SIVA, 2014). SIVA has ownership in over 60 innovation centers in Norway and has invested over NOK 300 million in these centers (Sætre et al., 2006). SIVA is one of the biggest governmental institutions promoting innovation in Norway with over 1500 stakeholders, including investors, industrial and financial corporations, companies, universities and R&D institutions. This makes SIVA-centers important network arenas for investors, USOs and other industry actors.

SIVA operates and finances several incubators in Norway, many of which have connections to universities and college environments (Branstad, 2009).

INNOVATION NORWAY

Innovation Norway was founded in 2004 with the purpose to promote and help nationwide industry development to create successful businesses and to create more jobs in Norway. They do this by providing soft money to promising ideas and projects in two phases. The first phase is in the start-up phase where the purpose is to validate the concept and to start proto-testing (max: $ 50 000). The second phase is the market introduction phase (max: $ 100 000) (Innovasjon Norge, 2013; Sætre et al., 2006). Innovation Norway have around 700 employees and are situated in over 30 Norwegian counties as well as in more than 30 countries worldwide, making it possible for Innovation Norway to offer services to Norwegian companies abroad (Sætre et al., 2006).

One of the most prominent programs that Innovation Norway provides is the IFU/OFU-programs (Rasmussen et al., 2007). IFU is an industrial R&D collaboration, which is collaboration between the new venture and an industrial partner. OFU is the public equivalent of IFU, where the collaboration is between the new venture and a public actor/organization. The purpose of IFU/OFU is to stimulate value creation in Norway by:

- Stimulating R&D collaborations between companies and potential customers
- Contributing in the development of competitive products
- Contributing in the development of industry networks and environments

SKATTEFUNN

SkatteFUNN is comprised, organized and managed by the Norwegian research council, Innovation Norway and the Norwegian tax administration (Branstad, 2009). The purpose of SkatteFUNN is to increase R&D and innovation efforts, and the way they do this is to give tax-reductions to relevant projects. Thus, SkatteFUNN could be very relevant for USOs as these are often research based. In fact, an evaluation made by FORNY in 2004 showed that close to 40% of all FORNY-related projects had been through the SkatteFUNN system, and the numbers from Branstad (2009) show that this trend is increasing because he found that around half of FORNY-related spin-offs had been through SkatteFUNN. Tax reductions could also be given in cash in cases where the company does not pay tax.

PRE-SEED AND SEED-FUNDING

According to Rasmussen and Sørheim (2012), pre-seed and seed-funding aims to lower the technological uncertainty associated with USOs and reduce the investment risk by the availability of early-stage funding. But because of the mentioned liability of newness and the fact that USOs typically develop radical, tacit and early-stage technology (Shane, 2004), Rasmussen and Sørheim (2012) refers to the absence of these types of funding schemes as the "funding gap for USOs".

The seed fund system in Norway is rigged in a way that it is a two-way split with public and private capital, and has come in several waves since the late 1990s without establishing a permanent structure. These are shown in table 7.

Table 7 - Seed fund overview

Source: (HubsNorway, 2014)

Name of fund	Established	Wave	Investment mandate	Size (MNOK)	Number of investments
Startfondet	1998	I	National	320	23
Såkorninvest Sør	1998	I	Regional	106	32
Såkorninvest Nord (SINAS)	1998	I	Regional	75	26
Såkorninvest Midt-Norge	1998	I	Regional	126	54
Såkorninvest Innlandet	2000	I	Regional	60	18
SåkorninVest	1998	I	Regional	88,5	22
Total in wave 1				**775,5**	**175**

Sarsia Seed	2006	II	National	333,5	9
SåkornInvest II	2006	II	National	341	6
Proventure Sees	2006	II	National	335	11
Alliance Venture Polaris	2006	II	National	339,4	8
KapNord Fond	2006	II	District	255	12
Fjord Invest SørVest	2006	II	District	216	2
Norinnova Invest	2006	II	District	272	9
Midtvest I	2008	II	District	179	1
Midvest II	2008	II	District	75	0
Total in wave 2				**2345,9**	**58**
All				**3121,4**	**233**

At the moment, there is a process of establishing two new seed-funds. Alliance Venture within the field of IT, and Proventure within the field of Oil and Gas. Each of them is going to administer funds of NOK 500 million where 50% will be covered by the investors and 50% by the government. Through this "two-way-split" with the investors, the government tries to lower the investor's barriers of investing earlier in new ventures. But even with these two funds available, the total available funding for USOs in early-phase is still considered insufficient.

In order to diminish the dependence on pre/seed funding from the government, some research institutions has collaborated to initiate regional seed funding mechanisms. I.e Medtech Trondheim, which is a medical pre-seed fund established by NTNU, SINTEF, St. Olavs Hospital, SIVA and Sør-Trøndelag City Council. Other examples are private seed companies, such as Sarsia Seed, which invests in Norwegian within the energy and biotechnology/life science sectors.

PUBLIC AND PRIVATE EQUITY FUNDING

The current system of government venture capital is also considered to be too weak in the early growth stages. In Norway, there are currently no government venture capital companies that provide equity capital in the early stages. In fact, Investinor, which is an investment company funded by the Norwegian government was intended for this role, but they have shifted to enter later-stage investments instead. The capital on Investinor is government placed capital and should therefore focus on investments that guarantee positive returns. This gives a natural risk-averse investment modus and might also be the reason why they have shifted investment focus from early-stage to international sustainable investment objects.

Argentum, which is another governmental system, investing in other private equity funds, has also shifted to a later stage, mainly the private equity and buy-out stage.

Private equity investors such as Business Angels (BA), Venture Capitalists (VCs) normally invests in a later stage. As mentioned in 2.4, investors are normally reluctant to invest in USOs, and in Norway, the available private equity-community seem to be even more reluctant.

4.3. TTO-REGIONS IN NORWAY

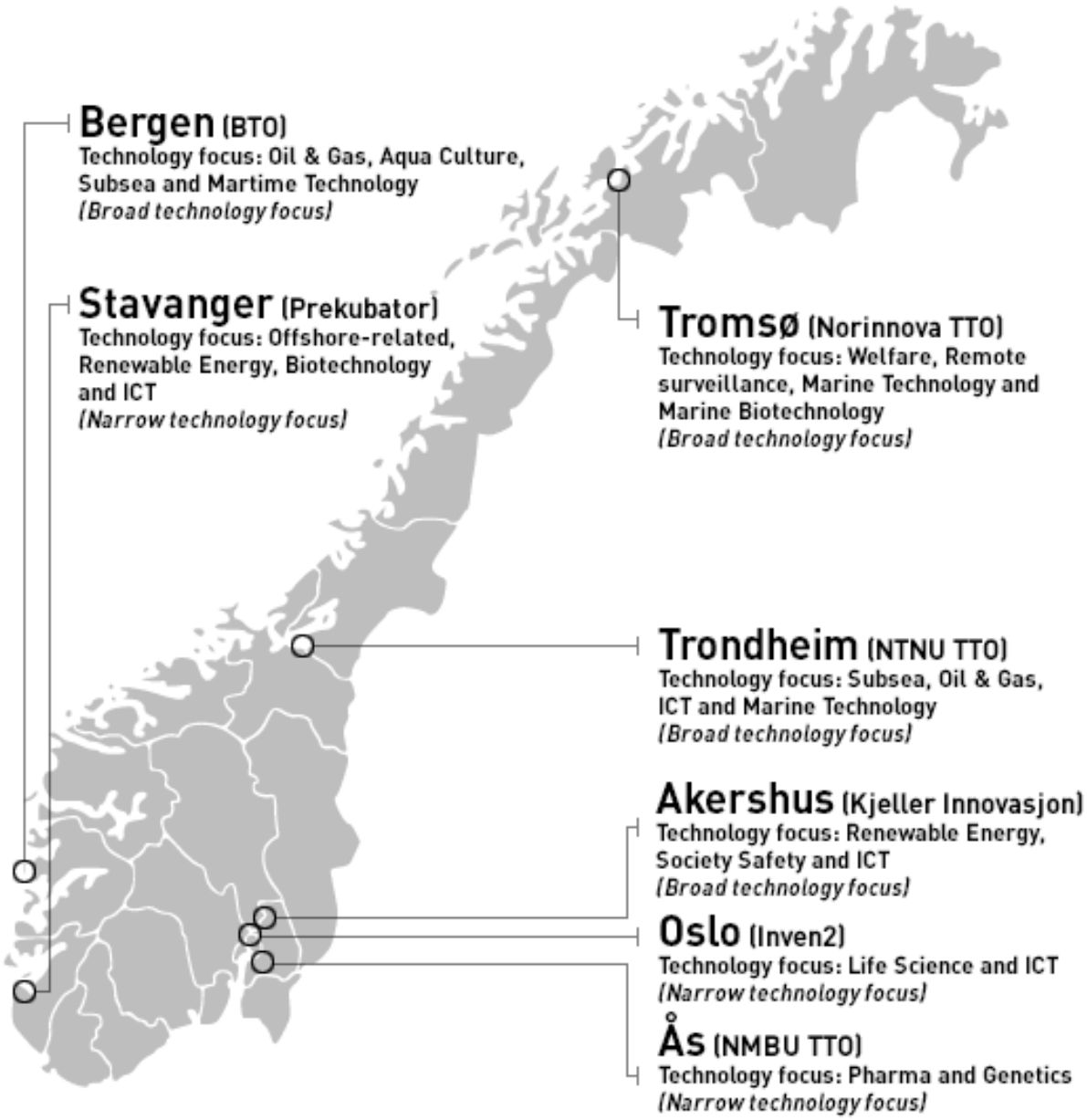

Figure 10 - TTO-regions in Norway

In Norway today, there are currently 8 universities, 20 colleges and 5 professional colleges under state ownership. There is also a number of private higher education institutions who

receive governmental subsidies. The regions shown in figure 10 presents the TTO-community affiliated with the universities in Norway. Three of the TTOs, Kjeller Innovation, Inven2 and NMBU TTO have a close proximity to the Oslo-region, southeast in Norway. The variety in technology focus makes these TTOs to somewhat complement each other in the region. The Oslo-region is commonly known for its financial and medical industry. The Trondheim region in mid-Norway is served by NTNU TTO. NTNU TTO focuses on a variety of technology sprung out from NTNU and other nearby research institutions. This region is known for its large industrial structure around microelectronics, marine technology and subsea. Tromsø, in the north covers the industry from the three northern counties in Norway. This is primarily marine technology and marine biotechnology. The TTO of the Tromsø-region is Norinnova TTO, and is currently located at the University of Tromsø. Bergen in the west, the second largest city in Norway after Oslo, is served by BTO. Their main technology focus has been Aquaculture for the last years, but they also have Oil & Gas-focus due to their closeness to the Norwegian continental shelf, where a large part of the world's extraction of oil happens. Stavanger, the "oil capital of Norway", has compared to Bergen an even stronger focus on Oil & Gas, and Prekubator, the TTO of Stavanger region, has established a number of USOs within this field of technology. Overall, Oslo, Ås and Stavanger seem to have a narrow technology focus, while the other TTOs have a wider technology focus.

We will in the next section present these case subjects and analyze the weaknesses and strengths in regards to their accessibility to resources in their entrepreneurial ecosystem.

5. CASE PRESENTATIONS
5.1. NTNU TTO
5.1.1. CONTEXTUAL FACTORS

NTNU TTO, in Trondheim, was formally founded in 2003. The main purpose of NTNU TTO is to transfer the research and findings at NTNU to the industry and society. NTNU TTO also functions as the technology transfer actor for Sør-Trøndelag University College. NTNU TTO is owned by the university (85%) and Helse Midt-Norge (15%). The main industries in the Trondheim region, and subsequently the focus areas of the university are energy and environment, medical technology, materials technology, marine and maritime technology and ICT (Sætre et al., 2006). NTNU TTO have a broad technology focus, but according to Erik Wold, head of venture at NTNU TTO, the dominating industries that they allocate most of their resources to are ICT, Oil & Gas, healthcare, marine and engineering.

NTNU TTO has 24 employees and generates around 25 deals per year with yearly revenue of about NOK 50 million. The revenue mentioned is the total revenue of the TTO and could come from other sources than from spin-offs. This could be from licensing, funding, royalties or dividends from equity positions. This applies for all TTOs that we present in this report. Around 50% of their deals are spin-offs and the rest are license agreements. According to Erik Wold, head of venture at NTNU TTO, the choice to spin off companies is taken when 1) the technology is not applicable for any corporations and 2) there are no corporations in the region that can apply the technology.

NTNU TTO has been ranked the best Norwegian TTO when it comes to generating USOs by the Norwegian newspaper Dagens Næringsliv (Norgesmester, 2010). The implementation of NTNU Discovery (See table 8), has, according to Wold, given positive effects for the commercialization efforts of NTNU TTO. Gulbrandsen et al. (2006) writes that already in 2001, before the legislation change, NTNU implemented a strategy which purpose was to increase the number of research based spin-offs from NTNU and other research institutions in the Trondheim region (predominantly SINTEF). With this strategy, NTNU wanted to become the most active Norwegian university with respect to innovation.

Based on the ranking of NTNU TTO, the Trondheim region seems to be a strong entrepreneurial ecosystem in Norway, and because of our proximity to this region, we will go more into detail on the components that constitute its entrepreneurial ecosystem. We also believe that NTNU TTO and the Trondheim region will function as a benchmark when discussing Norwegian TTOs up against each other. Table 8 illustrates some of the actors that contribute in making this region the way it is today.

Table 8 - Components in the EES of NTNU TTO

The university (NTNU) Generating talented graduates and researchers who come up with exciting new ideas.	**SINTEF** SINTEF is the largest independent research organization in Scandinavia. Several companies have been spun out of research from SINTEF and NTNU. In fact, according to Sætre et al. (2006), around 100 companies had been spun out between 1986 to 2006.	**Start NTNU** Student organization focusing on entrepreneurship. Inspiring students to think entrepreneurial and to believe in entrepreneurship as an important mean to increase the number of jobs and to better the region's economy.
NTNU School of Entrepreneurship (NSE) The NSE graduates around 30 students per year. These students are taught to think entrepreneurial and encouraged to start their own business either through their own ideas or by helping others to commercialize their ideas.	**NTNU Discovery** NTNU Discovery's purpose is to serve as a financing source for potential commercializable research findings at NTNU. The fund will fill the gap between NTNUs research communities on one side and government funding on the other (Innovation Norway, FORNY etc.).	**NTNU Entrepreneurship Center** NEC bridges technological and commercial expertise through the extensive cooperation between NTNU and other actors in the ecosystem. NEC's goal is to contribute to the advancement of Norwegian economic life through research, education, and business development projects.
Leiv Eiriksson Nyskaping (LEN) LEN promotes business development by helping to commercialize research based ideas. LEN administrates the equity fund Såkorninvest Midt-Norge and is also the regional director of the FORNY-program and is therefore also a financing actor.	**SPARK NTNU** SPARK NTNU is a newly started organization (2013) which purpose is to become a portal for students who have innovative ideas and do not know how to exploit them. SPARK will provide these students with guidance and make sure that they get in touch with the correct people in the entrepreneurial ecosystem. SPARK also give soft funding to these types of projects.	**Venture capitalists and Business Angels** There are several sources of capital in Sør Trøndelag. Examples are: ▪ Startup You (BA and incubator in Trondheim) ▪ Viking Venture (VC in Trondheim) ▪ Investinor (Government owned investment company) ▪ Proventure
Digs A new co-working place with the purpose of creating a common ground for entrepreneurs and startups in Trondheim. They are arranging meetups and houses	**NTNU Accel** NTNU Accel's purpose is to provide push and support to knowledge-based start-ups in Trondheim. They provide access to capital through Accel preseed AS,	**Government presence** There are several government driven actors who are present in the Trondheim region to help USOs and innovation projects. Examples are:

several of the most promising startups in the region.	mentors, customers and new colleagues. Accel takes a 10% "non-dilutable" equity in the companies they invest in. (Accel, 2014)	▪ Innovation Norway ▪ SIVA ▪ Leiv Eriksson Nyskaping

5.1.2. IMPORTANCE AND CHARACTERISTICS OF CRITICAL COMPONENTS IN NTNU TTO'S EES

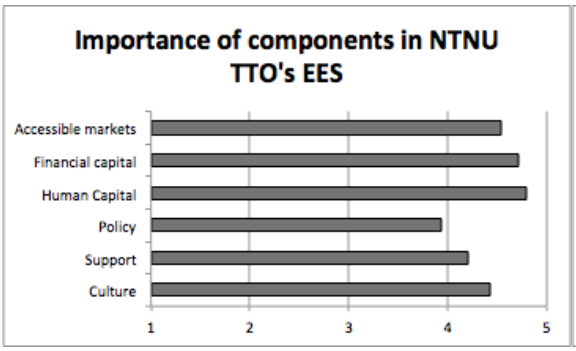

Figure 11 – Importance of components in NTNU TTO's EES

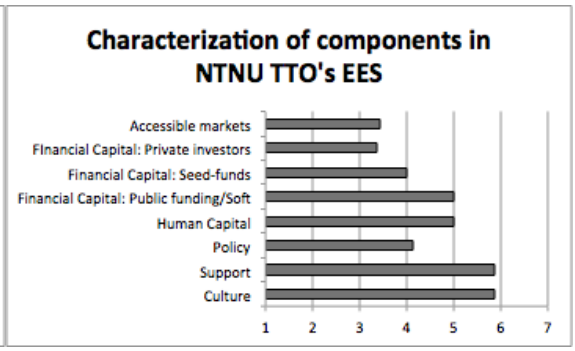

Figure 12 - Characterization of components in NTNU TTO's EES

Human capital in the region seems to be built up by the growing culture for entrepreneurship, which is made possible by actors such as NTNU School of Entrepreneurship (NSE) who educate young entrepreneurs and other actors who contribute in promoting entrepreneurship illustrated in table 8. According to Erik Wold, the access to human capital is important, but the Trondheim region supplies a comfortable level of human capital available for the firms. This is also, as figure 11 and figure 12 show, the opinion of the employees at NTNU TTO as they have ranked human capital as one of the strongest components in the EES. However, Wold states that they do need more talented business personnel that can go in and manage the USOs and they want to reuse successful entrepreneurs if they can. NTNU TTO have initiated a program called Entrepreneur in Residence (EiR) which is a program where they hire young entrepreneurs with the purpose of allocating them to the projects so that they can be project managers. NTNU TTO seem to focus on creating an organization that can handle any type of technology and thus reacting on the broad technology focus on NTNU mentioned above.

> *"Employees at NTNU TTO are "all-rounders". We have had anything from golf simulators to dynamic rock support beams."*
>
> *- Erik Wold*

Financial capital is, according to both Wold and the employees an important resource in order to successfully spin-off high-growth companies from NTNU. However, the characterization of financial resources compared to other resources indicates that there is potential for improvement in this area. Even though, as we mentioned above, Trondheim has

quite a few VCs, these will be reluctant to invest before most of the business risk is tolerable. In order to address this issue, NTNU TTO has together with NTNU, Sparebank 1 SMN, Sør-Trøndelag Fylkeskommune, Nord-Trøndelag Fylkeskommune and Helse Midt-Norge created NTNU Discovery, which is supposed to contribute to filling this financing gap. Lastly, in order to secure more capital to their USOs, NTNU TTO tries to build a great network of investors.

> *"We invite investors over for case presentations and networking. We have raised over NOK 150 million to our projects, so we have done quite well."*
>
> *- Erik Wold*

Accessible markets seem to be one of the biggest bottlenecks for NTNU TTO. Even though the entrepreneurial activity is good according to employees at NTNU TTO, there are not enough large corporations to help them by for example providing resources to conduct testing and product development to reach proof of concept. This concern is shared by the entire organization of NTNU TTO, as they have put both accessible markets as one of the most important resources in the EES, but in the characterization of the components in NTNU's EES, the component is ranked the weakest. This is also reflected in what Wold says about why NTNU TTO's choice of going for USOs versus license agreements because if there are no companies in the EES to take in the technology, spinning off a company might be the only commercializing route left.

To sum up, NTNU TTO operates in a relatively strong entrepreneurial ecosystem (Norwegian standard), but they as well experience imperfections in the EES. The most dominant imperfection is the lack of financial means in the pre-seed and seed-stage of USOs that they have tried to mitigate with NTNU Discovery and NTNU Accel. They ensure access to human capital through the hiring of external entrepreneurs, use of EiR and hiring competent TTO-employees. Lastly, Trondheim lacks the presence of large corporations, and to ensure good industry relations between USOs and industry, they arrange meet-ups through NTNU Accel and they arrange meet-ups with investors.

5.2. KJELLER INNOVATION

5.2.1. CONTEXTUAL FACTORS

Kjeller Innovation, in Lillestrøm, was established in 1995, and has been reorganized several times. Kjeller Innovation possesses the role as a commercializing unit of research and development activities and incubator services. The purpose of Kjeller Innovation is to commercialize research findings at research institutions such as Norwegian defence research establishments (FFI), Institute for energy technology (IFE), the Norwegian institute for air research (NILU), Oslo and Akershus University College (HiOA), as well as Akershus hospital (AHUS). Because these are applied research institutions, and not universities, Kjeller Innovation separates itself from other TTOs. The main technology focus areas for Kjeller Innovation are renewable energy, civil protection, health and IKT. The ownership structure is represented by a majority of owners, where the largest owners are SIVA and Statoil Technology Invest. Among the smaller owners are Akershus City council, NILU, IFE and

FFI. Kjeller Innovation has previously been the commercializing actor for the Norwegian University of Life Sciences (NMBU), but this link is no longer present as NMBU has launched their own TTO. Kjeller Innovation provides incubation services for spin-offs from the research institutions and supports them with resources such as human capital and financial capital through Akershus Teknologi fund, an early-stage investing venture fund which we will elaborate on further in section 6.2.2.

Kjeller Innovation has 15 employees and generates around 7-10 deals per year. Kjeller Innovation takes ownership in the projects that they work with, which have yielded a yearly revenue of around NOK 30-40 million from the deals. They have tried licensing, but have gotten a lot more back from going for spin-off creation, which is why most of their commercializations are spin-offs.

Kjeller Innovation is no longer formally connected to any university. Akershus Teknologifond has since 2009 funded the growth of around 30 companies linked to Kjeller Innovation with NOK 200 million.

5.2.2. Importance and characteristics of critical components in Kjeller Innovation's EES

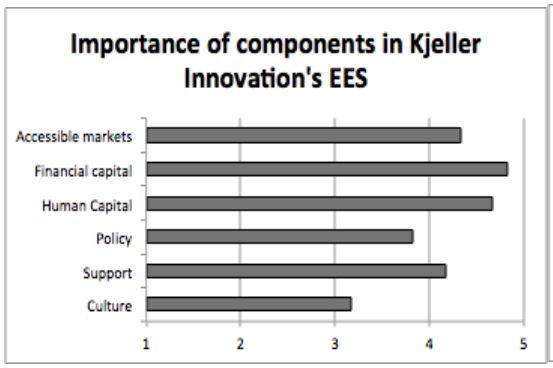

Figure 13 – Importance of components in Kjeller Innovation's EES

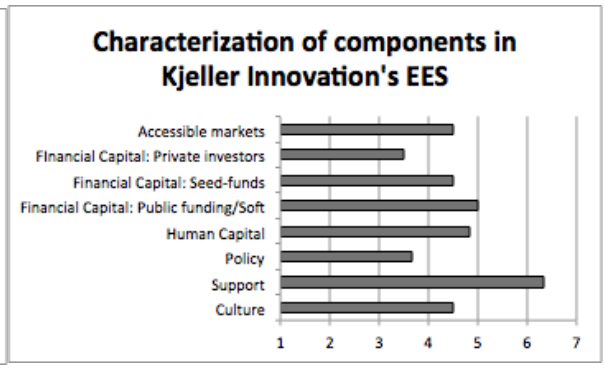

Figure 14 - Characterization of components in Kjeller Innovation's EES

Human capital is, according to Mariann Ødegård not an issue for Kjeller Innovation. Even though there seems to be an understanding that this is a very important resource compared to other resources, Kjeller Innovation does not struggle to find competent human resources because they have a good network to gather human resources from. The one thing that might hold them back would be if they did not have enough funding to pay human resources. This indicates that in order to ensure human capital to their USOs, Kjeller Innovation prefers to hire external personnel.

Financial means in the pre-seed and seed-stages is the big bottleneck for Kjeller Innovation. Figure 13 illustrates that Kjeller Innovation look at financial resources as the most important resource in order to successfully ensure the success of their spin-offs. However, the characterization of private and seed-funds in the region, illustrated by figure 14, shows that they are struggling to get these resources. Kjeller Innovation looks to the government to implement policies that will make financial resources more available in the early and very

important stages of the USO's life cycle, in order proof of concept, attract customers and show that there is a potential for the new venture to attract venture capitalists. Mariann Ødegård and the employees is however not satisfied with the current policies:

> *"Norway uses billions on research and only a little over 100 M NOK on commercialization, so commercialization is extremely under-financed. FORNY2020 should be multiplied by 3 or 4."*
>
> *- Mariann Ødegård*

Kjeller Innovation's way of addressing this issue, and a way to ensure more autonomy and thus decrease the resource dependency, was to establish their own fund in 2009 which is a fund they have built up in collaboration with Akershus county and Norsk Innovasjons Kapital. This fund is now called NIK but we will refer to it as Akershus Teknologifond, as this is the name that all of our interview subjects refer to it as. In reality, Akershus Teknologifond has ownership in the funds NIK1, NIK2 and NIK as shown in figure 28. However, Kjeller Innovation wishes that they could have something similar to NTNU Discovery in the future. The difference between the two is that NTNU Discovery functions as a government grant, controlled by NTNU, while Akershus Teknologifond is a venture fund, taking equity in the companies they support.

Accessible markets is regarded as an important component in the EES, but does not seem to be a bottleneck for Kjeller Innovation. One employee stated that an accessible market is important, but it does not have to be in the region as for example customers or other supporting actors might be all over the world. Looking at some of the successes from Kjeller Innovation (e.g. Opera Software and WaveTrain Systems), it might make sense that they are not explicitly looking at accessible markets the way we have defined it in section 2.4 - as the region's density of actors who can contribute in the USO's value chain.

To sum up, Kjeller Innovation's big bottleneck is to find enough funding for their projects in the critical pre-seed and seed-stages and their response to this was to create Akershus Teknologifond. Employees at the TTO characterize the access to private investors and government policies as the least favourable components in the entrepreneurial ecosystem.

5.3. PREKUBATOR

5.3.1. CONTEXTUAL FACTORS

Prekubator, in Stavanger, was established by the research institution IRIS, a large research institute in Stavanger, and IPark, a innovation park in close proximity to the University in Stavanger (UiS), in 2002. The main purpose for Prekubator is to build strong links between researchers and industry actors to create and develop new products. Prekubator is owned by the University of Stavanger, IRIS, IPark, Helse Stavanger and Nofima. Prekubator was founded on behalf of the university and the surrounding research institutions as a joint function of innovation. The Stavanger region is dominated by the Oil & Gas industry and several large Oil & Gas corporations have their main Norwegian office in the region. According to the UiS's website, the main areas of research within the university are Oil & Gas, health, civil protection and ICT. Prekubator allocate most of their resources on offshore

related technologies, but also on renewable energy, biotechnology and IT. In addition to being close with UiS, Prekubator also serves as the commercial actor for the University College of Stord/Haugesund.

Prekubator has 7 employees and generates around 5 deals per year from around 100 ideas in total. 50% of the ideas are research based. Their yearly revenue from the deals is around NOK 15 million. They focus equally on licensing and spin-offs. According to CEO Anne Cathrin Østebø, it is easier to nurture spin-offs than license agreements because the Norwegian system is build up in a way that makes it easier to raise funding for spin-offs compared to licensing projects.

The most prominent characteristic of the Stavanger region is its strong access to the Oil & Gas industry. As Erik Wold from NTNU TTO states:

> *"In Stavanger, they have a walking distance to all the important actors in the value chain within Oil & Gas. They even have the Petroleum authorities situated in Stavanger."*

This is also supported by other TTOs outside the Stavanger region.

5.3.2. IMPORTANCE AND CHARACTERISTICS OF CRITICAL COMPONENTS IN PREKUBATOR'S EES

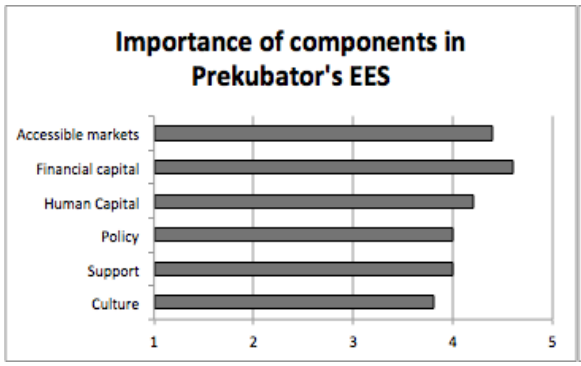

Figure 15 – Importance of components in Prekubator's EES

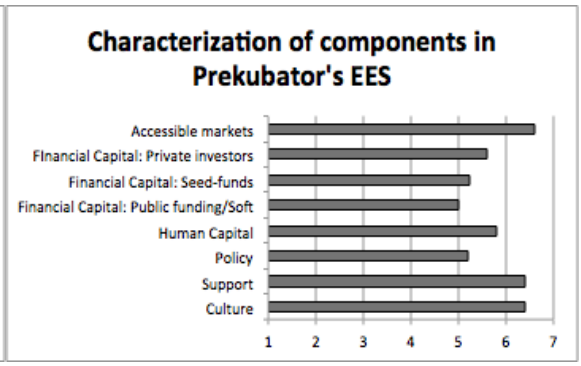

Figure 16 - Characterization of components in Prekubator's EES

Human capital is regarded by the CEO and the employees at Prekubator as a relatively important component in their EES and is, according to Anne Cathrin Østebø, a strong component in the Stavanger region. A highly contributive factor to this is the high density of Oil & Gas companies in the region. However, as mentioned earlier, because of high salaries and difficulties to attract skilled people from safe jobs to riskier entrepreneurial endeavors, these people might be costly to obtain, especially in the earlier stages. A mechanism they have used in order to get the best people involved in their projects has been to get them in as strategic board members.

> *"In the region, there are many retired people from the Oil & Gas industry who are not tired of working, so they want to help new ventures. These are*

people with substantial industry knowledge and experience. We usually offer them board seats, which is a cheap way to attract human capital!"

- Anne Cathrin Østebø

Students are also approached early to get them to write their thesis in collaboration with the USOs. Another tool to increase human resources is to work closely with the investment community.

"We work with investor environments such as Energy Ventures, Prokorn Ventures and if they invest in some of our companies, we demand that they provide a CEO or a Chairman in our companies".

Financial resources is regarded as the most important component in this region by the employees, and interestingly, when looking at how the different TTOs in Norway characterize different funding mechanisms, Prekubator turns out to be the only TTO who put private investments and seed -funding above public funding mechanisms. With offshore-related technologies being their main focus, the access to financial resources has for Prekubator been satisfying. Anne Cathrin Østebø points to the geographical advantages of being located near large oil companies:

"Within the Oil & Gas industry, we have managed to build up a sustainable value chain in regards to attaining financial capital. The best projects here receive government research funds, seed capital, venture capital and proposals for industry collaborations. Oil companies are very good at financing new companies in the early phase".

Even though there is a good access to financial resources in the Stavanger region, Prekubator stills suffers from lack of these resources when it comes to other industries than Oil & Gas. To find tools to address this issue, Prekubator is trying to work closely with public funding mechanisms to pull them to their projects. Another mechanism is Prosjekt-Plogen, which is a regional project with the purpose of supporting the development of new research based products by giving micro grants to faculty members. The Board at the University of Stavanger has decided to earmark NOK 1 million towards this funding system in order to ensure more financial autonomy in the early phase of extra promising projects. Prekubator is also in the process with other actors in the region to establish an early-phase fund.

Accessible markets in the Stavanger region are very strong for USOs operating in the Oil & Gas industry. This is also supported by how the employees at Prekubator characterize this component (figure 16). The cluster of oil-related companies, both large and small, gives a pulsating Stavanger region with the entire value chain in this particular industry represented. Østebø highlights the accessible markets in the entrepreneurial ecosystem:

"We are lucky to have many large industry actors in our region who have a lot of capital and who are used to innovation. Still we could be better in linking research with industry. In order to create this link, we should create meeting places and work together. That is, in my opinion, the only way to achieve something"

Because of the high density of Oil & Gas actors, it seems challenging for other industry players to become prominent. This reflects on the difficulties that Prekubator experiences with respects to spinning off USOs within other industries.

Summarized, Prekubator experience many positive outcomes because of their linkage to the Oil & Gas industry. Even though they wish to have a broad scope in transferring technology, many of the USOs spinning out from Prekubator are related to the regional Oil & Gas industry structure. Prekubator has managed to create a good financial value chain for their Oil & Gas related projects, which has made it possible for their USOs within this industry to succeed. One bottleneck is to find enough financial resources to support USOs within other industries and to find enough financial resources to hire the best entrepreneurs.

5.4. INVEN2

5.4.1. CONTEXTUAL FACTORS

Inven2, in Oslo, was established in 2010 after a merger between Medinova and Birkeland Innovasjon. Medinova was the TTO for Oslo University Hospital as well as the TTO for Helse Sør-Øst, while Birkeland Innovation was the TTO for the University of Oslo. Their purpose is to get products and technology to the society, aiming to build a local industry based on groundbreaking technology from the University of Oslo (UiO) and Oslo University Hospital, which are the two owners of Inven2. The main industries in Oslo are maritime, Oil & Gas, energy and environment and life science. One thing worth mentioning is that most headquarters for the broad industrial base in Norway is located in Oslo. The university however focuses primarily on life sciences, which seems to be strongly affecting the ideas that Inven2 works with. In addition to life science, Inven2 also has a broader technology scope as they have worked with geoscience, material science and microelectronics. This is however not as prioritized as the ones mentioned above.

Inven2 has 27 employees and had 38 deals in 2013. This was the first time a Norwegian TTO reached 30 deals in one year. They are aiming for 60 deals in 2015. The yearly revenue of Inven2 is around NOK 30 million generated from the deals. Of the 38 deals from 2013, only 7 were spin-offs, which illustrates that they are focusing much more on licensing.

Inven2 is organized differently than other Norwegian TTOs as they are divided into two groups - technology and business development. This means that an idea that goes through the Inven2 system first has to be screened by the technology team before it can be transferred to the business developers who then try to take it to the market. Other TTOs in Norway usually have a system where the employees follow the projects from invention disclosure throughout the business development phases.

5.4.2. Importance and characteristics of critical components in Inven2's EES

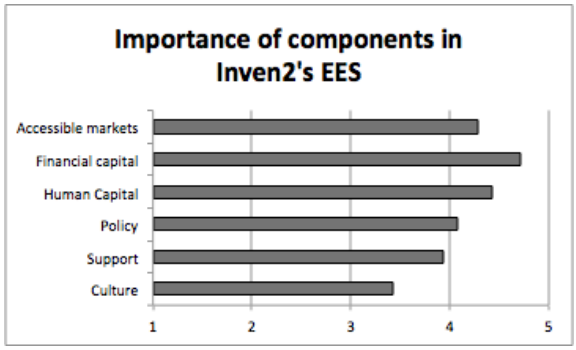

Figure 17 – Importance of components in Inven2's EES

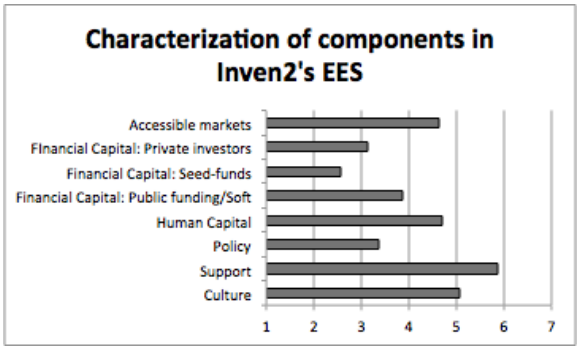

Figure 18 - Characterization of components in Inven2's EES

Inven2 is very different from many Norwegian TTOs because 1) they work mostly with licensing of technology instead of spin-offs, 2) they are very selective and supportive with respect to choosing what projects to pursue, and how much they do for the projects, and 3) they have a very specific industry focus compared to the other TTOs.

Human capital is regarded by employees at Inven2 as one of the most important components that need to be available for USOs seeking growth. However, the characterization shows that their access to such resources could be improved. Ole Kristian Hjelstuen state that they do want to hire more experienced CEOs but they cannot afford to do this.

> *"We could have hired surrogates or hired more employees. It is especially the verification phase that needs people. We want CEOs early on in the projects."*
>
> *- Ole Kristian Hjelstuen*

Financial resources is without a doubt the component that both Hjelstuen and the employees at Inven2 believe to be the most important in order to successfully nurture their projects. It is therefore concerning, that according to the employees, funding mechanisms is the weakest component in Inven2's EES. Hjelstuen states that one of the greatest challenges with working as a commercialization actor is to make sure that there is enough financial means in order to conduct the very important testing and developing to reach proof of concept, which is necessary in order to attract investors. He believes that the means from FORNY2020 should be up to three times as large, which is very aligned with the statements from the CEO at Kjeller Innovation.

> *"Right now it's 114 M NOK but this is too little because this is actually one of the few programs that actually supports in the verification phase. In this phase, the scientists believe it could be something commercial while others believe its just research, and there is still not enough data for investors. FORNY2020 covers all technologies, and the research council has another program called Biotech 2021 that has around 60 M NOK, and if you add*

this with the remaining 80 M NOK in FORNY, then that leaves around 140 M NOK for all new projects from research."

He also adds that the process of raising funds from public funding sources could be very time consuming and during this time, many of the best people might lose faith and "jump of the wagon". In order to increase the access to financial resources for their projects, Inven2 wishes to build their own fund and look to NTNU with NTNU Discovery or Kjeller Innovation's Akershus Teknologifond. Inven2's main mechanism to increase the access to financial resources is to build strong relationships with financial actors.

According to the CEO of Inven2, Ole Kristian Hjelstuen, it is not that they "focus on licensing", it is merely a matter of finding the best way to reach the market.

> *"We do not go for USOs if we don't have external funding available. On life science, there are not many "smart-investors", and on technology in general there is too little will to take risks."*
>
> *- Ole Kristian Hjelstuen*

Accessible markets, which according to employees in Inven2 is the third most important component in their EES, is characterized as a relatively strong component in the ecosystem. This is somewhat surprising as Inven2 has around 70 % focus on life science (especially pharma), and there are very few relevant actors in Oslo and in Norway in general. Hjelstuen emphasizes the importance of a stronger home market for life science. Today, there are some large actors such as Helse Sør-Øst and GE Healthcare who are large enough actors to be home markets themselves, and the presence of such actors are, according to Hjelstuen, very inducing for new ventures. However, Inven2 still has to go out and push for more projects, and help, from the industry. As a mechanism to ensure better relations with industry, they usually find entrepreneurs who have a connection to relevant industries within life science, thus ensuring better collaboration between the USO and the industry. One of the employees also said that Inven2 is good at arranging meet-ups between entrepreneurs and the industry.

To sum up, Inven2 focuses mainly on life sciences and they are very supportive and selective with respects to life science. Big bottlenecks are mainly funding and human capital. They want to create their own fund such as NTNU Discovery and they want more competent human capital but cannot do this before they get more funding. They arrange meet-ups and try to attract market actors in order to create better connections between USOs and industry.

5.5. NMBU TTO

5.5.1. CONTEXTUAL FACTORS

NMBU TTO, in Ås, was established in 2014 and is the newest of the Norwegian TTOs. It is also the only Norwegian TTO that is not founded in a city. NMBU TTO was started with the main purpose of transferring technology and knowledge from NMBU to the industry. This was previously a matter that Kjeller Innovation took care of. But now, the university itself, NMBU, is the owner of NMBU TTO. The university's main focus areas are Biology, Food preservation, Environmental studies and Natural resource management. Originally, this

university was the main Norwegian university for agriculture, which still has effects on the research being conducted. NMBU TTO is however mostly work with pharma and genetics according to the CEO of NMBU, Anne Kristin Holmeide.

NMBU TTO has 4 employees that have generated 2 deals thus far. Their yearly revenue is still not ready as they are in their first year of business. There is no particular focus towards either licensing or spin-offs. As the CEO Anne Kristin Holmeide said:

> *"The most important thing is to choose the best strategy in order to reach the market as fast as possible".*

5.5.2. IMPORTANCE AND CHARACTERISTICS OF CRITICAL COMPONENTS IN NMBU TTO's EES

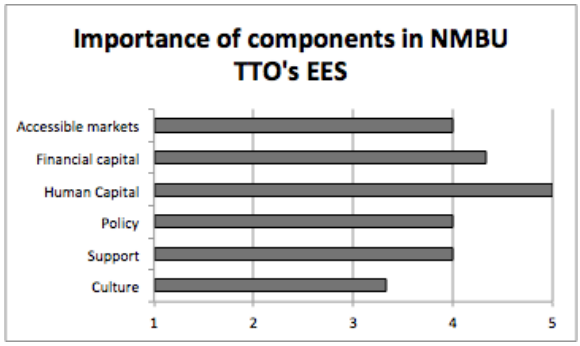

Figure 19 - Importance of components in NMBU TTO's EES

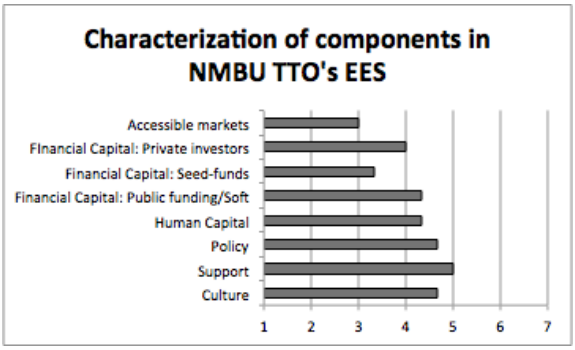

Figure 20 - Characterization of components in NMBU TTO's EES

Human capital is by the CEO and the employees at NMBU TTO, perceived as the most important resource for the region. But getting access to this critical resource is also considered as the biggest bottleneck according to the CEO. This differs from what the employees answer, as they characterizes this as one of the best component in the region. This could indicate different perceptions about what the term human capital really stands for. With only four employees, NMBU TTO is in great need of access to talents that can govern the projects further, and the CEO see it as a great challenge to set out the employees in management positions at USOs. Among the employees, the CEO is the only one with relevant management experience, especially from the pharma industry, which NMBU has one of its primary focuses on. In order to ensure increased access to human resources, NMBU TTO have tried to hire external entrepreneurs, but this has shown to be a difficult task.

> *"Retrieving competent human capital for leading a possible spin-off company is an issue for us and increasing this is a tough challenge"*
>
> *- Anne Kristin Holmeide*

Financial resources is seen as the second-most important resource in the Ås-region, which is no surprise as theory claims it to be the most important resource for new ventures, and especially USOs. It is fairly surprising that the employees do not score access to private investors lower because according to the CEO, they still have not succeeded in raising any

capital from private investors. Being a newly established TTO, NMBU therefore struggles to attract seed funding and private investors to their projects. To ensure better financial mechanisms to their USOs, NMBU tries to engage the university in hopes of creating internal funding mechanisms such as NTNU Discovery or University Venture capital funds mentioned earlier in section 2.4.

Accessible markets is by the employees at NMBU considered as fairly high of importance in their EES. It is however characterized as the weakest resource in the region. It is therefore a surprise that this differs from statements by Anne Kristin Holmeide, who do not experience this as a big problem, because of the closeness to Oslo and the industry there. The differences of the industries in the projects that the employees are working with can be an explanation for why there is a gap between the CEO statements and the employee-response. Another aspect to notice is that government policies are ranked fairly high within the EES. This is in line with CEOs statements of being dependent on governmental help to build up a good structure for commercialization in the region.

To sum up, NMBU has a great challenge in increasing and attracting human capital. Another challenge is to find private investors who are willing to invest in their companies, which is why they want to create their own fund. In assessing the importance of the different components in the entrepreneurial ecosystem, it is an alignment between the CEO and the other employees. However, in characterizing the different components, there are some differences. This strongly suggests that employees at NMBU TTO have different views on the entrepreneurial ecosystem.

5.6. NORINNOVA TTO

5.6.1. CONTEXTUAL FACTORS

Norinnova TTO, in Tromsø, was first established in 1993, with the purpose to commercialize business ideas based on research activities and new technologies in Tromsø and the northern parts of Norway. It has since then developed to become a TTO through the Northern Research Institute, who owns 51 % of Norinnova. Other prominent owners are SIVA, Statoil and the University in Tromsø. In 2011, Norinnova merged with TTO Nord AS and changed its name to Norinnova Technology Transfer. Main industries in Tromsø are marine technologies (mostly fish industries). The Northern Research Institute contribute to research in the region and their main research areas are biotech, arctic technology, renewable energy and remote surveillance. The University in Tromsø's main research areas are fishery science and marine biotechnology. Norinnova TTO has worked with all these technologies, thus having a broad technology scope.

Norinnova TTO has 16 employees and they receive around 100 new ideas per year whereas 50% are research-based ideas. At the moment, they have 32 commercialization projects and 22 companies in incubation, which have resulted in 8 deals. Yearly revenue for Norinnova is usually around NOK 20 million. Historically, Norinnova TTO has focused on spin-offs, but in the later years, the focus has drifted more and more towards licensing because of weak access to capital.

Having the commercialization role for the entire northern part of Norway, Norinnova TTO has a substantial responsibility. This makes Norinnova TTO the TTO that covers the largest area of all Norwegian TTOs. This area comprises several cities and also The University of Nordland.

5.6.2. IMPORTANCE AND CHARACTERISTICS OF CRITICAL COMPONENTS IN NORINNOVA TTO's EES

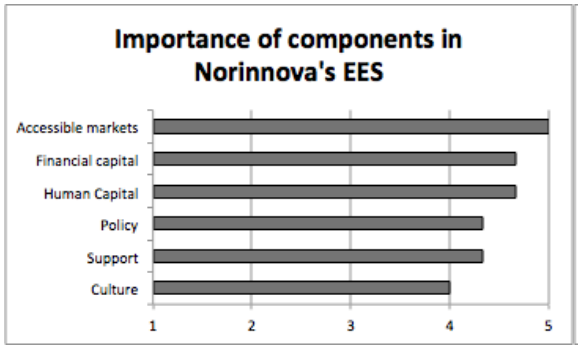

Figure 21 - Importance of components in Norinnova's EES

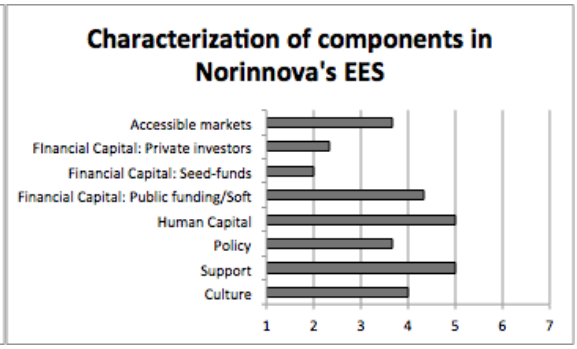

Figure 22 - Characterization of Norinnova's EES

Human capital is regarded, by the employees at Norinnova to be one of the most important components in their EES and also, one of the components that believe to be one of the strongest in the region. However, as Bård Hall says, it is the amount of initial funding that decides whether or not they get the best people for the job. In order to ensure better human capital conditions in the future, Norinnova TTO tries to build more entrepreneurial culture through recruitment of students by being active in the entrepreneurship programs at the university. By offering TTO staff-members as supervisors in master theses and arranging courses, the students are exposed to Norinnova's activity early on. However, access to experienced management personnel from the industry is a greater challenge. The challenges in attracting competent personnel from other regions in Norway, makes it necessary for Norinnova TTO to build these kind of resources themselves.

Financial resource is, as human capital, also regarded as one of the most important factors within EESs. It is therefore concerning that the employees characterize financial resources as the weakest components in their EES, especially when it comes to private investments and seed-funds. Bård Hall at Norinnova TTO explains that the major challenge in the region is to attract sufficient funds to their projects:

> *"It is too difficult to get enough capital. Public funding is easier to obtain. We have a great relationship with Innovation Norway, The Norwegian Research Council, and SIVA. The problem is to attract private capital. We are addressing this issue by arranging "Capital-day" once a year. We are also communicating a lot with the Union for Innovation Companies in Norway (FIN) because they are our communication channel to the government. For example, we want better tax-incentives for investors, and this, we take to FIN".*

Accessible markets is undoubtedly the most important component in the EES according to employees at Norinnova TTO. It is therefore concerning that they have characterized the component as one of the weakest of the components in the region. According to Hall, the reason for the low access to relevant industry actors is the lack of headquarters in Tromsø. He also claims that it is from these headquarters that the big industry pulls come from. Norinnova TTO has ambitions to gain a stronger link to the industry, which is fragmented over a wide geographical area. Through the Arena Program, Arena Biotech North, they offer financial and technical support to regional industry clusters. This tool is important to withhold the industry relations and ”bridging the gap” between the university and industry.

Summarized, Norinnova TTO is representing a larger area compared to other regions in Norway (see figure 10) Because of the challenges in attracting sufficient human capital from surrounding regions because of financial reasons, Norinnova is seeking to build up these resources internally through more student engagement. Private funding and seed funding seems to be the biggest bottlenecks for Norinnova TTO but they seem quite satisfied with the amount of public funding. The importance of reaching out to the geographically fragmented industry is also an issue they are trying to solve with innovation programs and meeting places.

5.7. BTO

5.7.1. CONTEXTUAL FACTORS

BTO was founded in 2004, and is the technology transfer office in Bergen, with the purpose of supporting the eight research institutions in Bergen with respects to commercialization and technology transfer. The TTO is owned by University of Bergen (40%), Haukeland University Hospital (40%) and Institute of Marine research (20%). The Bergen area’s most prominent industries are energy (mostly Oil & Gas), seafood and marine sectors. The educational and research institutes in Bergen covers a broad technology scope, but the focus lies mostly on aqua culture, which also applies for BTO according to BTO’s CEO, Anders Haugland.

BTO has 27 employees, and generate around 17 deals per year from around 150 ideas that come in. This gives yearly revenue of about NOK 53 million. BTO focuses both on licensing and spin-offs. Their focus is to choose the correct strategies for the specific projects.

According to CEO Anders Haugland, BTO Accel, which is a meeting place for USOs, investors, mentors and industry actors, arranged by BTO, has given positive effects for the commercialization efforts in Bergen.

5.7.2. IMPORTANCE AND CHARACTERISTICS OF CRITICAL COMPONENTS IN BTO'S EES

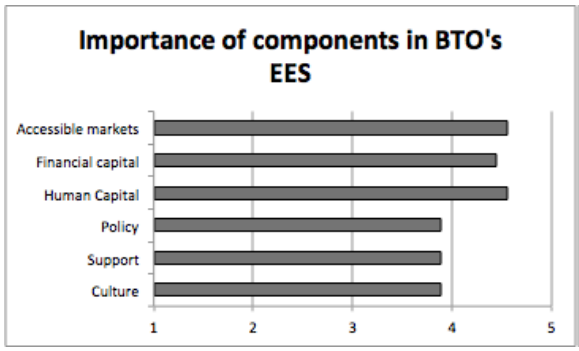

Figure 23 - Importance of components in BTO's EES

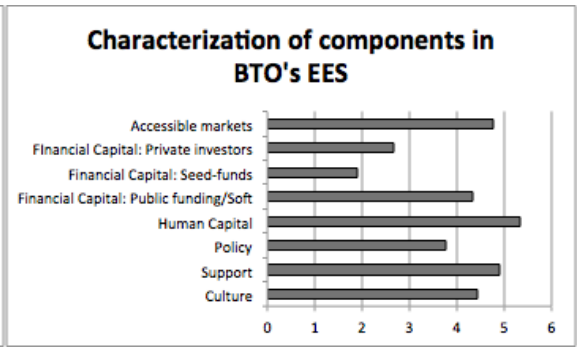

Figure 24 - Characterization of components in BTO's EES

Human capital is by both CEO and the TTO-employees regarded as the most important resource for spinning off ventures in the Bergen area. Interestingly enough, when looking at how employees at BTO characterize access to human capital in BTO's EES, it seems that they think the access to human capital is strong. This does not align well with the thoughts of Haugland, who means that access to human capital to lead spin-off projects is a difficult challenge for BTO, mainly because there is a lack of experienced entrepreneurs in the region. He highlights the importance of having USOs with both experienced personnel and students, stating that the mix of guts, network and freedom to act is the best combination for USO's growth. The great gap between the perception of the CEO and employees in regards of access to human capital can be explained by the employee's interpretation of human capital as access to management personnel, while the CEO has a more critical view at the types of human capital that can create sustainable USOs. BTO's way of solving the lack of human capital in the region is to hire interns from the research institutions that BTO are serving, and seeking out surrogate entrepreneurs in the adjacent regions to Bergen. BTO has also started innovation programs such as BTO Accel that aims to help USOs with coaching and counseling, hence educating the academic entrepreneurs to enhance their performance in business management.

Financial resources in the region is according to CEO, Anders Haugland, regarded as an equally important component in the region in order to spin off ventures. This is well supported by the employees. In regards to the perceived characterization of the financial resources, it is very noticeable and aligned with the CEO's thoughts that the employees think there is a lack of seed-funds in the region and that the access to private investments is limited. The CEO points out the critical dependence on financial resources:

> *"In my opinion, and experience, financial resources are scarce in all stages of our USO's life. The first available means of funding beside our internal funding options (FORNY2020) are the pre-seed funds. The problem is that they are cyclical and tend to invest in bigger ambitious projects".*

BTO hopes to make financial resources more readily available for their USOs by implementing funding mechanisms that do not have yield-demands. Haugland points to

NTNU Discovery in Trondheim as an example of this. He also emphasizes the financial model that Kjeller Innovation uses as a great example of resource leveraging, with their access to Akershus Teknologifond, that functions as a buffer between the ongoing production and the cyclical funds in the pre-seed funds.

Accessible markets is perceived as one of the most important components in the region by the employees and the CEO, but even though the Bergen region, according to CEO, has one of Norway's largest industrial environments in the areas of aquaculture, BTO experience challenges in accessible markets. Anders Haugland summarizes:

> *"We experience very little pull from the markets. I see a great potential in increasing the relationship between academic and industry, because we believe market pull is of the essence.*

This is the opposite of what the employees remark about access to the markets, when they rate it almost as the best resource accessible in the region. A reason that might explain why accessible markets has been scored as high by the employees might be that they do see a lot of industry actors in the Bergen region. In addition, these industry actors might not be relevant actors for the USOs nurtured by BTO. The problem is to get access to these actors, as mentioned by Haugland. Because they experience little pull from these markets, they promote the idea collection heavily within their academic institutions. What Anders Haugland refers to as "pull from the market" is a parallel to what Etzkowitz (2003) refers to as reverse linearity, elaborated in section 2.5. In addition, interestingly, an employee from BTO stated in the questionnaire that it was an absolute necessity to increase resources to attract investors earlier in the research phase. This can be interpreted in many ways, such as addressing industry challenges with good network earlier, or to show credibility in the investor arena to attract external funding, or even bringing in competent serial entrepreneurs with strong relations to the investor environment. All of which are representing the top three critical components overall for BTO.

To sum up, BTO, like many other TTOs are facing challenges in connecting with human capital, even though the employees may have interpreted the question as the availability of human capital. BTO are also facing challenges with raising funds for the USOs and generating a market pull for the projects. By building up a regional resource base of talent and funding, they are trying to solve these issues. BTO also wants to create their own fund in order to give their promising USOs the means to conduct the operations they need to achieve proof of concept.

6. DISCUSSION

6.1. TTO-MODES IN WEAK ENTREPRENEURIAL ECOSYSTEMS

As we mention in section 3.6, TTOs who are operating under circumstances with less developed entrepreneurial culture, might do better focusing on implementing high support and high selectivity modes (Roberts and Malone, 1996). However, it is not enough to be supportive and selective as entrepreneurial ecosystems are complex environments that do not have fixed conditions. As Ole Kristian Hjelstuen mentions, it is a matter of finding the best way to reach the market.

One thing to consider about supportive and selective TTO-modes is that being supportive and selective will require a great deal of resources (Wright et al., 2007), which many TTOs might have little of in the first place. Breznitz et al.'s (2008) example from Yale University, who successfully managed to create a sustainable entrepreneurial ecosystem by focusing on one industry and doing extensive efforts in making sure that these projects got access to the resources that they needed, would not have been possible if they did not have substantial resources to do all this work. The need for competent human resources to follow these USOs would be extensive with such a TTO-mode. Moreover, simply focusing on one industry could mean a remarkable decrease in deal flow for most regions. This is why we have defined two dimensions of selectiveness, 1) Industry selectiveness which is what Yale University decided to be, and 2) Case selectiveness which is when the TTO decides to use more resources on finding potential winners and allocate more resources on supporting these USOs.

We will argue that there are few TTOs in Norway that would be successful in implementing an industry selective TTO-mode. One is Prekubator because it is surrounded by actors within the Oil & Gas industry, the government is supportive towards Oil & Gas innovations, investors are keen on investing in the USOs from Prekubator, there are many experienced people who can go in and work for the USOs, and the university and research institutions in Stavanger have a strong focus on Oil & Gas. For many regions in Norway, it could make more sense to be case selective. For example, NMBU TTO in Ås operates under circumstances that many would call a weak entrepreneurial ecosystem because they are struggling to attract investors, they have a low number of new deals and the culture for entrepreneurship is weak. Being selective on what projects to work with and picking out the potential winners (case selectiveness), regardless of technology or industry, might be a better use of resources for NMBU TTO. Inven2 seems to be doing a mix of case selectiveness and industry selectiveness. On one hand, they are being very industry selective by working so much with life sciences. UiO and the University hospital has a lot of research in life sciences and the research activity here is substantially more than for most research institutions in Norway. On the other hand, they seem to be very case selective by using a lot of efforts in screening every case in order to find the potential winners that they can develop further.

One factor that seems to decide the degree of industry focus a TTO has is the degree of research focus in the universities. For example, at NTNU, there is a rather broad research focus and thus the ideas emerging from the institutes are very different and it could be

anything from software to industrial equipment. At UiO however, life science is a strong research area, which reflects on the ideas that Inven2 works with.

Another reason why simply turning to high support/selectivity when dealing with weak entrepreneurial ecosystems is that this gives very little governance guidance. Simply stating that the TTO should be supportive cannot explain what factors the TTO should focus on because these factors are contingent on external conditions. In section 3.6, we state that weak entrepreneurial ecosystems are complex environments, this means that one support mechanism to improve certain aspects of the environment could work well for one area, but may fail tremendously in another area. Because of the broad agreement among researchers (Mustar et al., 2006; Brush et al., 2001; WEF, 2013; Isenberg, 2010), and Norwegian TTOs (section 5), that human capital, financing resources and accessibility of markets are the most important resources for USOs, we will now look at different TTO-tools that Norwegian TTOs have implemented in order to support USOs by improving their access to these, as illustrated by figure 25.

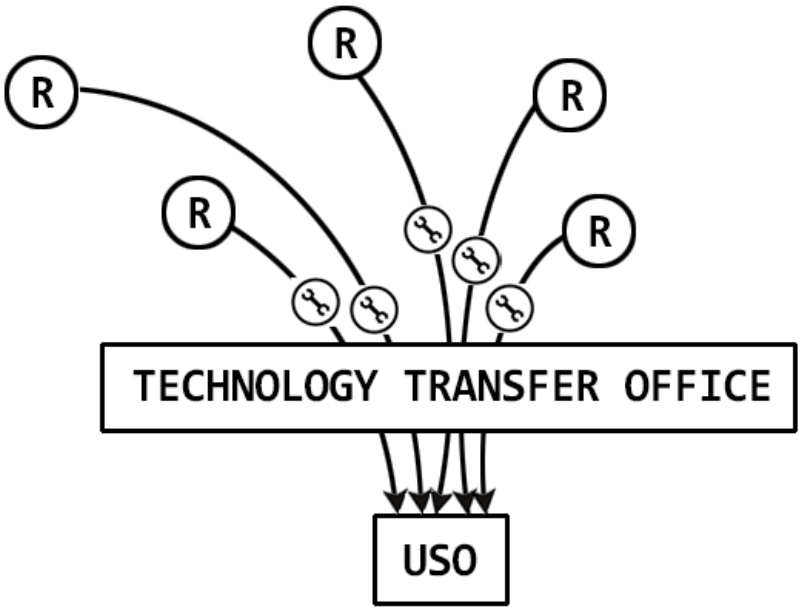

Figure 25 - TTOs ensuring USO access to important resources by using TTO-tools

6.2. HUMAN CAPITAL AND TTO-TOOLS IN NORWAY

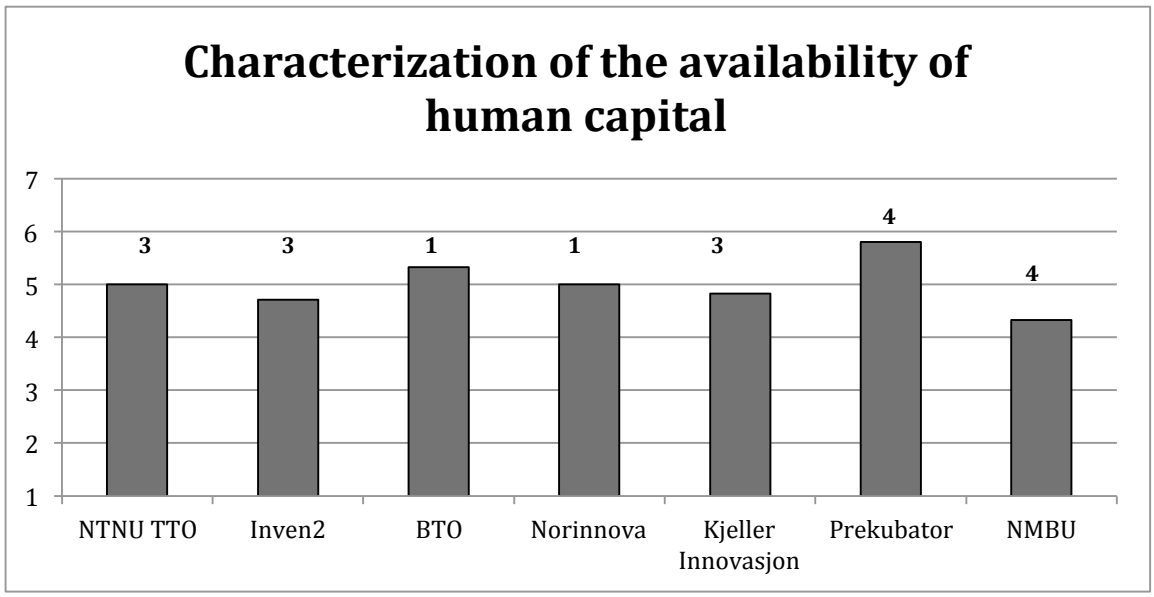

Figure 26 - Characterization of the availability of human capital in Norway

(by employees at TTOs)*

* Numbers above the different TTO-ratings describe the relative rating of human capital compared to other components in the TTO's EES

The different TTOs in Norway have given answers to how they characterize the access to competent human capital in their region, and the result is summarized by figure 26. It is important to have in mind that these are answers from the employees at the TTOs and that they did not have anything to benchmark their answers up against. Therefore, it might not be fair to conclude that Prekubator has the best human resources and Inven2 has the weakest human resources in Norway, just because figure 26 shows so. However, the best way to assess the strength of the different components could be to look at how they are ranked relative to the other components in the same region, which we have illustrated in figure 26. A collection of the characterizations and importance of the different components from the different regions can be viewed in Appendix 7

6.2.1. HUMAN CAPITAL: ENTREPRENEUR IN RESIDENCE PROGRAM

One TTO-tool which purpose is to increase the access to human resources is the Entrepreneur in Residence (EiR) program. As an example for a university that uses a similar program is NTNU TTO who seeks to increase the access to more business competence within their organization. The decision makers at NTNU TTO thought it could be wise to take advantage of the fact that they indeed have access to graduates within industrial economics and entrepreneurship. EiRs work as regular TTO-employees and are given the opportunity to enter management positions in USOs nurtured by the TTO.

One important factor that seems to be a necessity in order for the EiR TTO-tool to function is the access to new potential entrepreneurs in the regions. This means the presence of educational institutions that can foster new talents in entrepreneurship. All of the TTOs in

Norway, except for Kjeller Innovation, have a link to students doing a masters degree in Entrepreneurship, so the basics in order to use EiR are there. As mentioned in section 5.6.2, Norinnova TTO have problems attracting external entrepreneurs and they are therefore trying to build human resources in the region. EiR could therefore be a tool to increase USO's access to human resources in Norinnova's EES.

6.2.2. HUMAN CAPITAL: SURROGATE ENTREPRENEUR PROGRAM

As mentioned in section 2.4, Surrogate Entrepreneurs (SE) is one of the most used TTO-tools that universities use in order to increase their human capital. These resources are external, individual entrepreneurs who are hired by the university to take on technology-based USOs (Franklin et al., 2001), and for weak entrepreneurial ecosystems that struggle to find competent human resources, this can be an effective way to ensure that their USOs get competent CEOs and management teams. Moreover, the SE-tool will make it easier and less costly for USOs to find necessary human resources. This way, the TTO can act as a portal where USOs who are interested can come and where TTOs can proactively attract new SEs. This will also make it easier for other USOs in the TTO's portfolio to find human resources. For strong EESs, surrogates and startups seem to find each other, likely because of the network of informal and formal contacts mentioned by Van de Ven (1991), as well as network institutions that contribute with fluid flow of human capital. However, for weak EESs, these factors might not work properly, and therefore the TTOs need to take a more proactive role.

One thing to consider about SEs is that they may be expensive, and some TTOs might find it difficult to find the financial means to procure the human resources needed. In fact, several Norwegian TTOs (Inven2, Norinnova TTO, Kjeller Innovation) state that financial resources are important to attract the best people for the jobs. This aligns well with the arguments of Brush et al. (2001) about financial resources being instrumental resources as they can be used to procure other important resources, such as human capital. According to Bård Hall from Norinnova TTO in Tromsø:

> *"We have experienced that in the projects where we have had enough funding to attract the best entrepreneurs, we have succeeded. So it is all about our financial situation."*

The use of SEs might require financial resources, but another aspect of the matter is that these SEs need to have other incentives other than money to come to a region to work. Several of the TTOs who say that they struggle to find competent human capital say that the main problem is to retain the best people in the region, which is an aspect supported by the findings of Neck et al. (2004), elaborated in section 2.4, who state that competent human capital attract other competent people and ultimately even companies and investors. SEs could also come from existing industries, but with little industry to speak of, it is hard to find possible SEs. Prekubator, who have an abundance of large corporations and industry actors seem to have an easier time finding competent personnel that can be of use in USOs.

Another dimension of surrogacy is to allocate TTO-employees full-time as managers of USOs. In practice, the TTO-employee terminates his or her position within the TTO, to take

on a full engagement with the USO. NTNU TTO has done similar approaches, when USOs have needed management personnel. An example is the company Innsep AS where a TTO-employee who had been involved in the screening of the research findings, and assisted the scientist in developing the concept, went in to become the managing director in the company.

> *"Our TTO-employee, Sondre Jacobsen quit his job at our TTO to become managing director in Innsep, a USO who was spun out by NTNU TTO. As an employee at NTNU TTO, you are not allowed to own equity in the projects you are working with. The ownership is strictly related to the commercialization organization, NTNU TTO. It is therefore difficult for a TTO-employee to stay with TTO while being employed elsewhere as an interim manager".*
>
> *- Erik Wold, Head of Venture, NTNU TTO*

6.2.3. HUMAN CAPITAL: ENTREPRENEURSHIP PROGRAM

One TTO-tool that could increase the density of potential USO managers is an entrepreneurship program. One of the main concerns of many TTOs is to attract human resources to their region. This is for example a concern for Norinnova TTO who tries to address this concern by building a stronger culture for entrepreneurship in the region. This way, they wish to develop young talented entrepreneurs in the region and thus mitigating the dependence on external human resources. Erik Wold from NTNU TTO says that the presence of NSE in Trondheim has helped to increase the human capital in Trondheim, and this is also where they mainly recruit their EiRs.

During their two years at NSE, students learn about business strategy, entrepreneurship, and they get to start their own companies alongside their studies. This way, they get managing experience under safe conditions. This means that by being advocators for entrepreneurship and business programs, TTOs can indirectly ensure better access to human capital for their USOs.

6.2.4. HUMAN CAPITAL: STRATEGIC BOARD MEMBER PROGRAM

So human capital might be difficult to find, and even if the access to human capital is there, they might be very costly if they are to be hired as CEOs or in a management team. An interesting TTO-tool for increasing human capital is to implement strategic board member programs, exemplified by Prekubator in Stavanger. The CEO, Anne Cathrin Østebø says:

> *"Access to human capital is success factor number 1! We need two things: people and money. We have access to good people, but the problem is that they cost money. A mechanism we have used in order to get the best people involved in our projects is to get them in as board members. We have achieved most success when we have had investors helping to find the best people."*

This TTO-tool for increasing human capital seems fairly successful in the Stavanger region because they have an abundance of retired Oil & Gas employees who feel like they are not yet ready to stop working (retirement age in the Oil & Gas is 58), so they get involved in

young companies to give advice and experience. By inviting them in as strategic board members, the USO does not need to use a lot of money to hire them, and in turn, they get more credibility as a company, they increase their social capital immensely because, according to Anne Cathrin Østebø, these strategic board members have build up a good network during their working years, and they get invaluable business insight which can mean the difference between failure and success.

Just as with surrogate entrepreneur programs, the TTOs can create portals where they can proactively find and connect people who are interested in joining new ventures as strategic board members with USOs. Strategic board member programs could also make it easier for other USOs in the TTO's portfolio to get access to these human resources. A large industry and an abundance of industry actors who have trust in the work of the TTO are necessary factors in order to succeed with this TTO-tool.

6.3. FINANCIAL CAPITAL AND TTO-TOOLS IN NORWAY

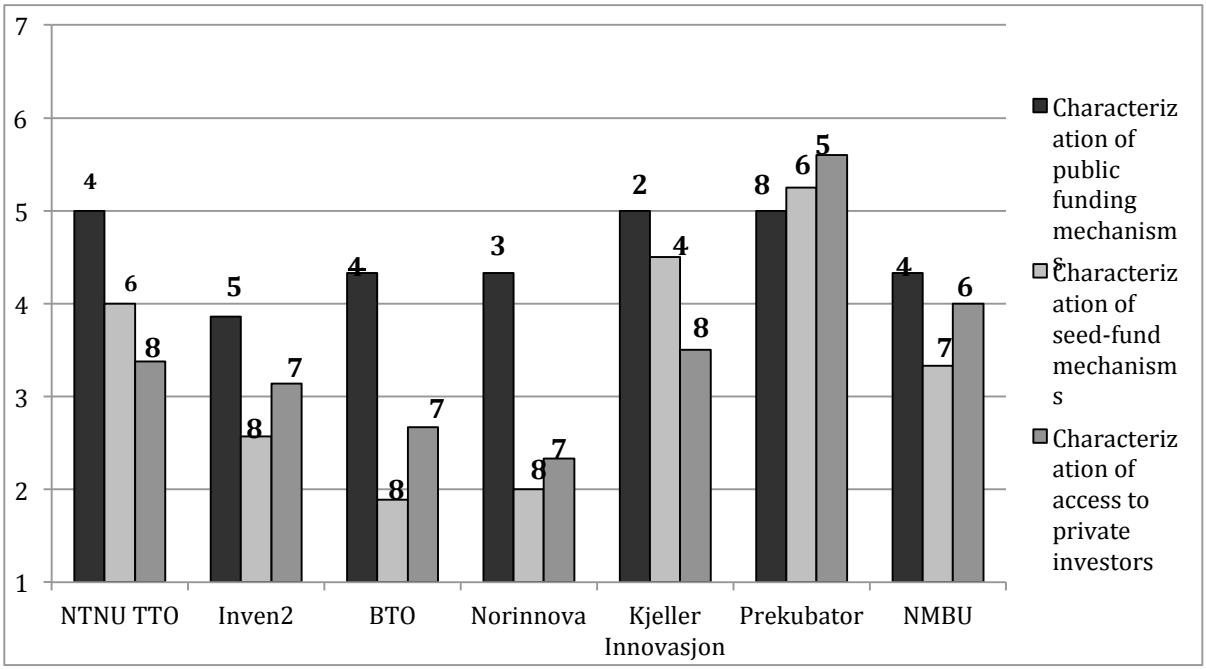

Figure 27 - Overview of the characterization of financial resources in Norway (by employees at TTOs) *

* Numbers above the different TTO-ratings describe the relative rating of financial resources compared to other components in the TTO's EES

Just as for human capital, the figure 27 shows how the employees from the Norwegian TTOs characterize the different mechanisms in their respective regions. One thing that is worth noticing is that with the exception of Prekubator in Stavanger, all Norwegian TTOs feel that access to public funding is better than the access to other funding sources. The peculiar part is that almost every interview object from the Norwegian TTOs mentioned a lack of sufficient government funding as one of their region's biggest problems. This could mean that they all have accepted the low access to private investors, which makes them turn to the government to compensate for the lack of private financial resources.

Another noticeable feature in figure 27 is that of all the TTOs in Norway, NTNU TTO and Kjeller innovation are the only ones that characterize access to seed funding above access to private investors. This is likely due to NTNU Discovery and Akershus Teknologifond which are both mechanisms that have the purpose of giving seed-money to USOs. Both mechanisms will be mentioned as TTO-tools later in the discussion. Seed funding is undoubtedly the funding mechanism that is considered the weakest by Norwegian TTOs. As much as three of seven TTOs (Inven2, BTO and Norinnova) rate this component as the weakest of all components presented in the questionnaire.

In discussing different TTO-tools to increase access to financial resources, we only focus on tools that TTOs can directly influence, thus not taking into consideration fund structures managed by the central government.

6.3.1. FINANCIAL CAPITAL: UNIVERSITY NON-EQUITY FUNDS

As a TTO-tool to ensure more autonomy, Widding et al., (2009) proposes that universities can implement their own university fund to tend to the financial needs of USOs in order to do necessary testing and development to reach proof of concept so that they can become more attractive for investors. They call these funds for University Venture Capital (UVC) funds that imply that they take equity in the projects they invest in. NTNU has however implemented a fund which functions as a non-equity fund. In other words, this fund, which is called NTNU Discovery, offers soft money to potential successes from NTNU (see table 8). Several of the interview objects from the different TTOs in Norway as well as several of our questionnaire-answerers have mentioned NTNU Discovery as the one mechanism that they would want for their region.

> *"Our strategies to make financial resources more available is to implement mechanisms that do not have yield-demands. NTNU Discovery is an example of this."*
>
> *- Anders Haugland, CEO of BTO*

According to Erik Wold from NTNU TTO, they are very happy to have managed to create a collaboration with existing commercial actors, and the government, to create NTNU Discovery, but he also stresses that, even though NTNU Discovery plays an important part in the verification of technologies, the NOK 1.5 million that the most promising USOs receive is still too little. This aligns well with the findings of Clarysse and Bruneel (2007) who state that USOs in the seed-stage might need up to NOK 8 million to reach proof of concept.

NTNU Discovery is, as mentioned collaboration between several actors in the entrepreneurial ecosystem, and this would not have been possible without the trust these actors have over the work that is being done at NTNU. This means that requirements in order to successfully create such a university non-equity fund is a university with eminence who can generate several good cases, regional politicians who understand the value of entrepreneurship, and a TTO that can put this together. The prospect of high university eminence being inducive for success is also supported by Di Gregorio and Shane (2003). Of course all of the Norwegian TTOs would like to have such a mechanism, but there are not many Norwegian universities

who have the same amount of eminence, and a rich entrepreneurial ecosystem (table 8), as NTNU in Trondheim. However, according to Karl Klingsheim, CEO of NTNU TTO:

> *"Getting NTNU Discovery up and running was no magic trick. It was all about hard work from day one. We worked on it for over 1.5 years! Of course it was an advantage that NTNU has an image for being close to industry and in research, but for example UiO is ranked higher than us in almost every ranking. I don't see why other universities couldn't do the same as we did with NTNU Discovery."*

6.3.2. FINANCIAL CAPITAL: EARLY-STAGE SEED FUNDS

Early-stage seed funds are funds which purpose is to help fill the financial gap before private investors. Akershus Teknologifond is an example of such a fund. This is a collaboration between Kjeller Innovation, the government through SIVA and NIK, and Akershus city county. We do not call it a UVC because it is not bounded to any university, but it is a model that several TTOs in Norway admire. Akershus Teknologifond is different from NTNU Discovery because the fund takes ownership in the USOs. However, as we mention in section 5.2, Akershus Teknologifond is able to provide a substantial amount more money than NTNU Discovery. They have since 2009 helped 30 companies by investing around NOK 200 million, which means an average of NOK 6,7 million, which actually is not far from NOK 8 million which Clarysse and Bruneel (2007) found that high-tech USOs needed in order to get through the critical early stages. According to Mariann Ødegård from Kjeller Innovation, Akershus Teknologifond is very much like a venture fund, except it invests primarily in the early development stages and contrary to venture funds, this fund is very close to the research environments and work closely with the TTO. The structure of the fund is illustrated by figure 28.

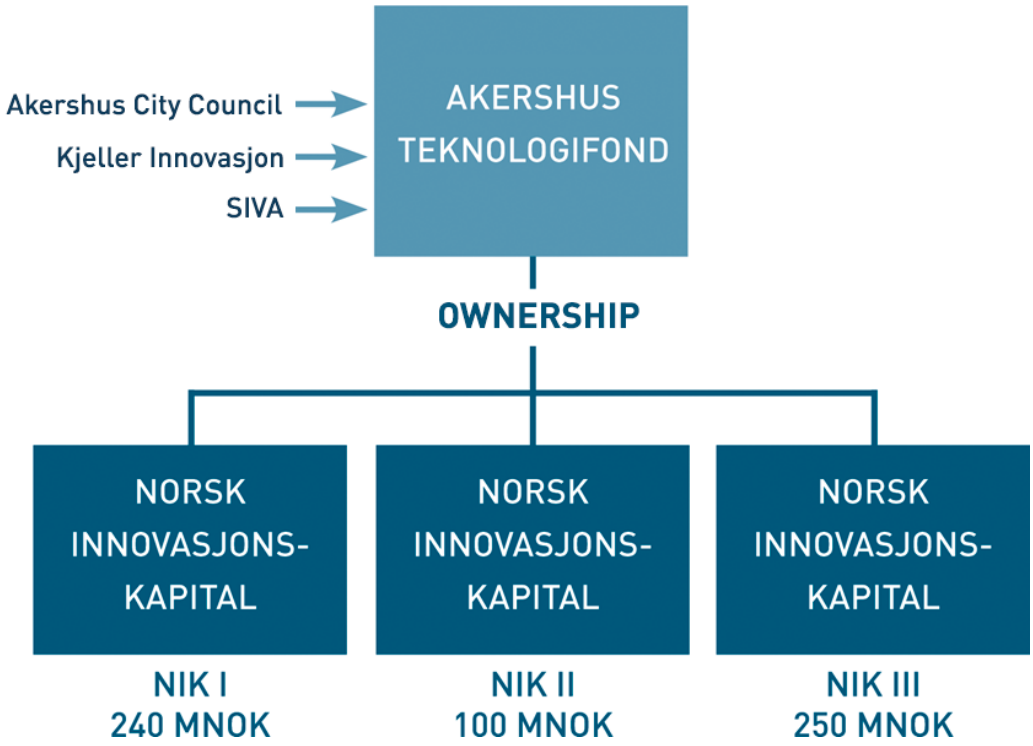

Figure 28 - The structure of Akershus Teknologifond

Compared to NTNU Discovery, Akershus Teknologifond does not have a university link. This is merely collaboration between the TTO, regional environment, and the government and seems therefore like a more suitable TTO-tool in areas where setting up a fund similar to NTNU Discovery might seem hard to do.

It is clear that this fund-structure is working for Kjeller Innovation because they have basically created a venture capital fund that can invest in the early stages where the USOs really need money, and where other VCs are reluctant to invest because they see too much risk. But why cannot every TTO in Norway just implement similar funds in their regions? When asked how they managed to create this fund, Mariann Ødegård from Kjeller Innovation said:

> *"We were very lucky to have regional politicians who saw the value in entrepreneurship. In addition, we could show to a very good deal-flow and good companies who were a result on the work we had done. I believe other TTOs in Norway might have a lack of initial capital. Through our owners, we had around NOK 20 million, and together with the money from the county, we could successfully create Akershus Teknologifond."*

This means that in order for this TTO-tool to be a reality, the region needs to have regional politicians who can see the value in entrepreneurship, TTO-owners who are willing to invest in this concept, and good cases and deal-flow to convince other important actors that this might be something worth investing in.

6.3.3. FINANCIAL CAPITAL: INVESTOR FORUM

According to Breznitz et al. (2008), in order to increase the access to private investors in the region, policy makers at Yale University talked to several investors to convince them to open offices in New Haven.

As previously mentioned in section 2.3, TTOs can diminish USO's resource dependence by playing the mediator role between USOs and investors or other financing sources. Erik Wold from NTNU states that it is mostly about the relationships that they manage to build with the investors. This means that by building relationships with the investors, they hope to even out the power balance between the TTO and the investors. This will again make it easier for USOs when they get in contact with the investors.

NTNU Accel is also a tool to bridge the connection between USOs and investors. Investor Day at NTNU Accel gathers all the investors in the Trondheim region together with promising USOs, and during this meetup, every organization get to shortly present themselves, both the investors and the USOs. Norinnova has a similar initiative called "Capital-day". These programs are still fairly new, so it is difficult to say whether they will be successes or not.

6.3.4. FINANCIAL CAPITAL: TTO-FIN FORUMS

As mentioned in section 4, TTOs in Norway are all members of FIN. Through TTO-FIN forums, TTOs can put forward their wishes for improvements, primarily politically. Because of the established relations between politicians and FIN, it can be beneficial for TTOs to use a strong political communication channel to influence government and other decision makers on important policy issues instead of doing this themselves. A specific activity within this forum can be to arrange conferences to highlight certain challenges that are shared by TTOs in Norway. An example of a topic could be to address the importance of the abovementioned pre-seeds fund, because of its absence in Norway.

Today's lobbying is fragmented, because some TTOs have established own organizational structures for lobbying. Some TTOs have also created their own mechanisms to be less dependent on governmental resources, i.e. NTNU TTO and Kjeller Innovasjon has their own fund system for early-stage financing. The governmental contributions in the early stage are critical, but less crucial for these TTOs compared to other TTOs, that are more dependent on national seed funds to gain access to financial support for the USOs. FIN is a advocator for this case, and the proposition for the government budget 2015 can be viewed in Appendix 8.

For this TTO-tool to be a reality, the TTOs needs to regularly interact with FIN, which again needs to further increase the communication with political actors. Doing this, TTOS can have a decisive influence, so that they can get political support behind their wishes and propositions.

6.4. ACCESSIBILITY OF MARKETS AND TTO-TOOLS IN NORWAY

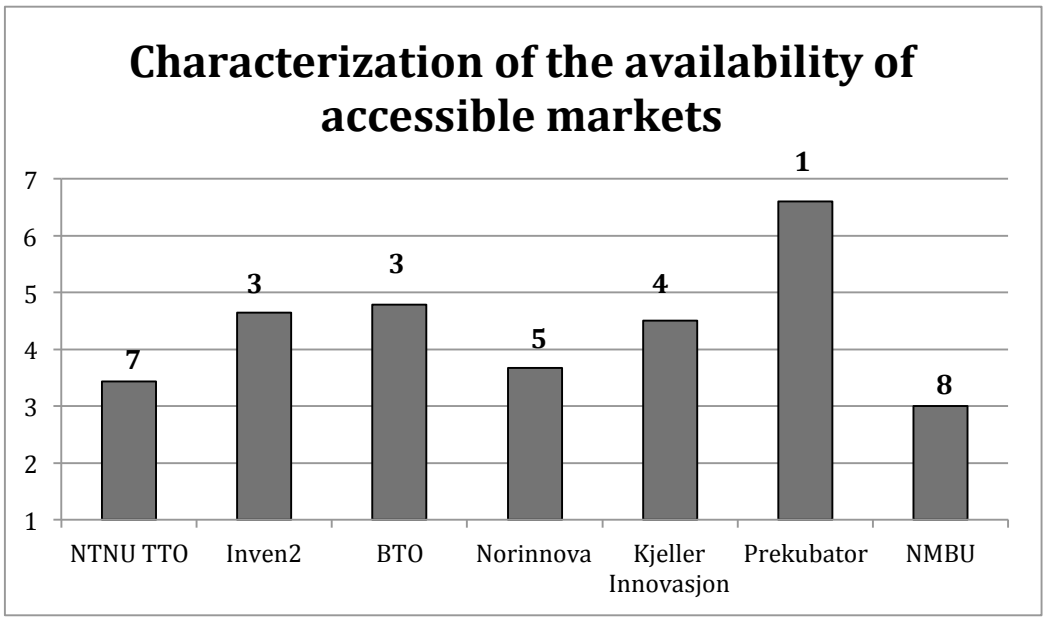

Figure 29 - Characterization of the accessibility of markets in Norway

(by employees at TTOs)*

* Numbers above the different TTO-ratings describe the relative rating of accessible markets compared to other components in the TTO's EES

Figure 29 shows how employees at the different TTOs in Norway characterize the accessibility of markets in their region. It is very clear that employees at Prekubator believe they have a very strong link to the industry. This market is primarily the Oil & Gas industry, but this is also where Prekubator allocates most of their efforts. This could explain why Prekubator seem to be having such a good coverage of funding, human capital, and markets to their projects. Looking at how Brush et al. (2001) defines instrumental resources, accessible markets could very well fit this definition, because through this, one can get access to other resources. Strong accessibility of markets will for example give access to both financial and human capital. Bård Hall from Norinnova emphasizes the importance of an existing industry by stating:

> *"We need a better collaboration between industry and the commercialization actors. Today, we have to sell in the technology instead of getting pull from the industry. We don't get enough respect for what we are doing."* *- Bård Hall, CEO Norinnova TTO*

6.4.1. ACCESSIBLE MARKETS: ACCEL-PROGRAMS

In section 2.4, we bring forth Mustar et al. (2008) who state that industry actors will be interested in working with a university if it has good reputation for research and a critical mass in the area. These two conditions are both covered for NTNU, but as Erik Wold says, there are very few large corporations in Trondheim. As a tool to ensure more industry relations to USOs are the Accel-programs initiated by NTNU TTO and BTO (see table 8). The purpose of Accel-programs is to connect relevant industry actors on both the supply-side

and the distribution side with the USOs. In 2013, SIVA supported the building of NTNU Accel with NOK 1 million and the CEO of SIVA, Erik Haugane, stated then:

> *"Many people believe that it is a given that generating startups is easier in the bigger cities. This is not always the case. In Trondheim, as an example, one has plenty of technology, but there is a lack of industry actors. NTNU Accel is a mechanism to compensate for this issue."*

The very thing that makes the building of accel-programs possible is that the industry in the region need to collaborate to 1) put a fund together (e.g. Accel Preseed AS in Trondheim), and 2) help the promising new ventures through mentorship and network by putting them in contact with other industrial players that might not even be in the same region

Necessary factors in order to succeed in establishing such programs are therefore industry actors who are interested in participating in building a stronger market, and a TTO and university who is willing to invest resources in establishing such an actor in the region. The fact that there is a lack of large corporations in Trondheim gives more reason to take action in making sure that there are linkages between USOs and industry.

6.4.2. Accessible markets: Networking events

In order to create linkages between USOs and industry actors, many TTOs arrange networking events. Attendees at such events could be entrepreneurs, investors, industry actors, TTO-employees or other people interested in entrepreneurship. Entrepreneurs will be interested in these events because this is a good way to meet potential investors or mentors, as well as meet other people that can give constructive advice regarding the entrepreneur's business. Investors would be interested in discovering potential winning projects as well as build on the relationships they have with other investors, TTOs or industry actors. Several industry actors are interested in the research that goes on within universities because these could be interesting technologies for them. This was for example the case for Innsep AS and Statoil, mentioned above. Employees at Inven2 state that they are very good at arranging meetups, and believe that this is an important success factor for them. This aligns well with the findings of WEF (2013), elaborated in section 2.4, where they say that industry relations can give customers, industry insight, access to suppliers, technology facilities, access to know-how, and other industry factors that could accelerate the growth of the company. Employees at Inven2 claims that they have been very good at arranging such meetups and that this have show to give a positive effect on their projects. Creating meeting arenas is an effective way of boosting USO's social capital, which Garnsey and Heffernan (2005) claim to have a big influence on firm performance.

In order to successfully create meeting arenas, TTOs need to succeed in bringing in industry actors from outside the region. In areas where industry actors are less available, the TTO needs to do other measures to connect USOs with industry actors. In section 5.6.2, we introduce Norinnova's mechanism for doing this - Arena Biotech North, which is a regional biotechnology cluster, where several important industry actors are gathered to make Tromsø the Norwegian hot-spot for cold biotech.

7. TTO-TOOLBOX AND CONCLUSIONS

Table 9 - TTO-toolbox

Improving what component?	TTO-tool	In which TTO	Success factors
Human capital	Entrepreneur in Residence program	NTNU TTO	▪ Education of entrepreneurs ▪ Mutual trust between TTO and University
Human capital	Surrogate Entrepreneur program	All	▪ Financial resources ▪ Incentives to make people want to stay in the region ▪ Industry that foster potential SEs
Human Capital	Strategic board member program	Prekubator	▪ Abundance of industry personnel ▪ TTO-credibility
Human Capital	Entrepreneurship programs	NTNU TTO	▪ Industry-university collaborations ▪ University culture for entrepreneurship
Financial capital	University non-equity funds	NTNU TTO	▪ University-eminence ▪ Regional politicians who understands the value of commercializing research findings
Financial capital	Early-stage seed funds	Kjeller Innovation	▪ Money-strong owners ▪ Regional politicians in favor of entrepreneurship ▪ TTO with good deal flow to convince stakeholders
Financial capital	Investor forums	All	▪ Availability of investors and financing sources ▪ TTO with good deal flow ▪ University eminence
Financial capital	TTO-FIN forums	None	▪ Communication through FIN ▪ Direct lobbying
Accessible markets	Accel-programs	NTNU TTO and BTO	▪ Industry actors, regional politicians and TTO interested in building entrepreneurial culture
Accessible markets	Networking events	All	▪ Relevant industry actors interested in building local indstry

The TTO-toolbox presented (table 9) illustrates some of the different tools that Norwegian TTOs use in order to address imperfections in their respective entrepreneurial ecosystems. The TTO-toolbox we are presenting is not complete, and should not be viewed as such under any circumstances. What it is is a collection of tools that TTOs can choose to use in order to address imperfections in their respective entrepreneurial ecosystems. In other words, these are tools TTOs can use to make resources more available to USOs and thus diminishing their resource dependency.

As we say in section 2.6, weak entrepreneurial ecosystems are not fixed entities. This means, that just as we say simply turning to a selective and supportive TTO-mode when dealing with weak entrepreneurial ecosystems will not work in most cases, the same thing can be said about TTO-tools. Even though a TTO-tool might work seamlessly in one region, it does not imply that one simply can copy this to another region, because this other region might not have the necessary conditions or the need to successfully implement the TTO-tool. For example, one of Prekubator's tools to increase human capital is to attract strategic board members to their USOs, which is possible because they have access to many retired Oil & Gas employees who still have capacity to work, and because Prekubator can showcase a good deal-flow which makes it lucrative for these people to join new ventures. These requirements, especially the first one, are hard to meet for several regions in Norway, and therefore it will make sense for these to use other TTO-tools to deal with increasing human capital. Another mechanism to do so is to do EiR-programs that NTNU TTO is an advocator for. This program takes in young and eager entrepreneurs as regular TTO-employees, with the possibility of being assigned as part of the management team and thus increasing the access to human capital for USOs. Implementing this tool would not have been possible without the close proximity to graduates from industrial economics and entrepreneurship. TTO leaders looking to use our TTO-toolbox should therefore first and foremost ask themselves the following:

1. What are the main weaknesses in my region that mostly inhibit our USOs from getting access to the resources they need?
2. Are there any factors in our region that could help us? For example a strong university, access to students, access to industry, well-willing regional politicians, etc.
3. What TTO-tools should we use to limit the consequences of weaknesses in our entrepreneurial ecosystem?

FINDINGS ABOUT THE NORWEGIAN CONTEXT

In addition to the TTO-toolbox mentioned above, our research has found that Norway still has a tremendous improvement potential in inducing the commercialization of research findings. The following will give short summaries of our findings with respects to policies, human capital, financial resources and the accessibility of markets in Norway.

POLICY

Leaders at the Norwegian TTOs emphasize the importance of more financial resources from the government. These TTO leaders emphasize especially two things:

1. Better incentives for investors so that more investors are willing to invest earlier
2. Increased government funding to commercialization efforts (e.g. FORNY2020)

HUMAN RESOURCES

- Availability of human resources, personnel that have the capabilities to go in and manage USOs, is generally weak. TTOs are keen on building the entrepreneurial culture in their respective regions in order to increase the access to human resources
- Surrogate entrepreneurs are often used as a tool to increase human capital, but these may be too costly at times, and some TTOs even struggle to attract these resources to the region because of non-monetary reasons. Hence the need to focus on building better entrepreneurs within the region

FINANCIAL RESOURCES

- The availability of financial resources is very different from region to region and it is very contingent on the characteristics of the industry structure in the region. For Oil & Gas projects, Prekubator in Stavanger have financial mechanisms in every stage of the USO's development. This is because of industry actors who are willing to help and invest in USOs, but also because of financial push from the government. USOs related to other industries generally struggle to find sufficient financial resources
- There is a lack of funding to do the testing and development needed in order to reach proof of concept and thus diminishing the risk for private investors
- TTOs look to the government to help fill this funding gap and a unanimous Norwegian TTO community states that the funding mechanisms from the government (FORNY2020) is way too small. There lies a great frustration amongst TTO-leaders around the fact that the government uses NOK 24 billion in research and only around NOK 140 million in commercialization efforts.
- TTOs look up to NTNU Discovery and Akershus Teknologifond as mechanisms that can give them more autonomy with respect to filling the funding gap, but implementing such funds require a collaboration between the TTO, regional politicians, local industry and government

ACCESSIBLE MARKETS

- TTOs utilize their network to bring USOs closer to investors and industry actors
- Accessibility of markets is weak in many Norwegian regions, and even though there might be industry present, the relationships between TTOs and industries could be much stronger in many Norwegian regions. This is for example the case in Bergen according to Anders Haugland at BTO. Stavanger is the only region where the access to large industry actors seems satisfactory
- TTOs arrange meetups between USOs and industry actors in order to increase the access to industry actors and customers

8. IMPLICATIONS AND LIMITATIONS

To finish this report, we will elaborate on implications for further research, policies and implications for our unit of analysis - TTOs. Lastly, we will end with the limitations we have put on this report.

8.1. IMPLICATIONS

IMPLICATIONS FOR FURTHER RESEARCH

This research has found that simply turning to Roberts and Malone's (1996) support-selectivity typology is too generalizing in order to correctly handle EESs. This is especially true for weak EESs that have a tendency to be very complex entities. For further research focusing on EESs, this implies that instead of concluding that weak EESs require high supportive and selective TTOs, it is necessary to take into consideration external conditions because these conditions might have grave influence on the TTO's prospects, in addition to internal conditions.

IMPLICATION FOR POLICYMAKERS

We have found that TTO-leaders all around Norway believe that the amount of financial resources allocated to commercialization efforts is insufficient and that FORNY2020 should be increased by 3-4 times. The difference between financial resources allocated to research and resources to commercialization is especially remarkable (NOK 24 billion to research vs NOK 107 million to commercialization). It is important to focus on research, but if the commercialization actors do not get the means to follow up on all the ideas that emerge, a lot of potential value could be lost. For policy makers, this means that current policies need to be reviewed and perhaps revised.

Another finding from our analysis is that there should be better incentives for investors so that they will be more willing to invest in new ventures instead of investing in real estate or other more risk-averse investments. Policy makers in Norway should therefore consider looking at countries such as Holland (see section 2.4 under funding and financing) who have succeeded in implementing policies that ensure tax-reductions for investors investing in start-ups (Wright et al., 2006). Today, investors in Norway are very risk-averse and they seldom invest before proof of concept. For USOs, reaching proof of concept might be very costly, hence the funding gap we present in section 2.4. Implementing better tax-incentives for investors might contribute in filling this gap.

In doing this research it has become more and more obvious for us that the government, as stated by Rasmussen et al. (2007) should allocate financial resources where it matters the most. Looking at Prekubator, they state that in Oil & Gas, they have a good value chain for financing where they actually have sources of funding in every stage of development. Having this kind of coverage in financial resources has had good effects on the value creation in Stavanger. What could this mean for government policies? Does this mean, that instead of allocating financial resources broadly across the country, the government should rather focus on the biggest regions? Perhaps a good approach would be to focus TTO-efforts to the

biggest cities/markets such as Prekubator, Inven2, NTNU and BTO? It seems that getting access to critical resources is easier when operating in the big cities or the strong ecosystems. This could be the reason why many tech-startups in the US move to Silicon Valley, and why Soundcloud from Sweden moved to Berlin - to get closer to these essential resources.

IMPLICATIONS FOR TTOS

One of our main contributions in this research is our critique on Roberts and Malone's (1996) Support-selectivity typology. We believe, that simply implementing high support/selective TTO-modes when dealing with weak EESs is not enough. Being a weak EES is not a fixed condition and there might therefore be several ways to handle the imperfections within these ecosystems. However, when dealing with weak entrepreneurial ecosystems, one can either be case selective, industry selective, or both. No matter what the TTOs choose, the decision must be made with respects to environmental and internal conditions. We argue that most TTOs in Norway would be better off with a case selective TTO-mode, but what would this imply for the TTOs? In order to successfully nurture USOs using the case selective approach, it is necessary to ensure access to human resources with a broad range of expertise. This is because a case selective approach implies taking in potential winning projects regardless of technology or industry. For many TTOs in Norway, this would mean hiring external entrepreneurs. However, by using more time on picking potential winners, we believe TTOs in weaker EESs could have better usage of their resources.

We have interviewed all TTOs in Norway, and created a TTO-toolbox that is a collection of different mechanisms used by Norwegian TTOs to ensure resource access to their USOs. For each of the tools in the TTO-toolbox, there are important success factors that need to be present in order to successfully implement the tool. This means that for TTOs who want to use this TTO-toolbox in the future, it is necessary to first examine their external environments and find out whether or not they have the correct conditions to implement the tool in question.

8.2. LIMITATIONS AND FURTHER RESEARCH

One of our most controversial abstractions from theory is the link between RDT and TTOs, and TTO's ability to decrease USO's resource dependence by helping them get access to external actors who hold important resources. By studying RDT and RBT, and by learning about USOs and the purpose of TTOs, it became clear to us that the power balance between new ventures and actors in the entrepreneurial ecosystem that hold the resources which the new ventures so desperately need is uneven. Due to the unique characteristics of USOs, this is especially true for them. TTOs however, may have had successes with earlier projects, and may have collaborated with the resource holders before. This means that the power balance between the TTO and the resource holders could be much better, and by representing the USOs, the TTOs can help to decrease this resource dependency. However, this notion has not been fully investigated yet, and should therefore be researched further before one can be sure when using this link in further research. A more extensive research focusing on USOs and resource dependence is needed to understand the special resource needs of USOs. In addition,

a research focusing on technology transfer and RDT is needed in order to understand the impact TTOs can have on the resource dependence of USOs.

Moreover, it seems to be one factor that both theory and practice emphasizes as the most important for USOs - funding and finance mechanisms. In the Norwegian context, this is no different, and it is especially government funding mechanisms and tax-incentives that many of our interview subjects have mentioned as being too weak. A comparative study between Norway and other countries that have succeeded better with respect to government engagement (e.g. Sweden) could be helpful to understand where Norway has the most potential to improve. This study could for example seek to answer the research question:

"How should governments support research based entrepreneurship?"

FOCUS ON EXTERNAL FACTORS

This research focuses on external factors and therefore we have not taken into consideration relevant factors within the universities that have influences on USOs and technology transfer. The reason why we chose to do so is 1) we wanted to focus mostly on entrepreneurial ecosystems, which implies an external focus, and 2) we had to limit ourselves in order to get a realistic scope in our research.

THE SCOPE OF RESOURCES

When we refer to resources we have intentionally chosen not to consider the quality of the resources but merely the access to resources. The reason why we have done this is because we already have a large research scope, and including the sizing of all the different resources and defining what "good" is and what "better" is would be too comprehensive for our research. We recommend that further research that want to investigate resources and the quality of resources to focus on only one or two different resource components. Thus making it easier to do a more in-depth investigation.

FOCUS ON HUMAN CAPITAL, FINANCE AND FUNDING, AND ACCESSIBLE MARKETS

Another limitation we had to make to narrow our scope was to focus on the three components that we found to be the most important ones for USOs. This is a clear limitation as this limits us of getting an overall picture and understanding of the components in EESs. Several of our interview subjects mentioned that it was hard to separate some components from one another because often they might be intertwined. Support actors could for example be intertwined with human capital, accessible markets, financial capital, and even entrepreneurial culture. A research that takes all components within the entrepreneurial ecosystem into consideration could therefore be better to grasp all the details.

DEFINITION OF SPIN-OFFS

The definitions of spin-offs in the literature have been widely discussed in different contexts in different regions of the world. The complexity of the definitions increases when researchers are treating the spin-off phenomenon from different levels; firm-level, industry level and governmental level. This has led to a large disparity in research findings based on the variety in research starting points. Because this research has laid the foundation for the content in our literature review, analyzing the literature has been a challenge due to the

different characterizations of spin-offs. Spin-offs from research institutions are for example often referred to as; Academic spin-offs (ASOs), University spin-offs (USOs), Research Based spin-offs (RBSOs), and New Technology Based Firms (NTBFs). There is therefore a limitation that we have treated spin-offs in our own definition, but conducted the research based on research material from a variety of definitions and assumed that they have the same characteristics as our definition of spin-offs.

FOCUS ON NORWAY

We have consciously chosen to focus on the Norwegian context because we believe it is interesting to investigate the differences and similarities in technology transfer inside one country. However, this is a limitation because there might be many important factors that we have missed because they might be not relevant in Norway. A positive thing about focusing on a small and transparent country such as Norway is that it is easy to get access to the information that we need and people are very willing to help students. However, in order to gain a full understanding of how TTOs in weak entrepreneurial ecosystems address imperfections in their ecosystems, a more extensive research covering several countries is needed. The low generalizability of this research is therefore a limitation due to the treatment of only one case country, and that there can exist other TTO-activities in other countries.

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APPENDIX

A1 - DIFFERENT USO DEFINITIONS

Authors	Year	Definitions	Who	How	What
Carayannis et al.	1998	A new company formed by individuals who were former employees of a parent organization (the university), around a core technology that originated at a parent organization and that was transferred to the new company	Former employees at the university	Must leave the university	Originated at parent organization
Pirnay et al.	2003	New firms created to exploit commercially some knowledge, technology or research results developed within a university	Unclear	Unclear	Originated from the university
Klofsten, M. and Jones-Evans, D.	2000	Formation of new firm or organization to exploit the results of the university research	Unclear	Unclear	Originated from the university
Shane	2004	USOs are companies founded to exploit a piece of intellectual property created in an academic institution. Companies established by current or former members of a university	Current or former members of a university	Can stay as employee at the university	Originated from an academic institution

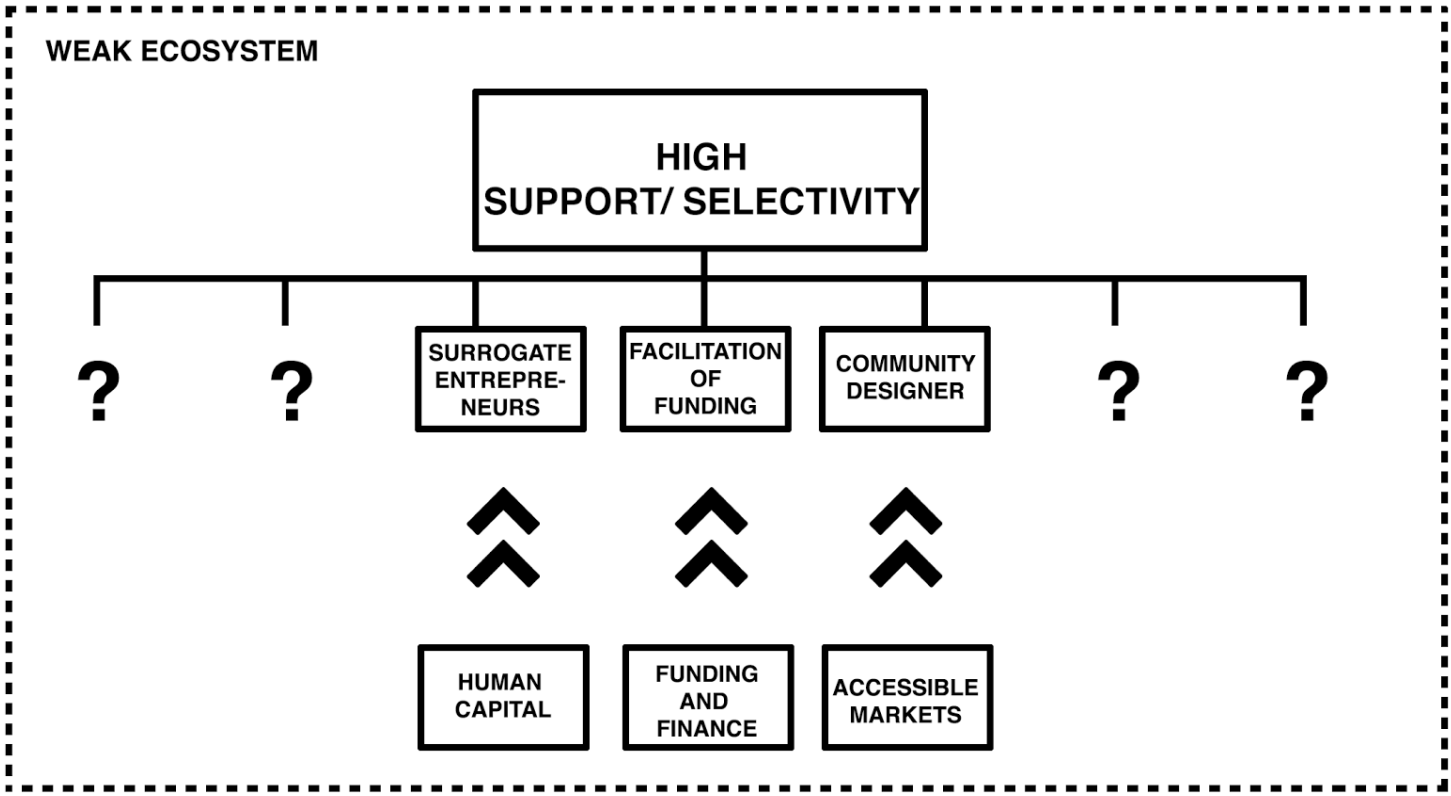
A2 - INVENTION EVALUATION CRITERIA

(Source: Retrieved from Bradley et al., 2013)

Criteria	Description
Revenue potential	Most universities consider explicitly if the invention is marketable as part of their patenting decision (Jensen and Thursby, 2001)
	The most important objective to the TTO is royalties and fees generated (Thursby, Jensen, and Thursby, 2001)
	TTOs focus their time and resources on technologies that can give the biggest and fastest financial return (Litan et al, 2007)
	The cost of patenting is only worth it, if royalties from licensing those patents exceed the costs of patenting (Shane, 2004)
	TTOs normally focuses on short-term cash maximization and are extremely averse to legal and financial risk (Siegel, 2011)
Licensing potential	If a potential licensee is identified, many universities tend to apply for patents conditionally on that specific identification (Jensen and Thursby, 2001)
Academic field of the invention	Certain fields of research are more likely to have invention disclosures. Some of them include pharmaceuticals, engineering, and biotechnology (Thursby et al, 2001)
	TTO must understand the field of research, and then evaluate where the technology is moving in order to determine whether to patent or not (Siegel et al., 2004)
Competitiveness	A revolutionary technology is much more valuable to the industry than an evolutionary. The more revolutionary the technology is, the less likely is it that competitors can come up with the same technology (Goldhor and Lund, 1983)
Extensibility	The discovery of a new technology can form the basis of a variety of products and processes, and can thus be extended by a firm's research in the future (Goldhor and Lund, 1983). TTOs are therefore more likely to patent inventions that has a broad commercialization potential.

A3 - CONCEPTUAL FRAMEWORK FOR STUDYING EXTERNAL IMPACT ON TTO-STRATEGIES TO CREATE USOS

(Source: Olsen&Balasingham, 2013)



A4 - INTERVIEW GUIDE - TTOS IN NORWAY

Part 1. Contextual parameters

- Background of the Technology Transfer Office?
- Overall strategy of the TTO and relations to university?
- Number of employees
- Yearly revenue
- Number of deals per year
- Licensing vs. USOs
- Organizational build-up
- Ownership structure
- Joint collaboration with industry partners
- What is the purpose of this TTO?
  Can you try to paint a "perfect future" for your company?
  What are your main obstacles in order to achieve this "perfect future"?

Part 2. Characterization of the Entrepreneurial Ecosystem
(Inspired by Isenberg, 2010)

We recommended the interview candidates to be specific when answering these questions

Culture

- Are there visible success stories that inspire young entrepreneurs?
- Does the culture at large: Tolerate honest mistakes, risk taking, and contrarian thinking?
- Do the society respect entrepreneurship as a worthy occupation?

Supports

- Are there venture-oriented professionals, such as: Lawyers, accountants, and market and technical consultants who will work with USOs on a contingency basis, or for equity?

Policy

- Do public leaders act as strong, public advocates for entrepreneurship?
- Does government create effective institutions directly associated to entrepreneurship, and remove barriers to entrepreneurship?
  (Regional and National)

Human capital

- Are there educational institutions that:
  - Teach financial literacy and entrepreneurship to high school and college students?
  - Allow faculty to take sabbaticals?

Funding

- Are there funding sources that:
    - Provide equity capital for companies at a pre-sales stage?
    - Add non-monetary value, such as mentorship and contacts?

Accessible markets

- Are there geographic locations that have: Concentration of high-growth ventures? Access to customers?
- What are the main jobs in the region? What types of industry are present?

Part 3. Characterization of TTO-modes

- Which measures are you using to increase the access to limited resources in the region?
- Can you go more into detail on what kind of measures you are doing in order to increase the rate of USOs or deal-flow?
- Do you focus on specific technologies?
- How do you support your inventors/USOs?
- How much do you see yourself as the "community facilitator"?
- How do you attract competent people that can lead the technology transfer process?
- How do you ensure a relation to the surrounding industry? And how do you take advantage of this relation?
- What do you do to make sure that the projects you are working with can get enough funding?

Purpose of the interviews

- Characterize all TTOs and find differences and similarities
- Get an understanding of the entrepreneurial ecosystems in Norway
- Map out similarities and differences in TTO-activities

Thus, with each TTO, we wish to end up with:

- Characterization of the entrepreneurial ecosystem
- Specific TTO-modes being used to address imperfections in the ecosystem
- Verify or disprove our propositions from our project thesis? It might be, that we find that some TTOs implement other TTO-modes in order to address the same imperfections.

A5 - QUANTITATIVE INTERVIEW QUESTIONS

Mapping entrepreneurial ecosystems and TTO mechanisms to address ecosystem imperfections in Norway

1) Which TTO do you work for?

Characterization of the entrepreneurial ecosystem components

2) Culture

Culture for entrepreneurship is about how people in the region perceive the notion of entrepreneurship and whether or not the region has success stories that can inspire young entrepreneurs.

How would you characterize the culture for entrepreneurship in your region?

1 - 7

3) Supporting actors

Supporting actors are actors in the region that can support entrepreneurial activity in the region. This could be business developers, advisors, accountants, lawyers or people with industry experience.

How would you characterize the access to supporting actors in your region?

1 - 7

4) Government contributions

Government contributions are about how the government facilitates and promotes entrepreneurship and the commercialization of research findings, for example through financial mechanisms.

How would you characterize the degree of government contributions to your region?

1 - 7

5) Human capital

Human capital is about having experienced entrepreneurs and/or strong technology experts in the region that can manage USOs.

How would you characterize the human capital in your region?

1 - 7

6) Public funding

Public funding are financial mechanisms from governmental initiatives such as the FORNY-program, Innovation Norway, or other regional funds.

How would you characterize the amount of public funding in your region?

1 - 7

7) Seed-funds

Seed-funds are early-stage investments that come in earlier than private investors.

How would you characterize the amount of seed-funds in your region?

1 - 7

8) Private investors

Private investors are business angels or other public or private risk capital.

How would you characterize the access to private investors in your region?

1 - 7

9) Accessible markets

Accessible markets is about having access to relevant industry for the USOs in the region.

How would you characterize the accessibility of markets in your region?

1 - 7

<u>Importance of components in the entrepreneurial ecosystem</u>

Ranking:

Not important -- Less important -- Neutral -- Important -- Very important

10) How would you rank the following components with respects to their importance for USOs?

- Culture
- Support actors
- Government contribution
- Human capital
- Funding mechanisms
- Accessible markets

11) Comments about the ranking of components?

12) In order to achieve better culture in our region, we have done the following:

- Arranged meetings and arenas
- Used previous success stories
- Urging people to attend meetups

Ranking:

Never -- Very rarely -- Rarely -- Often -- Very often -- Always

13) Other comments on the above?

14) In order to increase our relation with supporting actors, we have done the following:

- Established collaboration agreements

Ranking:

Never -- Very rarely -- Rarely -- Often -- Very often -- Always

15) Other comments on the above?

16) In order to increase the contribution from government, we have done the following:

- Used FIN as our political communication channel
- Our own lobbying

Ranking:

Never -- Very rarely -- Rarely -- Often -- Very often -- Always

17) Other comments on the above?

18) In order to increase our access to human capital, we have done the following:

- Used surrogate entrepreneurs
- Hired newly educated business or entrepreneurship students
- Educated our own employees
- Used industry actors

Ranking:

Never -- Very rarely -- Rarely -- Often -- Very often -- Always

19) Other comments on the above?

20) In order to increase our access to funding mechanisms, we have done the following:

- Established our own fund
- Foster relationships with investors
- Collaboration with industry actors
- Urged owners to contribute more

Ranking:

Never -- Very rarely -- Rarely -- Often -- Very often -- Always

21) Other comments on the above?

22) In order to increase our relations with existing markets, we have done the following:

- Established meetups and arenas
- Urging newly established USOs to stay in the region

Ranking:

Never -- Very rarely -- Rarely -- Often -- Very often -- Always

23) Other comments on the above?

24) How would you say the amount of staff in your organization is? Do you feel that you can handle the dealflow?

Ranking:

1 - 7

25) How would you characterize the degree of contribution from owners?

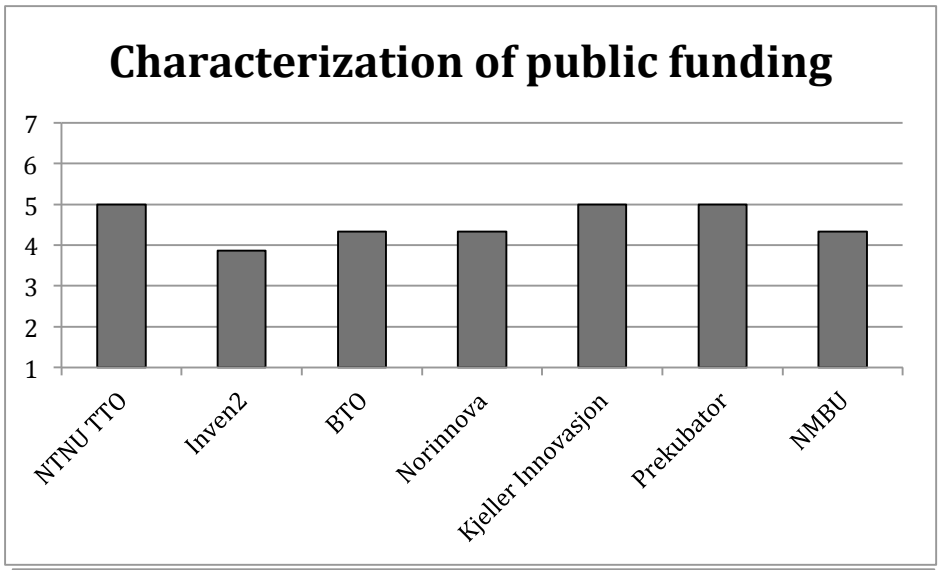
Ranking:

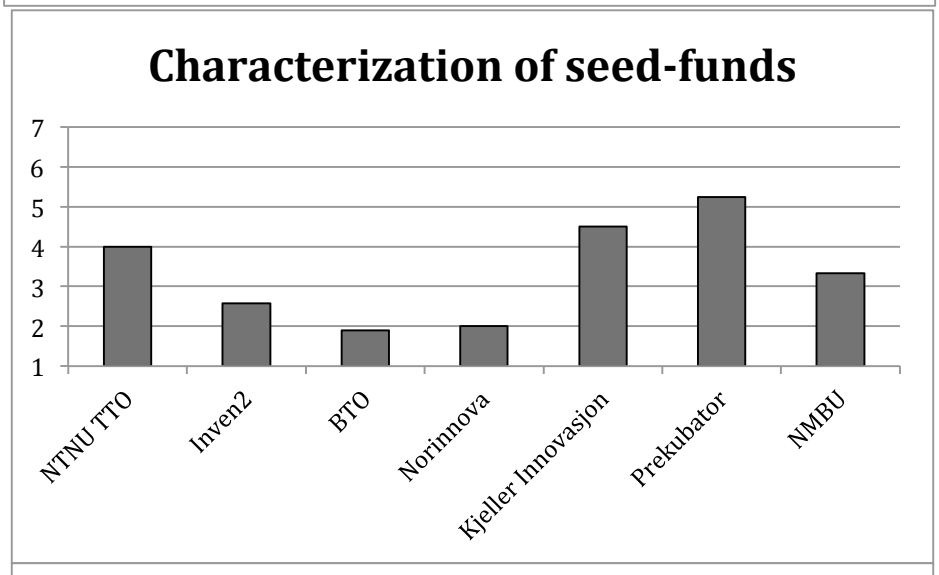
1 - 7

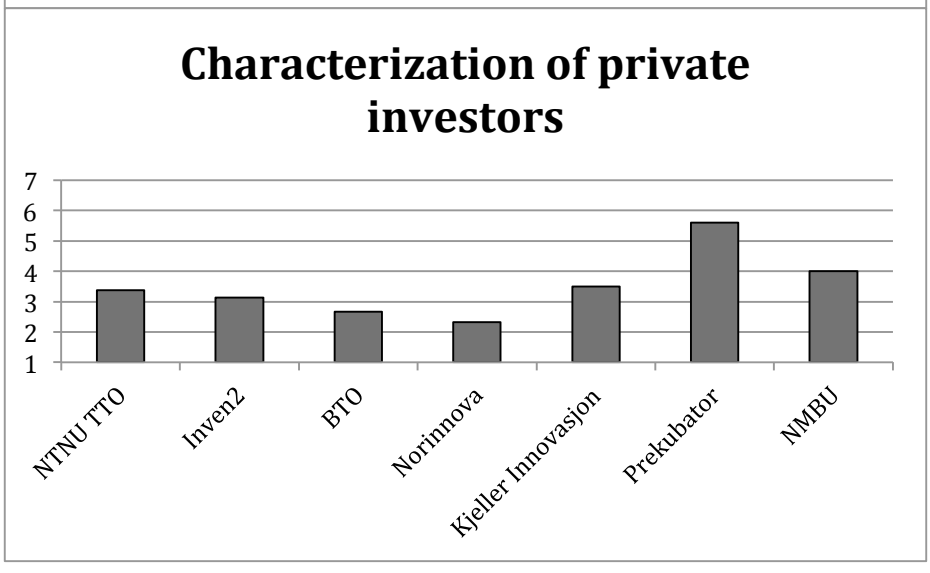
26) Which mechanisms do you miss for your organization? In other words, what kind of mechanisms do you see other TTOs in Norway have that your organizations do not but should have?

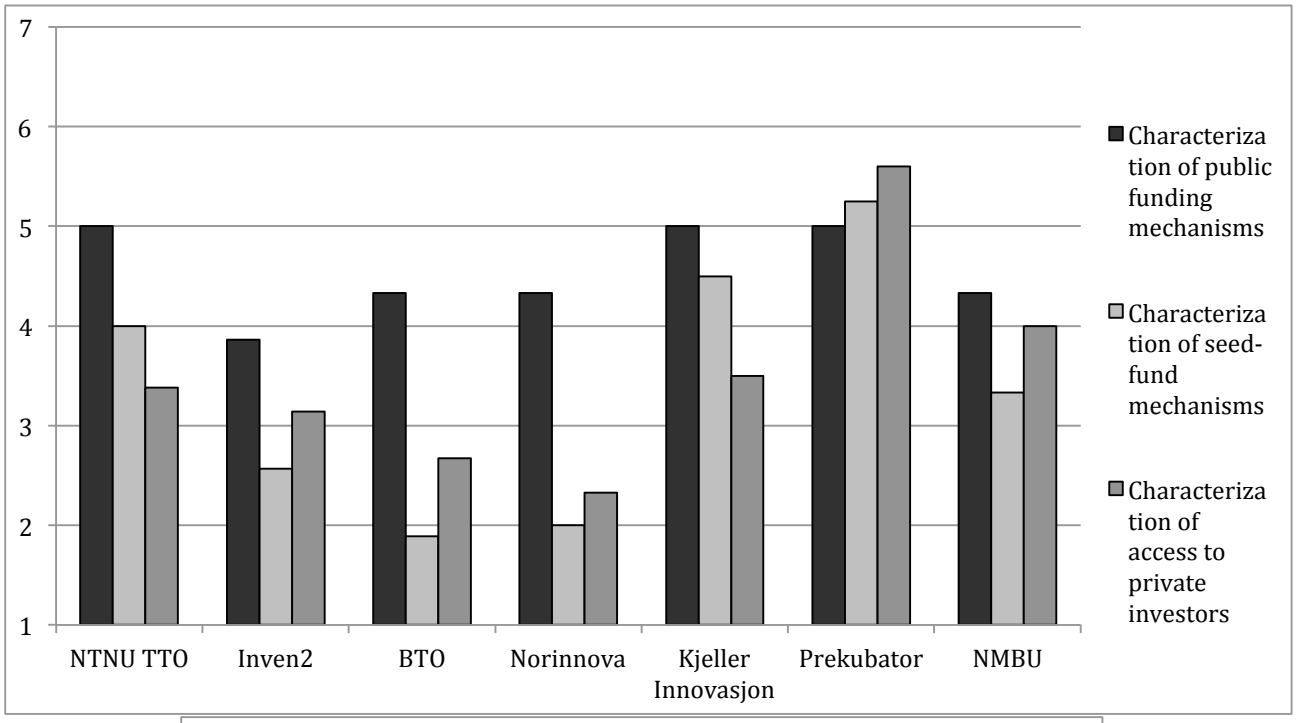
27) Which mechanisms do you think your organization is especially successful in using?

A6 - CHARACTERIZATION AND IMPORTANCE OF COMPONENTS IN NORWEGIAN ENTREPRENEURIAL ECOSYSTEMS





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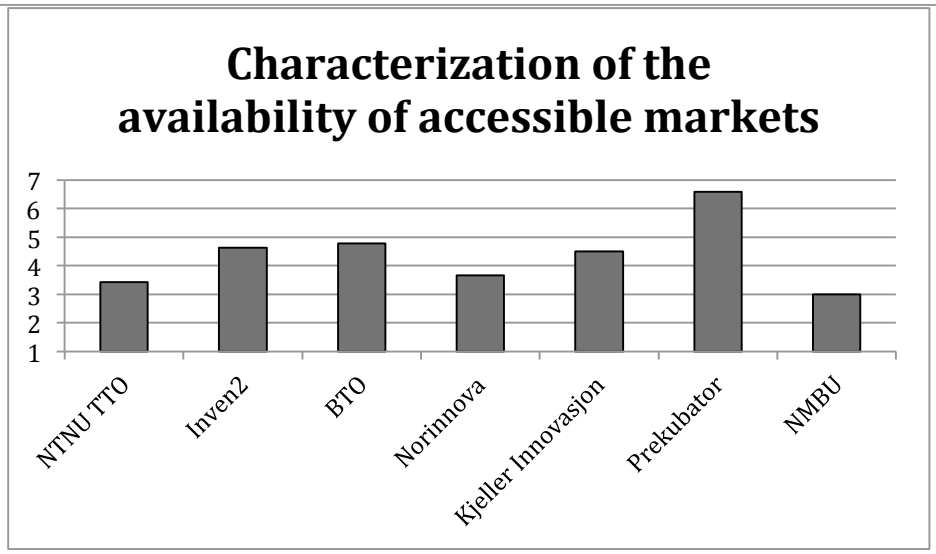
Prekubator
NMBU
Characterization of public funding mechanisms
Characterization of seed-fund mechanisms
Characterization of access to private investors


Characterization of the availability of accessible markets
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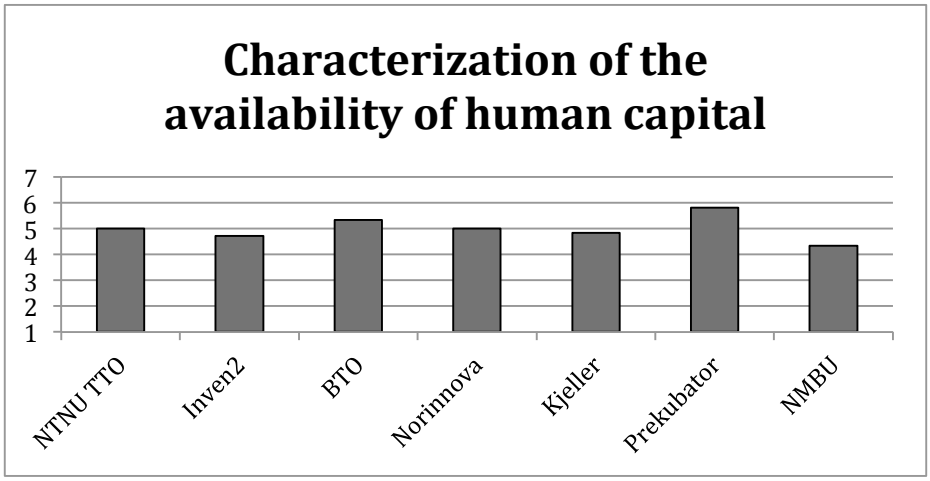
Characterization of the availability of human capital
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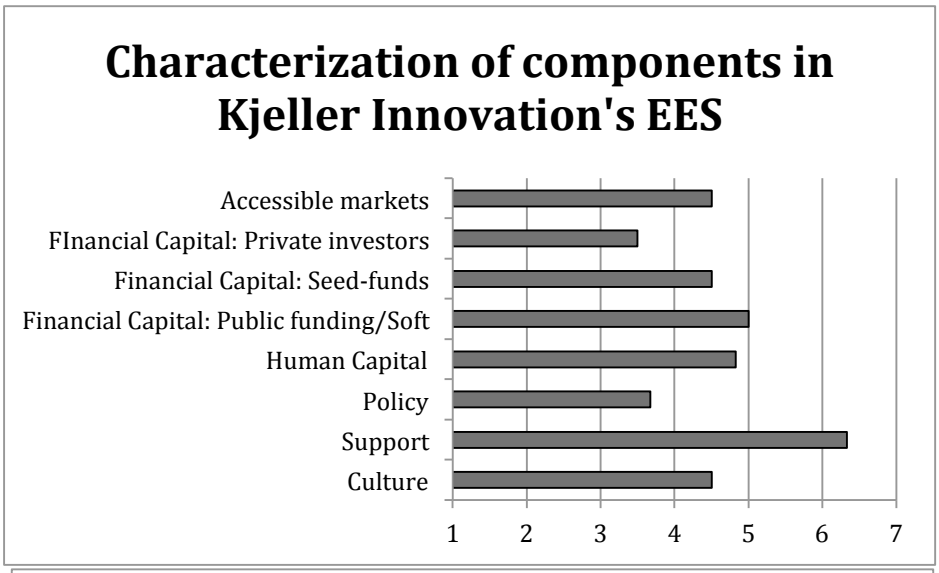
Characterization of components in Kjeller Innovation's EES
Accessible markets
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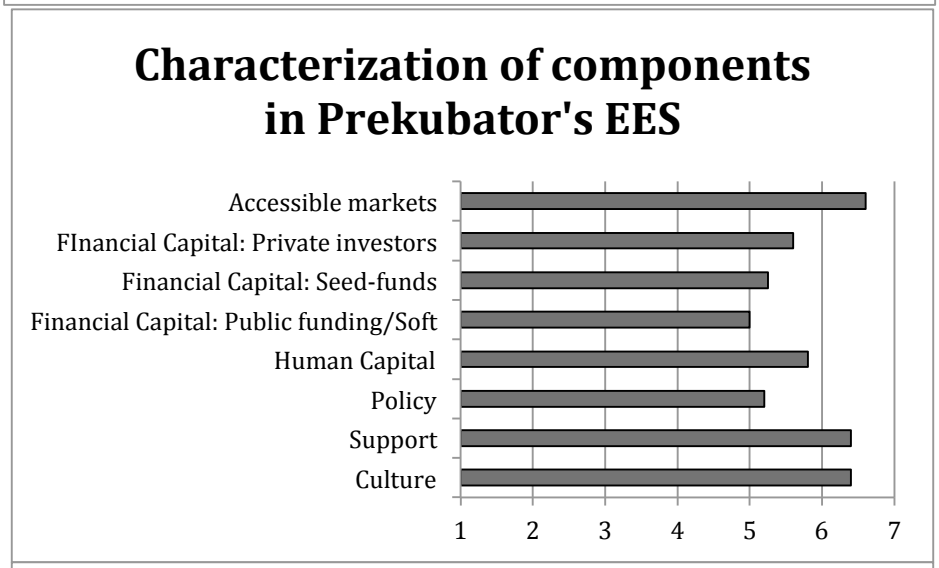
Characterization of components in Prekubator's EES
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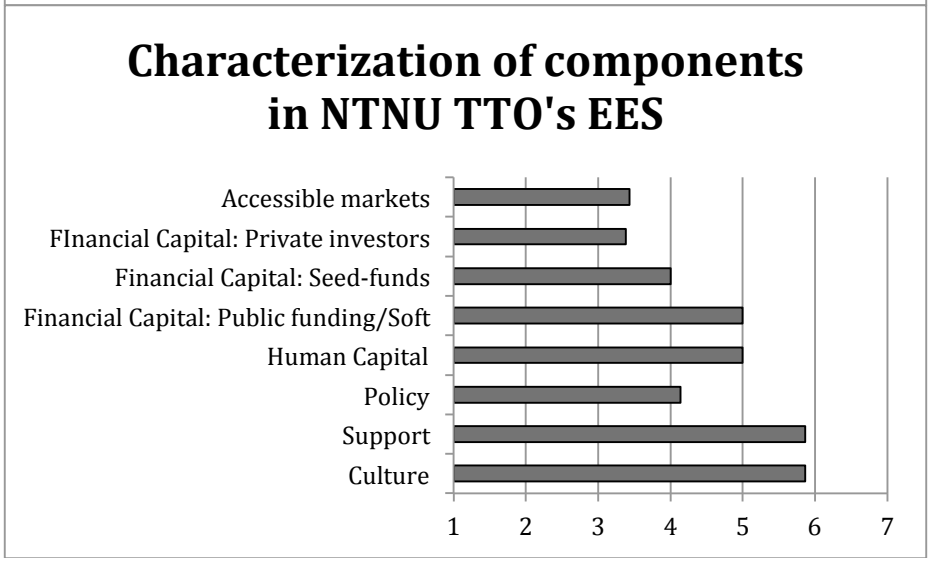
Characterization of components in NTNU TTO's EES
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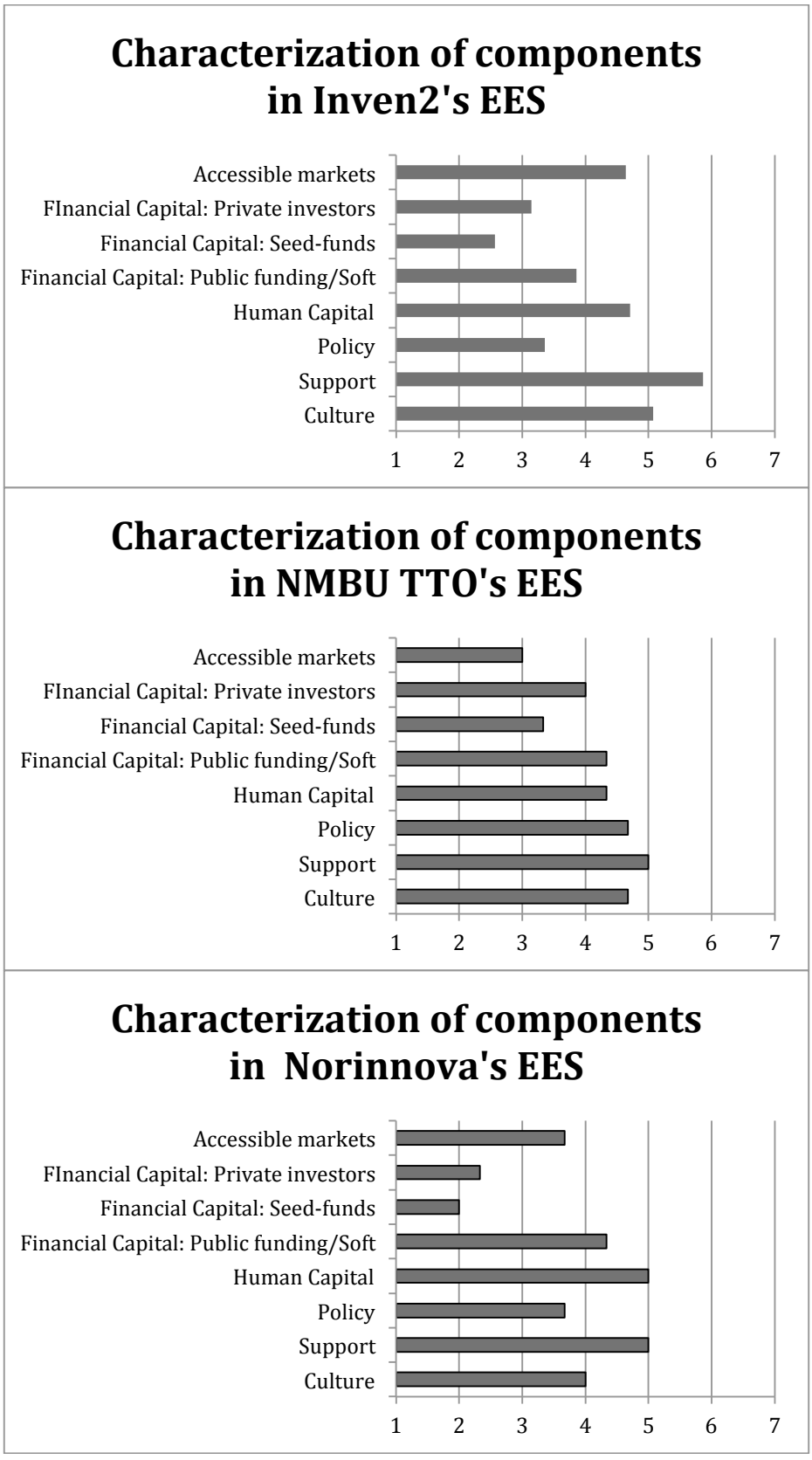
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Accessible markets
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Financial Capital: Seed-funds
Financial Capital: Public funding/Soft
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Characterization of components in NMBU TTO's EES
Accessible markets
FInancial Capital: Private investors
Financial Capital: Seed-funds
Financial Capital: Public funding/Soft
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Characterization of components in Norinnova's EES
Accessible markets
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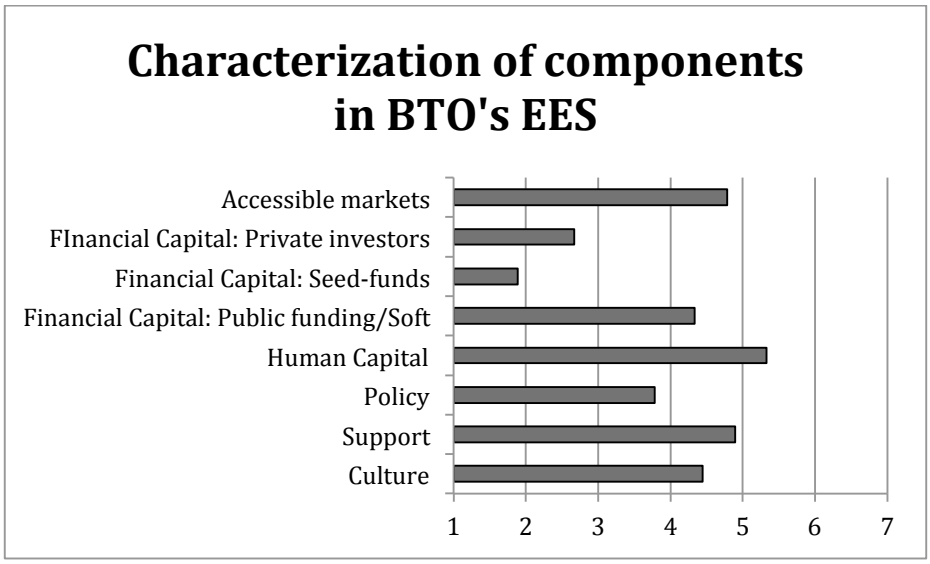
Characterization of components in BTO's EES
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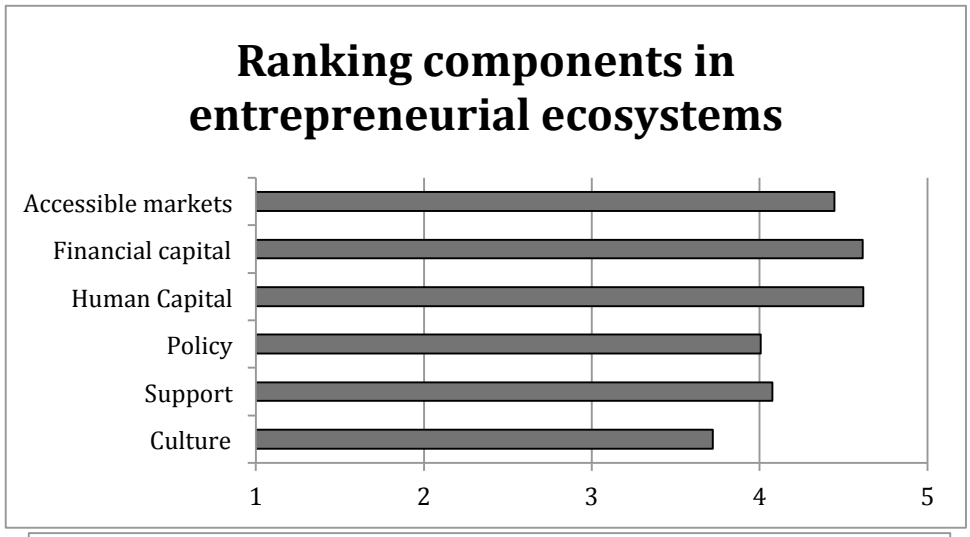
Ranking components in entrepreneurial ecosystems
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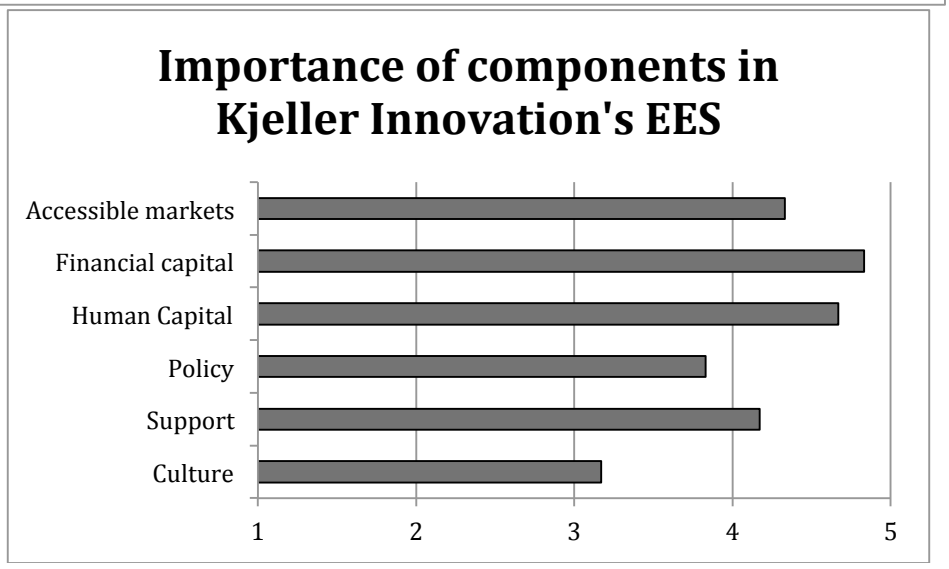
Importance of components in Kjeller Innovation's EES
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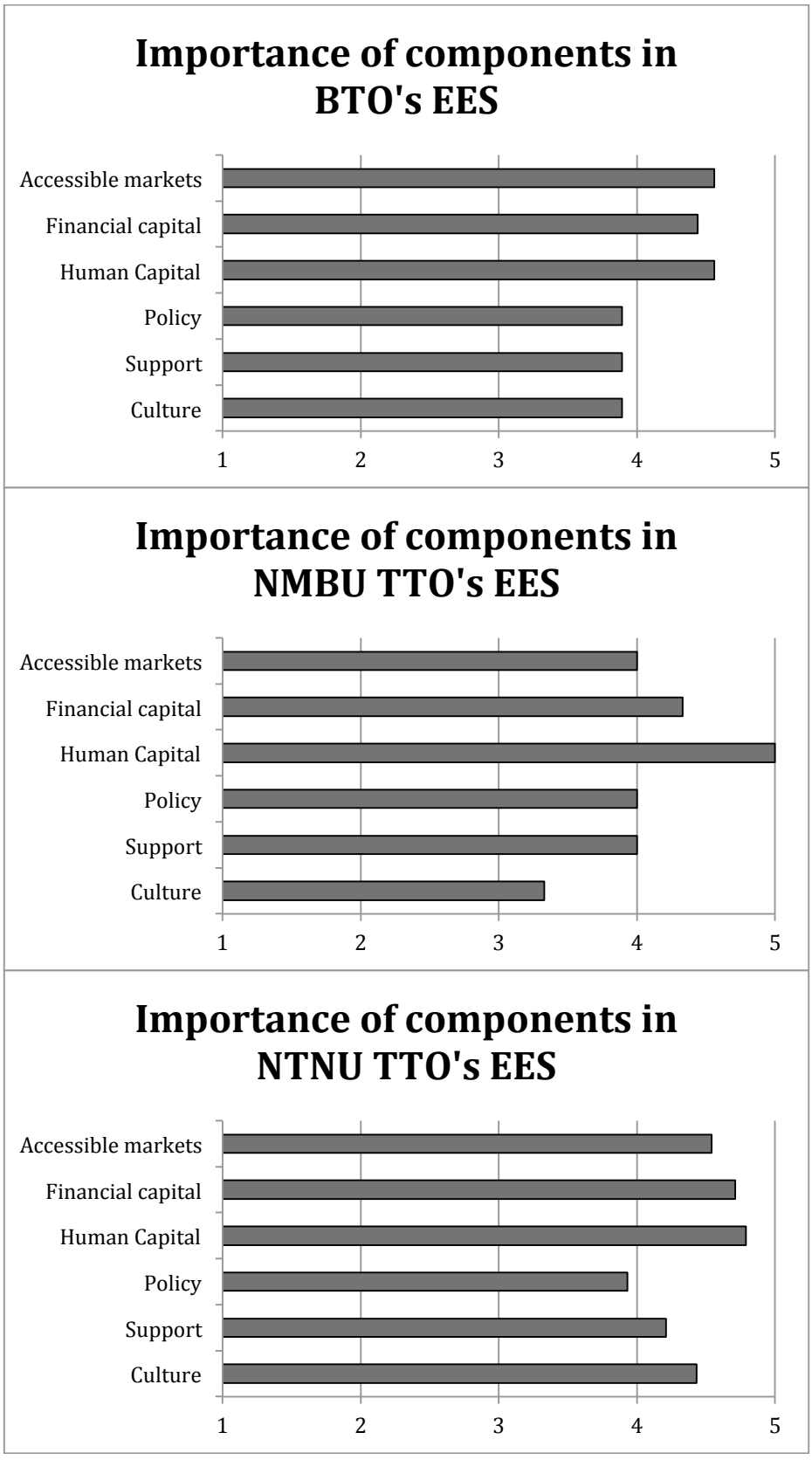
Importance of components in BTO's EES
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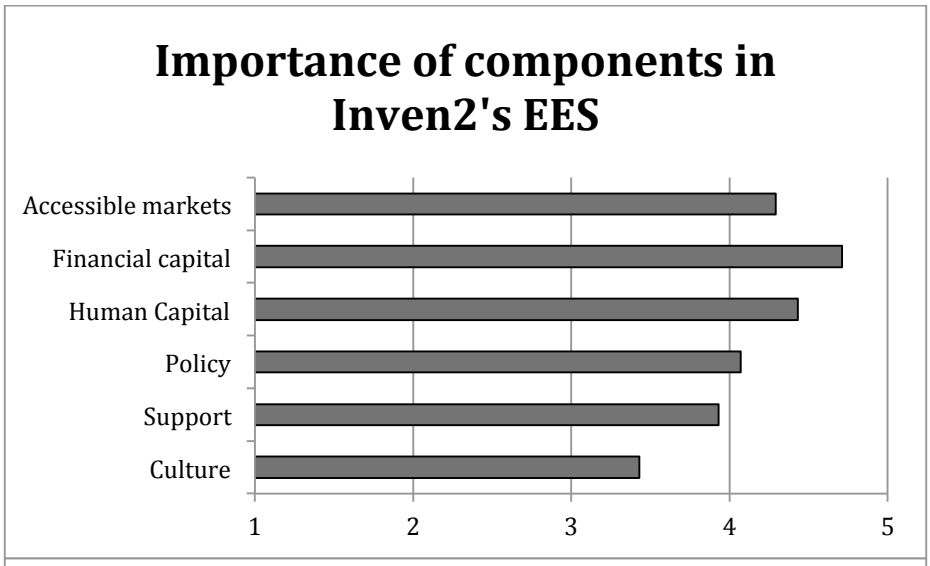
Importance of components in Inven2's EES
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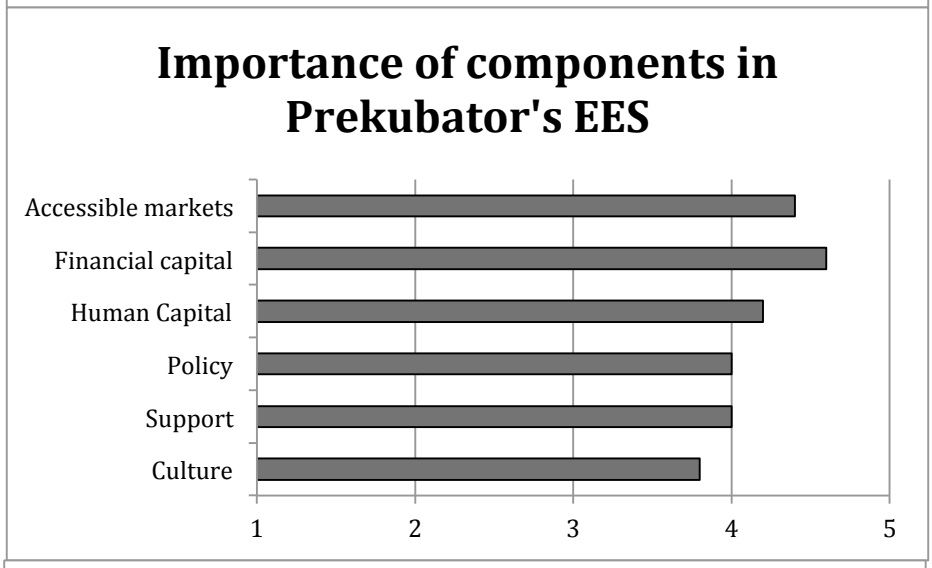
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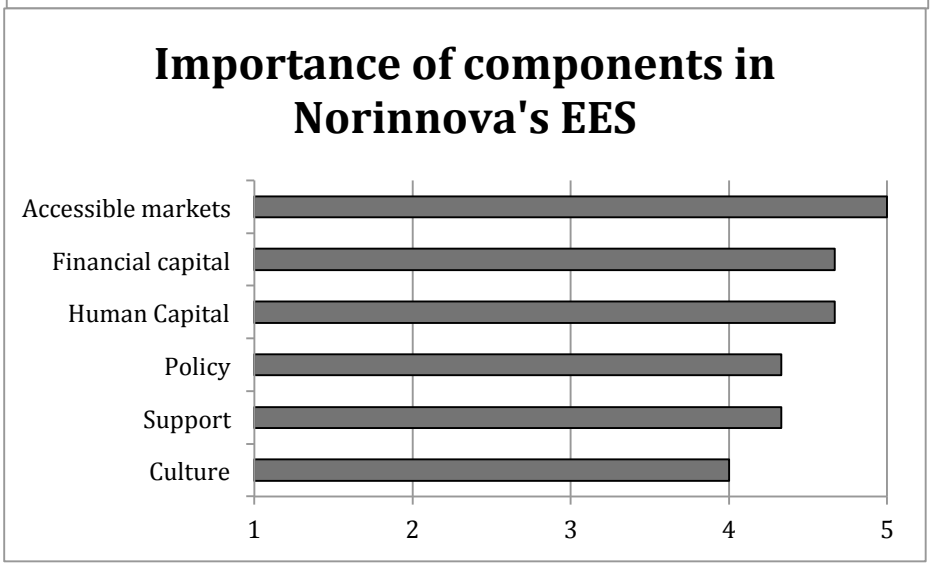
Importance of components in Norinnova's EES
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