

# Developing the resource base of academic spin-offs

*The role of technology transfer offices*

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# Abstract

Although academic entrepreneurship is increasingly catching the attention of scholars, the relationship between technology transfer offices (TTOs) and academic spin-off companies (ASOs) is relatively unexplored. Therefore, the purpose of this study was to explore how TTOs are working as intermediaries and helping the ASOs acquire essential resources.

The theoretical framework used was based on resource-dependence theory, resource based view and theory on innovation intermediaries. There are eventually four different types of essential resources; human, social, financial and technological resources. For an ASO there are mainly three ways to acquire these resources: the ASO acquire the resources directly from its surroundings, the ASO acquire the resources directly from the TTO, finally the TTO can work as an innovation intermediary to help the ASOs acquire these resources. The theoretical framework also propose four roles that can be taken by the TTO as an innovation intermediary: advisor, bridge, broker and community builder.

An exploratory case study was carried out in order to examine how resource acquisition is done by ASOs currently in partnership with TTOs and how TTOs is helping this process.

The analysis map how resources are acquired and how the TTO is helping this process. In addition to the roles of advisor, bridge, broker and community builder, a fifth role that could be taken on by the TTO as an innovation intermediary was identified, namely the role of moderator.

It was also found that the ASOs ability to attract resources of their own was found to be highly dependent on the experience, skills and capabilities of their entrepreneurial team.

Finally, to be able to offer resources to their ASOs, TTO should build their own resource base. The process of the ASOs acquiring resources from the TTO is not similar to resource flows between other companies, as TTOs will strive to make independent companies.



# Acknowledges

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# Table of contents

1	Introduction and research question .....	10
1.1	Problem statement and research question.....	11
1.2	The importance of this research project .....	11
1.3	Layout of the research project .....	11
2	Background .....	12
2.1	Academic spin-off companies .....	12
2.2	Differences between academia and business sector .....	13
2.3	Technology transfer offices (TTOs) .....	14
2.4	Other relevant concepts .....	14
3	Theoretical framework .....	16
3.1	Resource-based view .....	16
3.2	A resource-based view on ASO's.....	17
3.3	Resource-dependence theory .....	18
3.4	Resource-dependence theory in relation to the relationship between TTOs and ASOs.....	19
3.5	Innovation intermediaries .....	19
3.6	TTO as an innovation intermediary.....	20
3.7	Summary and synthesis .....	21
4	Review of the literature .....	23
4.1	Performance of TTOs .....	23
4.1.1	Comments on performance of TTOs.....	23
4.2	Human resources .....	23
4.2.1	Social skills of entrepreneurs .....	23
4.2.2	Network capabilities and entrepreneurial orientation .....	24
4.2.3	Entrepreneurial team formation .....	24
4.2.4	Comments on human resources.....	25
4.3	Social resources .....	25
4.3.1	Acquiring social resources. ....	25
4.3.2	Size and strength of partnerships of TTOs.....	26
4.3.3	Comments on social resources .....	26
4.4	Financial resources .....	27

4.4.1	Venture capital .....	27
4.4.2	Innovation support grants .....	28
4.4.3	Comments on financial resources. ....	28
4.5	Technological resources .....	29
4.5.1	Comments on technological resources .....	30
4.5.2	Obstacles for academic spin-offs (ASOs). ....	30
4.5.3	Comments on obstacles for ASOs.....	31
4.6	Critical junctures in the development of ASOs .....	31
4.6.1	Comments on critical junctures .....	32
4.7	Institutional factors .....	33
4.7.1	Comments on institutional factors.....	33
4.8	Intermediaries in technology transfer .....	34
4.8.1	Intermediaries in the UK Biotech industry .....	34
4.8.2	The role of the TTO in resource acquisition .....	34
4.8.3	Comments on the intermediaries in technology transfer.....	35
4.9	Synopsis and relevance to my research project .....	36
5	Methodology .....	38
5.1	Research design .....	38
5.2	Reliability and validity .....	38
5.3	Data collection process .....	40
5.3.1	Selection .....	42
5.4	Anonymity and identifiability .....	43
5.5	Analyzing the results .....	43
6	Results and analysis .....	45
6.1	Interview results from the ASOs .....	45
6.2	Interview results from the TTOs .....	46
6.3	Resource flow. ....	47
6.3.1	Human resources. ....	48
6.3.2	Social resources.....	51
6.3.3	Financial resources .....	53
6.3.4	Technological resources .....	56
6.3.5	Other resources.....	59
7	Discussion .....	61



7.1	The importance of human resources.....	61
7.2	TTO as an innovation intermediary.....	62
7.2.1	TTOs as advisors.....	62
7.2.2	TTOs as bridges.....	62
7.2.3	TTOs as brokers.....	63
7.2.4	TTOs as community builders.....	63
7.2.5	TTOs as moderators.....	64
7.3	The resource base of a TTO.....	64
7.4	Relation to theory.....	65
7.4.1	Resource-based view.....	65
7.4.2	Resource-dependence theory.....	66
7.4.3	Innovation intermediaries.....	66
8	Concluding remarks.....	67
8.1	Implications for TTOs and policy makers.....	68
8.2	Implications for ASOs.....	68
9	Referances.....	69
10	Appendix.....	72
	Appendix 1 Interview guide ASOs.....	73
	Appendix 2 interview guide TTOs.....	76

## List of tables and figures

Table 1: Comparison between the differences between academia and business (Einar Rasmussen, 2007).....	13
Table 2: Services carried out by a TTO (Porcel et al., 2012).....	14
Table 3: Presentation of interviewed companies.....	43
Table 4: Resource acquisition by the ASOs.....	46
Table 5: Research acquisition actions from the TTOs.....	47
Figure 1: The three different ways that resources might be acquired by a ASO.....	22
Figure 2: Human resource acquisition to the ASO.....	50
Figure 3: Social resource acquisition.....	53
Figure 4: Financial resource acquisition to the ASO.....	56
Figure 5: Technological resource acquisition.....	59

# 1 Introduction and research question

Technology transfer are increasingly catching the attention of Universities. Most big Universities in the US and Europe now have their own technology transfer offices (TTOs) where science are being commercialized. The development of TTOs are backed by governments with the goal of commercializing more academic research (Callan, 2000, Rasmussen et al., 2008) With the increased importance of TTOs in the science and entrepreneurship community, several scholars are increasingly catching an interest to TTOs (Rothaermel et al., 2007).

Technology is transferred from Universities in several different ways. Traditionally, technology were transferred through the publication of per reviewed articles, informal meetings, workshops, conferences and through education of students. We might call this indirect technology transfer (Research and Committee, 1999).

The commercialization of research took off with the Barath Doyle act in 1980, which introduced governmental incentives for Universities to patent and commercialize their research. The movement spread to other countries. Today most universities in the US and Europe have their own strategies on commercialization of research (Rothaermel et al., 2007).

Through TTOs universities are patenting and licensing out the technology. Another channel is through creating a spin-off company with the goal of commercializing the technology. The formation of companies to harness benefit from University research is often referred to as academic entrepreneurship. In my paper, I will focus on these academic spin-off companies (ASOs) (Rothaermel et al., 2007).

Although a lot of research have been published on academic entrepreneurship, the field is quite fragmented and there is a need of more studies to get a better understanding of the field. Many studies focus on the formation of ASOs as a determinant of the effectiveness of the TTOs, and what factors might lead to a higher number of ASOs formed (Anderson et al., 2007, Caldera and Debande, 2010, Siegel et al., 2007, Siegel et al., 2003). From these studies, we know that the size and experience of the TTO have a significant impact on the frequency of the formation of ASOs. (Djokovic and Soitaris, 2006)

Other studies have focused on how university/TTO policies can have an impact on the performance/growth of ASOs. We know that industry linkages and ties are especially important for the growth of ASOs (Djokovic and Souitaris, 2008).

Although a lot of research are, being published on ASOs, looking at the taxonomies of Djokovic and Souitaris (2008), Rothaermel et al. (2007) and Perkmann et al. (2013) Perkmann et al. (2013), there seem to be a lack of understanding on the relationship between TTOs and ASOs, and how the TTOs are helping the ASOs.

## **1.1 Problem statement and research question**

For my study, I will start with the notion that spin-off-companies need to develop a resource base in order to succeed (Brush et al., 2001) (Mustar et al., 2006) and then investigate how the TTOs are acting as innovation intermediaries to help the spin-off-companies' acquire these resources. Hence the research question:

*How does the TTO help build the academic spin-off-companies' resource base?*

## **1.2 The importance of this research project**

Through an extensive literature scan and literature review, I have uncovered a lack of knowledge on how TTOs are helping academic spin-off-companies. This paper aims to develop a framework that describes how TTOs are helping academic spin-off companies get access to essential resources. I will also do an exploratory case study within the Norwegian context to find evidence of TTOs helping academic spin-off companies and to examine and further develop my theoretical framework. I hope that my findings can add knowledge to a relatively unexplored, yet important field of study, and serve as a framework for future studies.

## **1.3 Layout of the research project**

Following is a literature review where I introduce the different concepts that are being assessed,, define a theoretical framework and then discover what other scholars have done in the field. Next, I describe the research design. Finally, I will present our results, discuss my findings and give some implications and conclusions.

## 2 Background

### 2.1 Academic spin-off companies

An academic spin-off company, is a company founded to exploit a piece of intellectual property created in an academic institution (Shane, 2004). Scholars suggest that ASOs are very important for industrialized countries, as creating spin-off companies is considered to be the most effective way of transferring technology from academia to business (Shane, 2004, Sternberg, 2014).

Previous research suggests several definitions of academic spin-off companies ASOs. Carayannis and Alexander (1998) suggest that an ASO is a new company that is formed by individuals that were former employees of a parent organization (in this case the university, research institute or university hospital) around a technology that originated at a parent organization and that was transferred to the new company. They also suggest that the founders must leave the University.

Similar to Caryannis definition is (Shane, 2004) that suggest that ASOs are companies founded to exploit intellectual property created in an academic institution by current or former members of a university. In Shanes definition, the entrepreneurs can stay as employees at the University.

Pirnay and Surlmont (2003) suggest that ASOs are new firms created to commercially exploit some knowledge, technology or research results developed within a university give a broader definition. The definition does not define who the entrepreneurs of the spin-off are.

Klofsten and Jones-Evans (2000) define ASOs as formations of new firms or organizations to exploit the results of university research within one University. Kolsten and Jones Evans does not give an explanation to whom the entrepreneurs within ASOs are.

For this thesis, I will focus on the different ASOs that have some technology or invention that is developed at a Norwegian university, research institute or university hospital. I am therefore look at spin-offs from a majority of origin institutions rather than just looking at spin-offs that originated from the Universities. I will also have a broad perspective at the origin of the technology looking at ASOs that are exploiting technology developed in a wide array of science disciplines. Scholars on ASOs have different definitions on whether the researcher or inventor

need to be transferred. For my research project, I am including both ASOs that are using surrogate entrepreneurs and ASOs where the researcher/inventor is transferred.

My study does not involve startup companies where the technology is licensed to the company, but the TTO or University have no stake in it apart from licensing.

## 2.2 Differences between academia and business sector

As I will further investigate later in this paper, the ASOs have a different starting point on building their resources than other startups. To understand the background of these differences it is useful to compare ASOs and other startups. Many ASOs start off with the researcher/inventor as the entrepreneurs. The differences in the skill sets of these researchers might be a challenge in developing their companies as they lack the experience from working with business. The differences are compared in table 1. These differences implies that researchers and other actors in academia are used to, and have experience from a sector that is quite different from the sector they are moving in to with their ASOs.

	<b>Academia</b>	<b>Business sector</b>
<i>Reward structure</i>	Recognition	Ownership
<i>Motivation</i>	Many factors (professional interest, prestige, economic etc.)	Economic
<i>Knowledge</i>	Sharing of knowledge	Protecting knowledge
<i>Cooperation</i>	Informal structures	Formal contracts
<i>Time horizon</i>	Long	Short
<i>Role</i>	Production of knowledge	Utilization of knowledge
<i>Goal</i>	Novelty is important	Market acceptance is important
<i>Leadership and management</i>	Academic freedom	Hierarchy

Table 1: Comparison between the differences between academia and business (Einar Rasmussen, 2007)

Several of these differences might be important when starting up a new business. Mainly, the difference between novelty and market acceptance is important as it might imply that ASOs are more innovative than their counterparts are but does not have the same market focus.

Researchers are also moving into an area where organizational factors like management and cooperation structures are completely different than what they are used to. Later in this report I will present findings that adds to this notion and shows how these differences impact an ASO.

### 2.3 Technology transfer offices (TTOs)

TTOs usually serve as an intermediary between suppliers of innovations (university scientists, other researchers) and those who can potentially help to commercialize them (firms, entrepreneurs and venture capitalists) (Siegel et al., 2007).

TTOs can offer a range of service to carry out its objectives:

<b>Services carried out by a TTO</b>	Guidance for Research and Development (R&D) and Technology Transfer funding
	Disseminate information
	Advice in the preparation of offers (management, spread and exploitation)
	Management of contacts
	Technological offers (the elaboration of the offer, spread and promotion)
	The advice in the creation of new business
	Evaluation, protection and transfer of both intellectual and industrial ownership rights.

Table 2: Services carried out by a TTO (Porcel et al., 2012).

For my research project I will focus on TTOs as an innovation intermediary and how the TTO helps channel essential resources to ASOs. The patenting/licensing role of TTOs are therefore beyond the scope of this report.

### 2.4 Other relevant concepts

In the following chapter, I introduce some additional relevant concepts from the Norwegian context

*FORNY*: *FORNY* is the Norwegian research councils program for commercialization of research. The program are cooperating with different stakeholders, and give financial support for commercialization projects and establishments of new businesses. For 2015 the *FORNY* project were given an allocation of 172 million NOK. Currently, there are seven TTOs that is supported by *FORNY* (*\_education\_and\_research*, 2015)

*SkatteFUNN*: *SkatteFUNN* is the Norwegian research councils program to stimulate R&D in SME's. SME's can apply for up to 20% tax relief on their R&D (*The\_Norwegian\_Research\_council*, 2015).

*Innovation Norway*: *Innovation Norway* is the Norwegian agency of innovation support. The agency is giving grants to innovation projects and startups. Another role of *innovation Norway* is the guidance of new companies. Startups can apply for a mentor program where someone from the industry steps in and give mentoring (*Innovation\_Norway*, 2015).

# 3 Theoretical framework

## 3.1 Resource-based view

Edith Penrose was the first to introduce resource-based view. She frequently criticized existing theory of the firm and suggested that the existing theory was inadequate to explain how firms grow. In her book “The theory of the growth of the firm” Penrose put an emphasis of the importance of the firm’s internal resources in order to achieve growth (Penrose, 1959).

When Barney (1991) published his article “Firm resources and sustained competitive advantage”, resource-based view started to gain strength. The theory has been a leading framework for examining venture growth and competitive advantage ever since (Mustar et al., 2006).

There are two assumptions that are elemental to Barney’s resource-based view: (1) resources are distributed heterogeneously across firms, and (2) these resources cannot be transferred from firm to firm without cost (Barney, 1991)

Resources are described as *all assets, capabilities, organizational processes, firm attributes, information, knowledge, etc. controlled by a firm that enable the firm to conceive and implement strategies that improve its efficiency and effectiveness* (Barney, 1991).

Barney (1991) also states that companies can be looked at as a grouping of resources and that these resources give companies competitive advantage if they are valuable, rare, difficult or impossible to imitate and non-substitutable.

The different grading of the resources can be explained as following.

- Valuable resources enables improved market position over its competitors.
- Rare resources enables a company to keep the competitive advantage over a longer period.
- Difficult/impossible resources are resources that are immobile and too costly for competitors to imitate.
- Non-substitutable resources are resources that cannot be substituted by other resources in order to follow the same strategy.



This is frequently referred to as VRIN (Barney, 1991).

Resources are assets owned or controlled by the company, while capabilities is the company's ability to deploy these resources (Makadok, 2001). When resources are combined, they can become capabilities. When capabilities are used properly, they become core competencies. Core competencies are things the firm does especially good that might lead to competitive advantage. Specialized and further developed core competencies that provides the ability to outperform competitors are recognized as strategic assets (Brush et al., 2001).

Resources can be characterized by their importance to the productive process ranging from utilitarian and instrumental. Utilitarian resources are applied directly to the productive process or combined to develop other resources while instrumental resources are used to gain access to other resources, for example financial resources are instrumental because they can be used to gain access to human resources, lab equipment etc. (Brush et al., 2001).

## **3.2 A resource-based view on ASO's**

A limitation to Barney (1991) is that the framework is not adjusted to new ventures. It cannot explain how new ventures with no experience and limited amount of resources can build competitive advantage. To be able to do this the resources must first be assembled. Building on previous work Mustar et al. (2006) therefore defined that ASOs rely on four different resources: *Technological, social, human and financial resources*.

*Technological resources* refer to the specific products and technology of the firm. ASOs might vary in level of innovativeness, scope of the technology, quality or legitimacy of the firms R&D, and where they are in the technology development cycle. *Social resources* refer to the firm's industry and financial contacts, *Human resources* define human capital as the size of the team, background of the team, management experience and size of the organization (Brush et al., 2001). *Financial resources* refer to the financing of the firm (Mustar et al., 2006). Brush et al. (2001) emphasizes financial resources as instrumental because they can give access to other resources such as people or equipment. This implies the importance for ASOs to get access to financial resources early on in their life cycle.

According to studies that have focused on human resources, the initial competencies of new ventures coincide with the competencies of the founders. The diversity of different ASOs are therefore determined by the characteristics of the founders (Cooper and Bruno, 1977).

For several reasons it can be challenging for ASO's to build a resource base. ASOs usually have a very limited initial resource base with only the researchers and maybe an initial concept or technology (Mustar et al., 2006). ASOs tend to be founded by scientists without the necessary business experience. The founders of ASO's tend to lack the network, experience and persuasiveness that an entrepreneur needs (Siegel et al., 2003). Another reason is that ASO's need a substantial amount of financial resources, as they are high-tech-companies with a high dependence of R&D in order to obtain the proof of concept (Clarysse and Bruneel, 2007). Financial and human capabilities, like marketing skill and entrepreneurial experience, are frequently mentioned as missing in ASOs (van Geenhuizen and Soetanto, 2009).

Introduced by (Stinchcombe and March, 1965), the liability of newness also explains how getting access to new resources can be particularly difficult for ASOs. ASOs may lack administrative experience, may not have access to a customer base and cannot point to a precious history of performance, which all contribute to the liability of performance.

### **3.3 Resource-dependence theory**

In the chapter on resource-based view I argued that most ASOs are lacking a number of important resources. The resource-based view is therefore not sufficient to describe the situation of the ASOs. These resources have to be acquired from the ASO's context, we can therefore use Resource-based theory to describe how these resources are acquired.

Resource-dependence theory (RTD) was introduced by (Salancik and Pfeffer, 1974) who argued that organizations are highly affected by external resources, for example labor, raw material, capital etc. 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"* (Salancik and Pfeffer, 1974).

Central to resource-dependence theory is the dependency between organizations because of these organizations resources. Resource-dependence theory state that an organization depend on resources. These resources originate from an organization's environment. The environment consists of other organizations that often holds the power of the resources that an organization needs. Legally independent organizations can therefore depend on each other (Salancik and Pfeffer, 1974)

Power is also central to resource dependency theory. It states that power and resource-dependence are directly linked. Organization A's power over organization B is equal to organization B's dependence on organization A's resources. Power is thus relational, situational and potentially mutual. An organisation will try to gain independence either by control over necessary resources or by gaining control over other organizations that control the necessary resources (Preffer and Salancik, 1978)

### **3.4 Resource-dependence theory in relation to the relationship between TTOs and ASOs.**

We established that ASOs is dependent on technological, social, human and financial resources. If the performance of a TTO should be measured by the input from the TTO into each of the ASOs, the performance can be described as how successful the TTO is in helping the ASOs acquire social, human and financial resources.

ASOs tend to initially have a limited resource base (Mustar et al., 2006, Siegel et al., 2003). They might also require more resources than other new ventures (Clarysse and Bruneel, 2007). The liability of the newness adds to the challenge as acquiring new resources might be particularly challenging for ASOs (Stinchcombe and March, 1965). The help from the TTO might therefore be of particular importance when it comes to acquiring new resources.

### **3.5 Innovation intermediaries**

I have established that ASOs have to acquire human, social, technological and financial resources in order to gain a sustainable competitive advantage. These resources have to be acquired from the ASOs context. I also established that acquiring new resources are hard for ASOs as they have little power and few resources to begin with. Ideally, the TTOs will act as an innovation intermediary and help the ASOs get access to these resources.

Innovation intermediaries can be described as “bridges”, “change agents” or “brokers” (Stewart and Hyysalo, 2008) and are conducting different tasks in order to facilitate and enable innovation. Inventors of a new invention or technology are seldom connected to potential users, complementary technology or expertise, necessary knowledge and resources. Innovation intermediaries help bridging the gap between the new technology/invention and these necessary assets (Stewart and Hyysalo, 2008).

Early research on innovation intermediaries found that the intermediaries had an impact on the adoption rate of the diffusion rate, both by household and firm adopters. The initial significance of third party intermediaries was found to be information dissemination and their impact on the adoption rate of the technology (Hagerstrand, 1952, Rogers, 1962). Mantel and Rosegger (1987) highlighted other roles such as support in decision-making.

Watkins and Horley (1986), did a more prospective approach and identified the role such intermediates could play in: identifying partners, helping package the technology to be transferred, selecting suppliers and providing support in making a deal between the firms involved.

Some researchers have focused on innovation intermediates as brokers; agents that facilitate the process of technology transfer “across people, organizations and industries”. Zaheer and McEvily (1999) highlighted the role of regional institutions (such as technology clusters) and how these regional clusters are helping firms who have a poor advice network and lack the necessary linking ties. These regional institutions provide important linkages to a firm’s network. Hargadon and Sutton (1997) proposed a more direct role, not only linking the ventures to an industry network and resources, but make it so that new technologies and opportunities arise, when different stakeholders meet.

The innovation intermediate as a broker are also described by some researchers as not only a linking role but also one that helps transform technology through combining previous solutions in order to provide their customers with new combinations of existing technology (Hargadon and Sutton, 1997). Innovation intermediates might also be useful to enable changes in a specific environment. (Callon, 1980, Callon, 1994) identified the role of intermediaries in initiating change within science networks and other more localized configurations, such as local collectives.

### **3.6 TTO as an innovation intermediary**

To summarize there are plenty ways that a TTO might act as an innovation intermediary. My research paper focus on how TTOs help ASOs on acquiring necessary resources. I will therefore mainly focus on four different intermediary roles that might be carried out by a TTO; advisors, bridges, brokers and community builders.

*Advisors:* TTOs might have an indirect approach in helping the ASOs acquire resources. Watkins and Horley (1986) described the role of the innovation intermediary as an advisor. The TTOs might help the ASOs to acquire resources through, pointing them in the right direction of the right resources, identify partners, package the technology for the market, selecting suppliers and help the ASO to make deals with partners. The advisory role might also come in the form of decision making as Mantel and Rosegger (1987) described.

*Bridges:* According to Stewart and Hyysalo (2008) innovation intermediaries helps to bridge the gap between the new technology/invention and these necessary assets.

*Brokers:* Hargadon and Sutton (1997) proposed a role that could be taken by intermediaries which not only linked the ASOs to resources, but also made sure that relevant stakeholders met so that new technologies and opportunities could evolve.

*Community builder:* Finally, the TTO might take the role as a community builder. (Callon, 1980, Callon, 1994) identified the role an intermediary can take in initiating change in a local system. For the TTO this might be carried out through hosting events and gatherings where ASOs can meet relevant stakeholders, the TTO can also develop different support functions such as agreement with universities, administrative services and grants and investment funds.

### **3.7 Summary and synthesis**

Based on theory on resource-based view, resource-dependence theory and theory on innovation intermediaries, there are three ways that resources can be acquired by an ASO. This is summarized in figure 1.

From the resource-dependence theory, we know that resources are acquired from a venture's context (Salancik and Pfeffer, 1974). It is a possibility that the resources are acquired directly by the ASOs from the ASOs surroundings. This might be challenging because of the liability of newness (Stinchcombe and March, 1965). ASOs might therefore have to acquire a minimum resource base, get a proof of concept or have entrepreneurial experience before this can be an option. Resource acquisition can also be acquired directly from the TTO. Resource acquisition directly from the TTO might be challenging for the ASOs, as according the resource-dependence theory, they face the risk of the TTO getting too much power over them.

Finally, there is the possibility of the TTO acting as an innovation intermediary and thus helping the TTO acquiring resources. (Callon, 1980, Callon, 1994, Hargadon and Sutton, 1997, Mantel and Rosegger, 1987, Zaheer and McEvily, 1999)

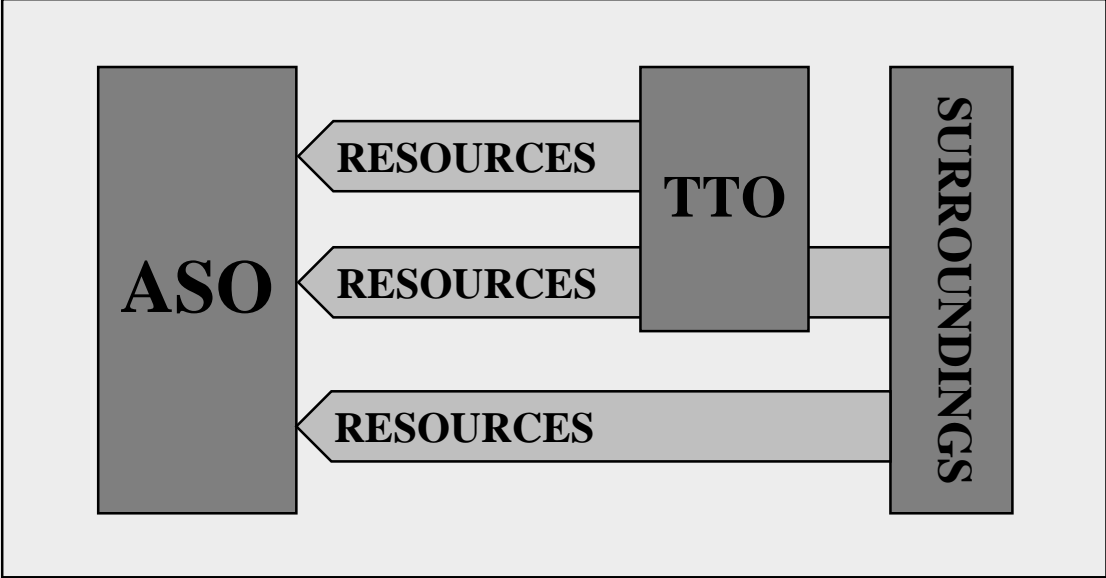


Figure 1: The three different ways that resources might be acquired by a ASO.

# 4 Review of the literature

## 4.1 Performance of TTOs

Several studies use quantitative determinants such as the number of ASOs, number of licenses, number of ASOs and licensing income when doing studies on the performance of the TTOs. (Anderson et al., 2007, Caldera and Debande, 2010, Siegel et al., 2007, Siegel et al., 2003)

These determinants are usually tested with a wide array of independent determinants such as research income, quality of faculty, external legal IP expenditure, number of TTO staff, age of TTO etc. (Siegel et al., 2007).

### 4.1.1 Comments on performance of TTOs.

These studies can give useful insight on how a TTO should be designed and what to take into consideration when working on Technology transfer. However, for our study we are looking at how TTOs are affecting the development of the ASOs. In this discourse we can say that the performance of a TTO is not determined by the output of the TTO in terms of number of spin-offs, number of patents, patent income etc. but by the way the TTO successfully manage to help their ASOs overcome their challenges and the input from the TTO into each of the ASOs.

## 4.2 Human resources

### 4.2.1 Social skills of entrepreneurs

Brush et al. (2001) defined five social capabilities that is important for entrepreneurs. *Social perception*, which is the accuracy with which the entrepreneur assesses the traits, intentions and motives of others. *Impression management*, which is the way one induces positive reactions from others. *Expressiveness* which is the ability to express emotions and feelings clearly and generate enthusiasm in others. *Persuasiveness*, which is the ability to change others behaviors in face-to-face encounters. Moreover, *social adaptability* which is the ability to adapt to, or feel comfortable in a wide range of situations.

## **4.2.2 Network capabilities and entrepreneurial orientation**

Drawing on a database of 149 university spin-offs Walter et al. (2006) did a study on the impact of a spin-offs network capability and entrepreneurial orientation on the organizational performance of spin-offs.

Network capability of a spin-off was defined as the abilities to initiate, maintain and utilize relationships with various external partners. The term “network” expressed that managing relationships goes beyond coping with single relationships and alliances. While entrepreneurial orientation was defined as the proactiveness, innovation, risk taking, and assertiveness in business development (Walter et al., 2006)

Networking capabilities were found to be significant for several performance variables like growth in sales, sales per employee, profit attainment, perceived customer relationship quality, realized competitive advantage and long-term survival. Entrepreneurial orientation was found to have a direct effect on the spin-offs competitive advantage (Walter et al., 2006)

## **4.2.3 Entrepreneurial team formation**

Following an ASO from the initial idea face to the second investment round Clarysse and Moray (2004) investigated how the entrepreneurial team evolved during the different stages of the ASOs development.

(Clarysse and Moray, 2004) showed that an experienced team might be a more attractive investment for an investor. However, they argued that if an experienced team cannot be accomplished without hiring external people the strive for an experienced team might become a disadvantage. There are several reasons why hiring a surrogate investor might be a disadvantage; for example, surrogate entrepreneurs generally have a high turnover, they might have a problem with accepting academic research and that they may lack the technical understanding necessary to successfully lead the ASO.

Instead, they suggested that the original team would learn the necessary skills and capabilities to successful commercialize their technology. Thus, instead of employing a surrogate entrepreneur, the study suggests that an investor or other stakeholder should involve someone who can coach the original entrepreneurial team or do the coaching themselves (Clarysse and Moray, 2004).



#### **4.2.4 Comments on human resources**

Walter et al. (2006) gives a good understanding on what capabilities to focus on when starting to build the entrepreneurial team. As we discussed earlier in this paper ASOs are often lacking entrepreneurial network and experience (Siegel et al., 2003) as well as marketing skills (van Geenhuizen and Soetanto, 2009). The findings of Walter et al. (2006) enhances the notion that commercial and networking skills are of severe importance and should therefore be acquired quickly.

Many spin-offs will have high innovativeness as a lot of resources are spent on R&D and the technology is sophisticated. The study also show that the network capabilities will moderate and enhance the entrepreneurial orientation – spin-off performance relation. For example, a spin-off who are talking with the market and have partners within the industry will be able to make better products that fits the markets needs and industry standards and thus enhance the spin-offs performance (Walter et al., 2006).

Clarysse and Moray (2004) gives several implications for my research topic. It argues that coaching the original team might be favorable in comparison to hiring a surrogate entrepreneur. In a resource perspective, this will mean that hiring new employees might not be the only way to strengthen the human resources and that strengthen the teams through coaching might be favorable.

Clarysse and Moray (2004) also discussed that hiring a surrogate entrepreneur might be challenging for several reasons. Finding and hiring a surrogate entrepreneur is therefore something that the ASO may need help with.

### **4.3 Social resources**

#### **4.3.1 Acquiring social resources.**

(Mosey and Wright, 2007) did a longitudinal study to find out how entrepreneurs with different levels of experience acquired their social resources. In the study, ASOs with entrepreneurs who had previous entrepreneurial experience were compared with ASOs where the entrepreneurs had no previous commercial experience.

It was found that entrepreneurs with prior business ownership experience had a wider network and was more able to acquire new network ties. While less experienced academic entrepreneurs, encounter structural holes between their previous scientific network and industry network (Mosey and Wright, 2007).

### **4.3.2 Size and strength of partnerships of TTOs**

As part of a study done among Italian University Technology transfer offices the researchers assessed how a number of characteristics of the TTO influenced the generation of ASOs. The study was done among the 48 Italian Universities that was carrying out Technology transfer activities, 37 of the Universities answered the questionnaire (Nosella and Grimaldi, 2009).

One of the characteristics that were assessed was the Universities social resources. Social resources was here referred to as the size of the TTOs professional network and the strength of the different partnerships and ties (Nosella and Grimaldi, 2009).

The researchers found a significant relation between the strength of the TTO-industry ties and the number of generated ASOs. However, the size of the network did not show any significance (Nosella and Grimaldi, 2009).

In contrast to other studies, it shows no significance of the size of the social network. It does however show the importance of the TTO having strong relationship with people in the industry (Nosella and Grimaldi, 2009).

### **4.3.3 Comments on social resources**

As with several other studies, Nosella and Grimaldi (2009) used the number of generated ASOs used as dependent variable. The study shows that the industry links have an impact on the number of spin-offs generated but it does not tell us how the TTO-industry links affects the further development and growth of these companies.

The findings of Nosella and Grimaldi (2009) might imply that the TTO is working as a broker between the industry and the university in order to create new ventures. Further, it implies that the partnerships between with the industry need to be of a certain strength before the industry partners engage in spin-off creation.

Mosey and Wright (2007) found that entrepreneurs with previous business experience had a larger industry network and were more effective in acquiring a new industry network. Contrary to the findings of Clarysse and Moray (2004), Mosey and Wright (2007) advocates that experienced entrepreneurs might be favorable as this will give the ASOs necessary industry links and network capabilities.

## **4.4 Financial resources**

### **4.4.1 Venture capital**

For ASOs, it is challenging to obtain capital investment from venture capitalist and other investors. Academic entrepreneurs are often having inadequate commercial awareness and lack the necessary experience that is needed to market a product or technology. Venture capital investors generally seek to invest in more experienced teams. Some venture capitalists might also find ASOs to be too risky (Lockett et al., 2002).

Venture capital investors may have requirements that the investee must comply with. Some venture capitalists might for example not invest in a company before a full time surrogate investor was in place (Wright et al., 2004).

Comparing two high tech university spin-offs that was funded by venture capitalist and two joint venture spin-offs who had been developed in cooperation with a partner organization, Wright et al. (2004) did a case study to find which method was the most favorable. A total of 36 in depth interviews were conducted among the founders of the ASOs and joint ventures and venture capitalists.

Contrary to the fact that many venture capitalists do not want to invest in ASOs before a full time surrogate investor was in place, they found that it was difficult to attract talented managerial resources before sufficient venture capital investments were made that could secure the ASO's early growth. The study also suggested that the joint venture method of commercializing was favorable compared to the other ASOs. The joint venture came with human capital that had a track record of starting business and also came with a network in the relevant industry (Wright et al., 2004).

Another issue that were discussed was that getting venture capital investments was time consuming. Especially for an unexperienced academic entrepreneur which did not have the requisite resources, skills and support (Wright et al., 2004).

Finally, the study showed that the relationship between the joint ventures and the industrial partner seemed to be a bit more transparent then the relationship between the ASOs and their venture capitalist. As the relationship between the joint venture and the industrial partner seemed to be relying on a bit more trust and a bit less information asymmetry (Wright et al., 2004)

The fact that venture capitalists are biased towards ASOs in comparison to other high tech companies is a common myth. Munari and Toschi (2011) did a study among 247 companies (123 academic spin-offs and 124 other) to find out if venture capitalist were actually being biased towards ASOs. All the companies came from the micro and nanotechnology sector in the UK. No evidence of a bias of venture capital firms towards ASOs were found.

#### **4.4.2 Innovation support grants**

In his comparison of ASOs to its peers, Stephan (2014) found that 77 per cent of the ASOs had received innovation support from grants and 53 per cent were planning to apply for it. This was about 12-13 per cent higher than the other startups.

Stephan (2014) does not argue why the spin-offs are more effective in obtaining innovation support from grants. One reason might be that academics are used to applying grants to fund their research. Another reason might be that the TTO are pushing them or helping them to apply these grants.

#### **4.4.3 Comments on financial resources.**

The comparison of the joint venture and the ASO with venture capital funding favorites the joint venture way of commercializing (Wright et al., 2004). Still, many of the things that make ASOs unfavorable can be mitigated with a TTO as an innovation intermediary. Primarily, the TTO should be able to find a surrogate entrepreneur or temporarily use some of their own employees as the CEO to become more attractive for an investor. Secondly, the TTO should have the necessary resources and skills to help the entrepreneur get in contact with and secure

venture capital funding. Finally, the TTO should be able to help the spin-off-company in their interaction with the venture capital firm.

Wright et al. (2004) seemed a bit biased as it is stated early in the article that the goal of the study was to show why the joint venture method of commercializing were favorable. Nevertheless, the challenges for ASOs to get venture capital funding were still real.

The literature is somewhat divided when it comes to the relation between ASOs and venture capital funds. Munari and Toschi (2011) found that venture capital investors are not biased towards ASOs. Lockett et al. (2002) highlighted several reasons why venture capitalist might not invest in ASOs. This is because ASOs often are founded by unexperienced teams that lack entrepreneurial experience and commercial skills, while Venture capitalist usually invest in experienced teams. Human resources and capabilities is therefore important to attract big investors and should be a priority for ASOs and TTOs.

Stephan (2014) found that ASOs are better in acquiring grants than other new ventures. However, he does not argue why the spin-offs are more effective in obtaining innovation support from grants. One reason might be that academics are used to applying grants to fund their research. Another reason might be that the TTO are pushing them or helping them to apply these grants. A third reason might be that ASOs have access to dedicated grants in addition to the same grants as their venture counterparts.

## **4.5 Technological resources**

Building on patented university technology it is fair to believe that ASOs have a higher degree of innovativeness than other startup companies. This notion was confirmed by Stephan (2014) using a sample of 2800 companies from highly innovative sectors. Stephan showed that ASOs were superior when it comes to innovation production compared to their peers.

Even though the ASOs showed to be far superior on innovativeness than their peers there is still certain aspects of building technology resources that the ASOs might need help with. As we discussed earlier, innovativeness, as part of entrepreneurial orientation was found to have low impact on the ASO's performance. In fact, if entrepreneurial orientation should have an impact on the ASOs performance, it was important to have good networking capabilities (Walter et al., 2006).

### **4.5.1 Comments on technological resources**

According to Mustar et al. (2006) human and financial resources is relatively well explored by scholars, while technological resources have not caught the attention by scholars in the same way. This was confirmed in my scan for relevant research papers, as it was very hard to find relevant articles.

Building on the notion that ASOs have great innovativeness but generally lack the networking skills to utilize this capability, we can suggest that one important task for TTOs when it comes to building the ASO's technological resources (Walter et al., 2006). TTOs might contribute to this, by acquiring human resources with the right capabilities or by to be an intermediary between the researcher/developer of the technology and the market.

TTOs might also be useful in developing the technology through introducing ASOs to relevant partners they can develop their products in cooperation with or simply giving the ASOs access to lab equipment, raw materials or other necessities that is needed to finish the product as this might mitigate the urgent need for capital, described by Clarysse and Bruneel (2007).

### **4.5.2 Obstacles for academic spin-offs (ASOs).**

(van Geenhuizen and Soetanto, 2009) did a study on obstacles to growth among Dutch ASOs from the Netherlands. The study was done among 58 ASOs that was founded between 1994-2003. All the ASOs had been supported by the university on a weak support program. They also did in-depth interviews among 15 ASOs. The ASOs was asked about obstacles in relation to market, management, finance, physical, and governmental obstacles.

It was found that a lack of marketing knowledge was the most frequently reported obstacle (16.1% of all reported obstacles). Next to marketing knowledge sales skills was the second most reported obstacle (13.2%). The third most reported obstacle was a lack of positive cash flow (12.6%). Dealing with uncertainty was the fourth most reported obstacle (11.5%) (van Geenhuizen and Soetanto, 2009).

van Geenhuizen and Soetanto (2009) also did an analysis on how frequent the obstacles occurred on a basis of how old the ASOs were. Naturally, there was a decrease of the occurrence of different obstacles as the ASOs grew older. However, to identify trends in the decrease of the occurrence of these obstacles an "obstacle reduction rate" was measured. Market related

obstacles seemed to be the most persistent obstacle with an obstacle reduction rate of 20.6% between the ASOs that was less than three years and the ASOs that was more than 6 years. Financial related obstacles dropped with 56.9% and management related obstacles with 61,4% in the same time period (van Geenhuizen and Soetanto, 2009).

### **4.5.3 Comments on obstacles for ASOs**

van Geenhuizen and Soetanto (2009) showed that most of the ASOs face obstacles with human resources, as both management related and marketing related obstacles are related to human capabilities. We also see that many companies face obstacles related to cash flow.

The study also differ highly innovative spin-offs and assesses whether these develop differently. Mainly the highly innovative spin-offs face more problems initially but have a stronger decrease of obstacles in later years.

This study have several weaknesses and limitations. Primarily a lot of the companies that were included in the study was service companies (70%). While this study implies that the financial obstacles will be solved early on, other studies have suggested that the need for funding is increasing as the company grows and the need for R&D or production facilities are needed. (Powell et al., 2002, van Geenhuizen, 2003)

Another limitation is that the sample of ASOs are all from the Delft area, a relative small area in the Netherlands. This might be a weakness as geographical, structural or cultural factor might have an impact on the result of the study. However, being from the same environment most of the external factors will be the same for all of these ASOs, this might make the results more credible.

The findings of van Geenhuizen and Soetanto (2009) confirms the notion that ASOs generally lack entrepreneurial experience and marketing and sales skills (Siegel et al., 2003, van Geenhuizen and Soetanto, 2009)

## **4.6 Critical junctures in the development of ASOs**

Based on previous research and a case study Vohora et al. (2004) described how an ASO goes through distinct phases in development of resources and dynamic capabilities. These phases

were labeled as research, opportunity framing, preorganization and reorientation phase. They found that the ASO had to overcome certain junctures in order to advance to the next phase.

The first obstacle that has to be overcome in the research phase is “opportunity recognition”. As academic entrepreneurs seldom have entrepreneurial experience and knowledge of the market, it can be hard to conceptualize a technology to fit a need in the market and achieve proof of market. ASOs therefore need to acquire a capability to combine scientific knowledge with an understanding of the market (Vohora et al., 2004).

The second obstacle, “entrepreneurial commitment”, is faced in the opportunity framing phase. As this phase has a lot of uncertainty surrounding the technology and finding suitable applications for the technology in the relevant market, the entrepreneurs involved have to be emotionally committed. The commitment of the researcher or inventor might be especially important to achieve continued innovations streaming in to the ASO. This does not mean that the researcher/inventor are best suited to be CEO (Vohora et al., 2004).

In the preorganization phase, “credibility” is an obstacle that needs to be overcome. Credibility is recognized as a key issue for most new ventures. However, the issue of credibility is more significant for ASOs than for other startups. Credibility needs to be achieved to reach customers and necessary investors. In order to achieve credibility it is necessary to acquire human and social capital, it was therefore found to be important to hire a surrogate entrepreneur. Further, initial resources need to be obtained in order to attract a surrogate entrepreneur (Vohora et al., 2004).

Finally, to advance from the Re-orientation phase to sustainable returns, the obstacle of “sustainability threshold” needs to be overcome. The ASOs that moved beyond this juncture managed to continuously re-configure existing resource weaknesses, inadequate capabilities and social liabilities into resource strengths, distinctive capabilities and social capital to generate returns for the ASOs. To achieve this, the ASO depends on the right entrepreneurial capabilities (Vohora et al., 2004).

#### **4.6.1 Comments on critical junctures**

Critical junctures are beyond the scope of this study, still Vohora et al. (2004) is important for two reasons. Primarily, the obstacles that need to be overcome involves gathering resources and capabilities. I can therefore say that ASOs have certain moments in their development where



certain resources is highly important. To successfully evolve, the ASO must acquire the relevant resources for each obstacle.

Secondly, overcoming the obstacles for each juncture involves acquiring resources and capabilities in order to get access to new resources and capabilities. This indicates that some resources and capabilities are more important as they unlock the access to other resources. According to Brush et al. (2001), financial resources are instrumental because they can be used to acquire other resources. According to Vohora et al. (2004) the same can be said about human resources as many of the obstacles are overcome by acquiring human resources and capabilities, and overcoming the junctures gives access to new resources.

## **4.7 Institutional factors**

Some of the universities stood out from the rest with a superior number of ASOs created compared to the other universities. These, included the Massachusetts Institute of Technology who in the period 1995-2001 generated a total of 132 ASOs and the University of California system that generated a total of 118 ASOs in the same period (O'Shea et al., 2005).

O'Shea et al. (2005) assessed institutional factors on the universities that stood out, compared to institutional factors at other universities. The study provided several interesting findings. Primarily, universities had different resource stocks available because of their previous history and success with spin-off formation. Secondly, the quality of the university faculties was shown to be of high relevance. Thirdly, the amount of funding allocated to spin-offs had an impact on generation. A fourth result was a significant impact because of the number of TTO staff.

### **4.7.1 Comments on institutional factors**

O'Shea et al. (2005) show that the internal resources had an impact on the ASOs generated. However, using the number of ASOs generated as the only dependent variable makes the study somewhat irrelevant for me. The study shows how the internal resources influences the number of generated ASOs but we don't know much about how these ASOs develop and grow beyond the point of formation. Perhaps the most interesting finding is that as universities grow a history of generating ASOs, they develop a resource base that can be useful in developing new ASOs. The study also emphasizes that it is important for a University to form partnerships with industrial and governmental funding agents, to make resources available for ASOs.

Many of the findings imply that the more resources you put into spin-off generation the more spin-offs will be generated. This makes sense but it would have been interesting to see what measures that was most effective to improve the resources in ASOs out ratio. It is however interesting to see that the number of TTO staff have an impact, as this shows that the TTO is highly relevant in formation of ASOs.

## **4.8 Intermediaries in technology transfer**

### **4.8.1 Intermediaries in the UK Biotech industry**

Shohet and Prevezer (1996) did a study on technology transfer in the UK Biotech industry. In this study, they investigated what role different public and private actors were playing in the technology transfer process of biotech.

Through interviewing private and public stakeholders as well as drawing knowledge from policy documents, official reports and other public documents, Shohet and Prevezer (1996) identified three roles intermediaries task that could be conducted by intermediaries in the technology transfer process:

1. *Agents operating in an imperfect knowledge market:* Research and inventions in the biotech industry comes with high uncertainty. Many of the researchers/inventors do not have the commercial skills necessary to commercialize their ideas. Intermediaries could therefore play the role as advisors, helping to commercialize value and deal with uncertainty.
2. *Providing a liaison service:* Intermediaries could act as contact points or middlemen for companies that are seeking external partners or looking to find complementary technology from other universities or stakeholders.
3. *Provision of, and signposting to, complementary assets:* Intermediaries may play a role in acquiring complementary assets through using network, helping companies apply for grants and setting up investment funds. (Shohet and Prevezer, 1996)

### **4.8.2 The role of the TTO in resource acquisition**

Leitch and Harrison (2005) did a case study on spin-off formation at QUBIS, which is the TTO at the Queens University in Northern Ireland and one of the oldest of the TTO's within the UK.

The study focus on one of the spin-off companies to spin out of the TTO (Kainos) and the relationship between the QUBIS and Kainos. The study further explores the relationship between QUBIS and the second order spin-off companies to spin out of Kainos.

One of the topics that is explored in the study is how QUBIS enables resource acquisition for the Kainos and the second order spin-off companies. Resources were here defined as finance, advice, support, people and technology which has some similarities with Mustar et al. (2006). (Leitch and Harrison, 2005)

The study is still different from Mustar et al. (2006). The main differences are that Mustar also include social resources in his framework, such as partnerships and industry links. There is also a difference in the definition of the different resources as (Leitch and Harrison, 2005)define technology as technological infrastructure and tools while Mustar et al. (2006)define technological resources as the technology and the products of the ASO.

In general, Leitch and Harrison (2005)suggested that the QUBIS play an important role when it comes to both giving advice and support, as well as giving the companies access with necessary resources such as finance, people and technology.

Another interesting observation was that the QUBIS did play an important role in connecting the second order spin-off company as well as the first order spin-off company. The article states that the reason Kainos involved QUBIS in the second order spin-offs is because of their status in the region, their experience with QUBIS as a professional and stable actor and because the possibility of benefiting from the experience and networks that QUBIS have gained during years of experience (Leitch and Harrison, 2005).

#### **4.8.3 Comments on the intermediaries in technology transfer**

The article is highly relevant for my study as it gives a thorough case study on how the TTO, QUBIS is giving the spin-off companies access to resources. The framework that is used is also very similar to Mustar et al. (2006). The study is somewhat different from the context of this paper due to the involvement in three of the second-degree spin-offs of one of the former companies. While it shows that TTOs acts as intermediaries and provide resources for these companies, the focus of the study is more on what stake the TTO have in second-degree spin-off companies.

(Shohet and Prevezer, 1996) identified three tasks that could be conducted by intermediaries in a technology transfer process. These tasks can be summarized as advisory, broker and bridge, which confirms the framework I have introduced in the theory chapter. The study does not look at one organization or stakeholder, but innovation intermediaries as a whole. TTOs aren't mentioned and the article is a bit dated.

## **4.9 Synopsis and relevance to my research project**

To conclude my literature review I will give a synopsis of the review. I will make some relevant implications as well as position my research subject in comparison to previous research.

Despite Clarysse and Moray (2004) proposing that training the team in entrepreneurial skills, several of the other studies that I have looked at favor a surrogate entrepreneur. As we discussed earlier ASOs tend to be founded by scientists without the necessary business experience, the founders of ASOs tend to lack the network, experience and persuasiveness that an entrepreneur needs (Siegel et al., 2003). The relevant literature implies that an experienced entrepreneur might be needed in order to acquire financial resources (Lockett et al., 2002). In the research on technological resources it was found that entrepreneurial orientation in ASOs were higher than in other startup ventures (Stephan, 2014). Innovativeness was found to be less significant for an ASO's success than network capabilities. In addition, network capabilities was found to be important for utilizing the entrepreneurial orientation of the ASOs (Walter et al., 2006). This implies that hiring an experienced surrogate entrepreneur is of high importance when acquiring resources for an ASO.

Research on critical junctures, showed that different resources were needed for different moments in an ASO's development. Many of these junctures were related to human resources and capabilities, adding to the notion that an experienced entrepreneur must be acquired (Vohora et al., 2004).

Although most of the research reviewed point out that a surrogate entrepreneur might be favorable, the commitment of the researcher/inventor is also important. Vohora et al. (2004) commitment of the researcher or inventor might be especially important to achieve continued innovations streaming in to the ASO. They also underlined that this does not mean that the researcher inventor is the best fit for a CEO.

When it comes to social resources, it was found that the strength of a TTOs industry network had an impact on the spin-off formation of the TTO. This can imply that the partnerships between the industry have to be of a certain strength before an industry might engage in spin-off formation activities (Nosella and Grimaldi, 2009)

The research on technological resources in relation to ASOs was found to be a bit limited. We know that the innovativeness of ASOs tend to be far superior to other new ventures, but need to be combined with entrepreneurial orientation in order to be utilized fully (Clarysse and Moray, 2004, Walter et al., 2006). Besides hiring an experienced entrepreneur, one option might be to utilize the entrepreneurial experience of the TTO itself.

A lot of research on TTOs uses the number of ASOs generated as a dependent variable. While this might give implications on how to get researchers to engage in entrepreneurial activities, it does not say anything on how the ASOs develop after they have been founded (Anderson et al., 2007, Caldera and Debande, 2010, Siegel et al., 2007, Siegel et al., 2003)

According to my literature scan, the literature on TTOs as innovation intermediaries are very limited. Leitch and Harrison (2005) did a similar study when they were looking at how a TTO provided ASOs and second degree ASOs with necessary resources. However, the study focused more on which resources that were provided and how the TTO committed to second-degree spin-offs, and not so much on how the process of getting these resources was done.

(Shohet and Prevezer, 1996) identified three roles that could be conducted by innovation intermediaries in commercialization of biotech in the UK; Agents operating in an imperfect knowledge market, Providing a liaison service and Provision of, and signposting to, complementary assets. The study looked at innovation intermediaries as a whole and not one single organization or stakeholder.

My research project focus on how TTOs acts as innovation intermediary in order to help ASOs acquire resources and build their resource base. While a lot of research are focusing on number of generated ASOs as a TTOs output, we are focusing on how the TTOs are helping the ASOs as an output. While (Leitch and Harrison, 2005) were focusing on which resources were provided to the ASOs from the TTOs, we are focusing on how these resources are acquired.

# 5 Methodology

## 5.1 Research design

This study was done using an exploratory case study research design. The exploratory research design was necessary, as little research have been done on this particular field. The goal of this study was to explore how TTO's are helping academic spin-offs to get access to necessary resources which is needed for a company to succeed. In other words, the phenomenon we are looking at is how TTO's is helping the ASOs. Carrying out this study, we used a very specific theoretical framework to describe the phenomenon; the study was therefore partly descriptive as I looked at how several existing theories are matching the phenomenon (Wilson, 2014)

A case study design was selected as this study is conducting an analysis of a “*contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident*” (Yin, 2013).

Because of the variations in technology, team, background etc. there are probably as many variations to how ASOs is carried out as there are ASOs. As I carried out my research I also found a lot of variations to the relationship between ASOs and TTOs. I therefore choose a multiple case design as looking at one specific ASO from one specific TTO was too inaccurate to provide an understanding of the research question.

As the TTOs and ASOs might have different experiences with this phenomenon, I also used an embedded analyses design (Wilson, 2014). With the bases of figure 1, there are basically two actors that need to be studied, one is the ASO which acquire the resources, and one is the TTO which is helping the ASO acquire these resources. In order to get a full understanding of the case I therefore chose to interview both the ASOs and the TTOs.

In total there are seven cases being analyzed in this study, with each of the ASOs being different cases. The analysis was based on how these cases relate to the theoretical framework consisting of resource-based theory, resource-dependence theory and innovation intermediaries.

## 5.2 Reliability and validity

In order to maintain reliability I needed to interview both the CEOs of spin-off companies and people working at TTOs. This approach provided us with two different perspectives on the relevant cases. Many of the companies that were interviewed was from the domain of medical/pharmaceutical technology. I also interviewed companies within energy, software and hardware domain to get a more general understanding on the phenomenon and not just how the phenomenon carried out on medical /pharmaceutical domain. Both resource-based view, resource-dependence theory on innovation intermediaries were used to analyze the data as theory triangulation (Wilson, 2014).

One of the ASOs that were interviewed had a particularly bad experience with their TTO. Therefore, to ensure reliable data about how that TTO carried out their operations I chose to interview yet another company. The sample extension was based on the first sample clearly differencing from other samples and increased the variation in the selected samples.

This study is limited to the Norwegian context and samples companies from six different TTOs. To obtain a broad understanding I have sampled seven cases. An alternative approach could be to interview a sample of companies from one TTO. The latter might not have been optimal in building a general idea of the phenomenon, as there might have been specific characteristics concerning that specific TTO which might not have been the case with other TTOs. Nevertheless, one reliance risk that comes with our method is that we may have interviewed companies that have a particular good or bad experience with the TTO. To mitigate this risk I tried different methods of selecting the sample ASOs, as some were referenced by the TTOs and some companies were contacted directly without involvement from the TTOs.

Another reliability risk with this study was hindsight bias (Wilson, 2014). As I was looking at a phenomenon that had been ongoing for years, it would be optimal to do a study over time. This was not an option with this study as I had limited time to carry it out. I therefore had to ask the interviewees about past events. This may have had an impact on my results. To mitigate the hindsight bias I only interviewed ASOs that was currently in partnership or partly owned by the TTO.

In order to ensure validity I changed my research question. My initial research question was “How are TTOs helping academic spin-off companies?”. The scope of my initial research question was very broad and covered many areas which was not covered in the theoretical framework used. Therefore, I chose to limit my research question to only concerning resources

and how the TTOs are acting as a innovation intermediary to help ASOs get access to this resources (Wilson, 2014).

There were a couple of other validity risks involved in this study. I found that a some of the companies that I contacted dropped out of the study, as they could not find time to be interviewed. This came from the fact that the interviewees had a busy schedule and did not have time to participate. There were not a lot of interviewees that dropped out, but still the mortality might have had a small impact.

While some of the ASOs interviewed were referenced to me from the TTO, there was a risk of instrumentation (Wilson, 2014). In order to mitigate this risk I also interviewed companies that I contacted directly.

Despite these risks, the study is still relevant as the main goal of the study is not to assess the quality of TTOs or give empirical answers to how the TTOs are helping ASOs. The study aims merely to give an understanding of a phenomenon that could be topics of further study rather than making concrete conclusions.

### **5.3 Data collection process**

The first step of collecting data for this study was to find relevant literature to review. The literature was primarily found through three previous literature reviews and taxonomies: “University entrepreneurship: a taxonomy of the literature” (Rotharernel et al., 2007), “Spinouts from academic institutions: a literature review with suggestions for further research” (Djokivitch and Souitaris, 2006) and “Spinouts from academic institutions: a literature review with suggestions for further research” (Perkmann et al.,2013). In addition, I did a citation scan for the relevant theory articles. Some articles were found through searching on google scholar and some literature was provided by the supervisor. The relevant literature was selected on the bases of its relevance to the research topic and theoretical framework. The quality of the used articles was measured by citations.

When selecting articles I also chose studies from a similar context. With a few exceptions this meaning studies carried out in Western Europe or United States. The novelty of the articles were also a concern as some articles were found to be dated.



The second step was to find relevant candidates for the qualitative data collection. I contacted all the biggest TTOs in Norway to get introductions to some relevant ASOs. The following criterias were used in selecting interview candidates:

1. The ASO had to be high tech growth company.
2. Their technology had to be developed at a University, Research Institute or University Hospital.
3. The TTO had to have some impact on the development of the ASO.
4. The ASO had to have an experience with one or more years within the TTO, with the TTO as a current stakeholder.
5. Although not a criteria, the initial inventor should still be a part of the company as a part of the entrepreneurial team.

Criteria 1 was selected, because I wanted the company to be involved in some form of company. A lot of the theory I used have technology companies as a basis. Service oriented companies do not necessary apply to the same framework.

Criteria 2 was selected, as I wanted there to be a relation with the mother institution. It was interesting to see how the technological and human resources are transferred from the mother institution to the ASO.

Criteria 3 and 4 was selected, as I wanted to see ASOs where the TTOs has had some kind of impact. Some companies might self-driven or more or less ignored by the TTO after formation. In that case, the interviews would not have given us insight on how TTOs carries out their role as an innovation intermediary. The goal of this project is not to generalize the results and level of involvement by the TTOs but rather to give implications on how this role is carried out by the TTO.

The last criteria was not absolute. Still, having the inventor onboard, would give me more insight of the full history of the TTO.

In addition to the TTOs introducing me to relevant ASOs I contacted two of the companies myself as I wanted to ensure the reliance of the ASOs that I interviewed.

Carrying out the interviews I also found it necessary to interview some of the TTOs. This was mainly because it felt necessary to have two different perspectives on the phenomenon. Another reason was that I saw that the data gathered from the ASOs was somewhat convergent and I

wanted to find some pattern and general thoughts on how the phenomenon usually carries out. The relevant TTOs was chosen based on their profile, their focus on ASOs and response from the ASOs.

Most of the interviews were conducted face to face or via skype, two of the interviews had to be conducted on phone. The interviews were conducted using a semi structured interview method (Wilson, 2014). Interview guides were developed for the different groups of interview subjects containing primarily questions and optional probe questions. The resource-based view framework of Mustar et al. (2006) was mainly used as a basis for the interview guides. The interview guides are attached in the appendix.

All of the interviews but one were recorded in order to give a more accurate interpretation. The interview candidates were also sent a case description of their relevant interviews to verify my findings, all of the interviewees answered and minor adjustments were made to the case descriptions. This was especially important as the interviews was conducted in Norwegian and the report written in English.

### 5.3.1 Selection

Following is a presentation of the different interviewees. Due to issues of anonymity and identifiability certain details of the companies are left out.

	<b>Interviewee</b>	<b>Experience</b>	<b>Industry</b>	<b>Established</b>
<b>ASO 1</b>	CEO	Experienced	Oil and gas service	2006
<b>ASO 2</b>	CEO	Experienced	Airline security/hardware	2010
<b>ASO 3</b>	CEO	Student	Cleantech/software	2013
<b>ASO 4</b>	CEO	Unexperienced researcher	Biotech life science	2013
<b>ASO 5</b>	CEO	Experienced	*	*
<b>ASO 6</b>	CEO	Experienced	Life science	2013
<b>ASO 7</b>	CEO	Unexperienced researcher	Life science/software	2009
<b>TTO 1</b>	Business developer	NA	NA	2004

<i>TTO 2</i>	Head of portofolio	NA	NA	1995
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Table 3: Presentation of interviewed companies

\* the interviewee asked to not be identifiable. Information that might allow readers to identify the interviewee are therefore left out.

## 5.4 Anonymity and identifiability

All the interview candidates were giving the option of anonymity. One of the interview candidates was particularly preoccupied with identifiability because of a current dispute between his company and the TTO.

In order to respect the wish of this candidate to not be identifiable, the different ASOs and TTOs are all be presented without names. None of the other companies gave requests regarding anonymity or identifiability, but if every other company is presented by name it is easy for a TTO or other stakeholder to identify that exact company if they knew that they participated in this study. I am also not giving away details that can lead to them being identified.

## 5.5 Analyzing the results

Before starting the analysis, all the interviews were transcribed. A short summary from each of the interviews were sent to the interviewees for confirmation. All the interviewees confirmed and minor adjustments were done.

Each transcript were then given a color code. I then started coding the interviews by using a combination of emergent coding and priory coding (Wilson, 2014). The interviews guide were made with a basis of the framework of (Mustar et al., 2006). I therefore used selective coding to categorize the data in accordance with: human resources, social resources, financial resources, technological resources and other resources. Each of the categories were then split up in to the subcategories; help from TTO, other sources and interpretation/other information.

One issue that was met was the interconnectedness of the different resources. E.g., the social resources acquired might also be important stakeholders in developing the technology or investing in the company. To solve this I labeled the relevant citation in accordance to the relevant question, and thus basing the labeling on the interviewees interpretation. All the data from the categories and subcategories was gathered in an excel sheet.

As this is an exploratory case study, no propositions were developed to analyze the findings (Yin, 2013). Instead, the analysis was done in accordance to figure 1. The data for each category was grouped by their similarities and patterns. I then made illustrations for each of the resource groups: human resources, social resources, financial resources and technological resources.

When I had categorized the relevant info about resource acquisition, I categorized the additional of the data in accordance to an open coding system (Wilson, 2014). The following labels were used; Relationship between TTO and Spin-off company, change over time, general help from TTO, resource base and characterization of the TTO.

*Relationship between TTO and Spin-off company* was general answers about the relationship between the TTO and the spin-off companies and how this relationship might affect the service given from the TTO to the spin-off company. *Change over time* related to how the need for resources had changed over time and how the ASO had evolved during their lifespan. *General help from the TTO* was everything relating to how the TTO had helped the company in other ways than through resource acquisition. *Characterization of the TTO* related to everything that was said about what a TTO was and what role a TTO should have in relation to ASOs.

Finally, I interpreted the findings in accordance with the theoretical framework of resource-based view, resource-dependence theory and theory on innovation intermediaries. To ensure triangulations the empirical evidences and findings of some of the articles reviewed were used as secondary data (Yin, 2013). The additional findings were also used when interpreting the results as these gave some additional understanding on how the different roles of the TTOs as innovation intermediaries were carried out. I also identified a fifth role that a TTO could take in intermediation: moderator.

# 6 Results and analysis

In total seven companies were interviewed. In table 4, we summarize how the ASOs acquired their resources with an emphasis on how the TTOs are helping.

## 6.1 Interview results from the ASOs

	<i>Human resources</i>	<i>Social resources</i>	<i>Financial resources</i>	<i>Technological resources</i>
1	One person recruited internally from TTO. Most human resources recruited through network. Technology manager came from O&G company where tech was developed.	TTO have not played a part in acquiring customers/partners. Most customers and partners acquired from the team. Some contacts came with recruited employees.	TTO played an important part on the early stage by acquiring funding from Innovation Norway and FORNY. Have also acquired a lot of funding through research contracts with O&G-companies	TTO have played a small part in development of technology mostly through IPR. Some suppliers have also played an important part.
2	TTO have not contributed to acquiring human resources. Technology manager original inventor. Limited relevant expertise in Norway thus had to recruit international.	TTO have played the role as a moderator between research institutes. Other social resources have been acquired directly from the ASO. Most necessary network is international.	TTO have helped the company getting grants. The TTO has also set up a VC fund to help the ASOs.	TTO played an important part in developing the technology as they introduced the ASO to important partners. This was more important in the earlier stage. The company is now developing the technology with international airline companies.
3*	TTO tried to introduce the company to one person. The person was not hired. Most human resources acquired through network and remote friends.	TTO have not helped the company with acquiring social resources. Most network connections have been acquired through friends and family.	TTO gave the company 100 000 NOK and covered the formation expenses, this was given as a business plan competition prize. The ASO have struggled as other investors felt the ownership that was acquired from the TTO was too much compared to what they had invested. The ASO have later acquired 410 000 NOK from Innovation Norway and invested 210 000 themselves.	TTO introduces the ASO to a patent office that the company already had been in contact with. Other than that that the TTO did not contribute to the development of the technology. Have gotten some help from the University as the University set up a lab for them to use.
4* *	The CEO was the inventor of the technology. Have not acquired other human resources.	TTO had not helped the ASO with acquiring any social resources. The company cooperated with a German Biotech company and international interest organization.	TTO helped the company acquire grants from Innovation Norway. Had also gotten funding from FORNY. TTO put together an investment forum for their companies to	Under the impression that the TTO should stay away from the development of the technology. Three researchers at the University developed the technology.

5 ** *	The CEO originally worked as project manager at the TTO. Two other hiring's were done by the TTO.	The TTO had introduced the ASO to faculty deans at the University. The TTO also arranged for the company to go to Silicon Valley to meet potential partners/customers.	meet potential investors. The company was originally established to acquire funding for a project. Have acquired funding from several funds at the University and the TTO, and FORNY.	The TTO have helped the ASO with IP protection. The lab where the technology is further developed was also set up by the TTO. The technology was initially developed by another corporation.
6	The CEO was familiar with the TTO prior to the founding of the ASO. The ASO was established by the CEO contacting the TTO to obtain intellectual property to commercialize.	TTO invites the ASO whenever they have visitors from the life science industry. The development partners have been acquired directly from the ASO.	The TTO have invested a couple of hundred thousand. Have also gotten 14 million in soft funding through an IFU/OFU project with a University Hospital and lab partner. Have invested 6 million themselves	TTO funded the project that led to the technology. Are helping the ASO with IP. The proof of concept and clinical trials are being done in cooperation with a University hospital and lab partner.
7	CEO was the inventor of the technology. Had no previous startup experience. The hire was made possible through a cooperation agreement between the TTO and the hospital. The TTO had trained him in commercial skills. The marketing manager was a previous employee at the TTO. The rest of the team had been recruited through consultant deals, internships and network.	The company have acquired a global social network through interest groups and other network. The first initial partner was a Danish hospital that contacted the company to get access to their technology.	The TTO in cooperation with the chairman of the board have been important in acquiring funding. The ASO had gotten funding through several innovation and research grants like OFU and Skattefunn. They had also gotten some funding from private investors and the local bank.	The TTO helped the ASO to orientate the product towards the market. The TTO also helped the company with the IP evaluation. The technology was initially developed at the University hospital.

Table 4: Resource acquisition by the ASOs.

\*the company differs from the rest of the companies as they became partners with the TTO through a business plan competition, The technology was developed by students and the relationship between the company and the TTO was significantly worse than the other companies interviewed.

\*\* was unable to record the interview as it had to be done by phone, a summary of the interview was sent to the interviewee to ensure validity

\*\*\* the interviewee asked to not be identifiable. Information that might allow readers to identify the interviewee are therefore left out.

## 6.2 Interview results from the TTOs

To ensure the validity of the study I interviewed two TTO's. The TTO of ASO 2 and 7 were interviewed. From TTO 1, a business developer who had been working on the relevant ASO was interviewed. From TTO 2 I interviewed the portfolio manager. The TTOs were throughout the interview asked to give examples on how they helped the relevant companies and were also asked specific questions about these companies. Answers about the specific ASOs are included

in table 4. The TTOs also gave general answers about how they usually deal with resource acquisition on behalf of their companies. The general answers can be read in table 5.

	<b>Related ASO</b>	<b>Human resources</b>	<b>Social resources</b>	<b>Financial resources</b>	<b>Technological resources</b>
<b>1</b>	7	Usually someone from the TTO enters as the CEO. The entrepreneurial team is recruited based on an assessment of when different skills and capabilities are needed. In some cases the inventor is trained to be the CEO. Usually they try to hire a CEO with entrepreneurial experience as VC-investors demands this.	The TTO have been in business since 2005 and thus have a big network. They also try to take advantage of the mentoring program form Innovation Norway. Are also offering the companies a program called "Accel" where the ASOs design business plans and interact with people from the industry.	Considers the job of acquiring funding to be the most important task of a TTO. Put a lot of effort to increase the value of the company through grants and smaller investors before they acquire VC-money.	TTO are helping ASOs with IP. Are also helping the ASOs with market orienting their product. Uses Lean Canvas to find if hypothesis is right and then does small pivots and adjustments according to input from the market. Are also connecting the ASOs with resources necessary to develop the technology.
<b>2</b>	2	Someone from the TTO usually acts as the CEO in the initial stage. Have a pool of skilled entrepreneurs that they are hiring on a frequent basis. Does not offer a training program but are indirectly training the entrepreneurial team through mentoring.	Have a portfolio of 94 successful ASOs and are using these ASOs deliberately to enhance the network of new ASOs. Does also have a moderating role between the different research institutes and higher education institutions which are owners of the TTO.	Have a lot of experience on acquiring grants from Innovation Norway and the Norwegian Research Council. Are a registered FORNY actor. The TTO usually invests some of their own money into ASOs and have also developed a fund in cooperation with the county. Have contact with a lot of VCs and usually initiates the contact between VCs and ASOs.	Differs from other TTOs as they are not working with patents. The TTO are helping the companies with a market orientation of their technology. Are also acting as a moderator between the different research institutes and between the institutes and corporations in order to facilitate innovation.

Table 5: Research acquisition actions from the TTOs.

### 6.3 Resource flow.

In the following chapter I analyze the different cases to give a greater understanding of how resources are acquired by the ASOs. I try to emphasize on how the TTOs are helping the spin-off companies. However, for some of the cases the TTOs played little or no part in acquiring the resources while other stakeholder was very important. I am therefore giving a general picture of how the resources are acquired.

### 6.3.1 Human resources.

The most obvious route for ASOs to acquire human resources is when the researchers/inventors decide to be a part of the entrepreneurial team when forming an ASO. The human resources will in this case come from the University. There might be different ways that a TTO might play a part in the transition from a scientist at a University to an entrepreneur. The interviewee from TTO 1 explained that the choice to hire an inventor in the entrepreneurial team and what role this person would have in the team was something that was assessed when starting the project:

*“We usually start with an expectation clarification where we map what the subjects ultimate goal is. Then it is important that the researcher says something about whether he wants be in academia or if he want to take on journey of starting a company, and if he wants to return to academia. It is slightly different in each case.”(TTO 1)*

The TTO might also assist in making agreements with the University or research institute to onboard the researcher. In the case of ASO 7, the researchers continued to work 50% at the hospital while working 50% with the ASO.

*“The TTO has made the negotiations directly with Haukeland, where this has become a model for how to drive innovation at the hospital. They try to make it general with us as a pilot.” (ASO 7)*

In the cases where the researcher acts as a CEO the researcher may require some training in order to develop commercial skills and capabilities. Clarysse and Moray (2004) argued that this model might be favorable as hiring an experienced surrogate entrepreneur is difficult and time consuming. Among the 7 ASOs I studied only ASO 3, 4 and 7 had the inventor/researcher acting as a CEO. According to TTO 1, part of the assessment that was done before taking on the project was the researcher’s ability to learn. The interviewee also stressed the issue that venture capitalists might demand an experienced CEO.

*“It is not everyone you can or will train. In the relevant case, the researcher acts as the manager, but he is aware that the investment round we are running now intends to replace him as the CEO.” (TTO 1)*

TTO 2 also confirmed the notion that Venture capitalist demands that the companies they invest in have an experienced CEO (Wright et al., 2004).



Another source of human resources is the TTO itself. Both TTOs interviewed usually followed a process where they stepped in as CEOs of the companies. For TTO 1 this meant working full time for the company:

*“For example, I go in as general manager. This means we take all administrative and mercantile work, to relief the researcher from this work. This mean that we are creating companies and taking all shareholder agreements, any transfer of IP etc. We can join in as general manager for a period that may last anywhere from a few months to a few years.” (TTO 1)*

In other cases the project manager or someone else from the TTO becomes permanent employees in the ASO. In ASO 5, the CEO was initially hired as a project manager for that specific project, on a later stage he became the permanent CEO. In ASO 7, the marketing manager was an employee of the TTO before becoming employed by the ASO. When it comes to hiring a surrogate entrepreneur there seemed to be no consistency to how it was done. Most of the surrogate entrepreneurs seemed to be hired because they knew someone at the TTO, research institute or ASO. TTO 2 had a database of surrogate entrepreneurs that they frequently used:

*“We would like to deal with people who we know and where there is a mutual trust. We would also like to have people who have a stake to a case and that can come back and work on other cases.” (TTO 2)*

When it comes to the rest of the team the general method of recruiting these people seem to be through networks and acquaintances. Thus, there is an importance that the people already working with the ASO have industry ties and relevant acquaintances. In the case of ASO 6 the core team were acquaintances of the CEO. When the CEO was hired, the team came on board more or less automatically.

In summary, the TTO works as an intermediary when transferring human resources from the mother institution to the ASO and when hiring a surrogate entrepreneur. When transferring human resources from the mother institution the TTO acts as an advisor, assessing the inventor’s commitment to the ASO ability to learn and negotiate terms with the hospital. When it comes to acquiring surrogate entrepreneurs the TTO acts as a bridge (Stewart and Hyysalo, 2008) as they it take advantage of the networks and acquaintances. As shown on figure 2, the TTO works as a bridge between the university/surroundings and the ASO.

Human resources might also be acquired directly from the TTO. The disadvantage with this is that the ASO may become too reliant of the TTO. From the resource-dependence theory we know that when a company A’s power over company B equals company B’s dependence of company A’s resources (Preffer and Salancik, 1978). Someone from the TTO acting as a project manager in an ASO is a good example of this, as the TTO in this case will be in full control over the ASO. This are not ideal for the TTO either, as the goal of most TTO is to build independent companies. The representative from the TTO therefore need to become full time employed by the ASO, or the ASO need to acquire another surrogate entrepreneur elsewhere. This is illustrated at figure 2.

Finally, there is the opportunity that human resources are acquired directly to the ASO. To achieve this the ASO need a network with relevant contacts. This is highly dependent on the capabilities of the entrepreneurial team. As we see on figure 2, the TTO usually plays no part in the hiring when human resources are acquired directly from the ASO.

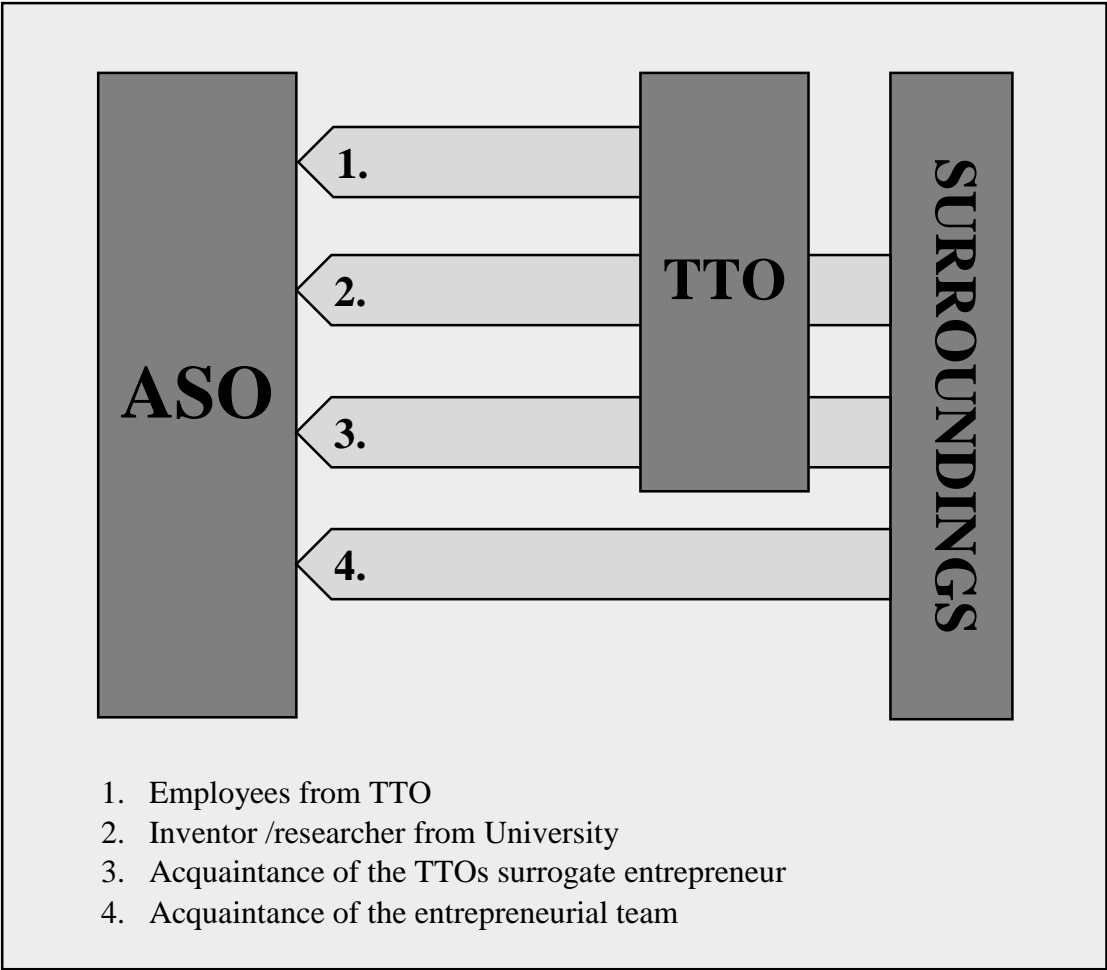


Figure 2: Human resource acquisition to the ASO.

### 6.3.2 Social resources

Both the TTOs underlined the importance of their portfolio and that previous ASOs might be useful industry collaborators for the new ASOs. TTO 2 also underlined the importance of having a distinct profile and that the TTO could develop a network within this profile:

*“We have throughout the years prepared the 94 business establishments. Therefore, in the areas that we are pricked inside, we have the relevant initial network.” (TTO 2)*

ASO 2 highlighted the role of the TTO as a regional actor. As their TTO served as a commercialization agent of many different research institutes, higher education institutions and one university hospitals it was easy for ASO 2 to utilize the resources within other institutions than their mother institute:

*“They have been good in helping us build other infrastructure, like the office, but also contacts with the college, the adjusting system, the IFE etc.” (ASO 2)*

Both the TTOs was concerned about “owing their own network. TTO 1 described their network as a ring where the TTO was in the center and the TTO network surrounding the TTO with close connections near the center and remote connections in the outer realm.

*“A TTO surrounds itself with services. For me, the core services may lie in the ring outside of the TTO. These core services are the kinds of solutions you can buy. Then you have a ring outside the core where you find business developers. Finally there is the most remote ring were you have the fund.” (TTO 1)*

Several of the ASOs also highlighted that the TTOs had established several events and venues where the ASOs could meet potential industry contacts. ASO 6 was relatively self-driven and did not get a lot of help from the TTO as they managed to conduct the necessary tasks themselves. One of the few aspects they highlighted as important help from the TTOs was the events where they could meet people from the industry:

*“They usually invite us when there is an event where companies from the industry that might have an interest in us are present.” (ASO 6)*

Another source of industry network that had a significant importance for both ASO 4 and 7 was collegial networks like professional unions and industry associations. For ASO 7 their involvement in international professional unions had resulted in an access to the global market.

As a result of their involvement in these organizations they also managed to make their product the industry standard, thus leading customers to them:

*“International epilepsy and international federation of newer physiology helped to support this work and also participated and organized it. Moreover, they bring in resource persons in the field so we get the best from around the world.” (ASO 7)*

Nevertheless, the most important source of networks and industry links seem to be the network of the entrepreneurial team. Almost all of the ASOs had examples of using acquaintances of the CEO or other people in the entrepreneurial team to build their social resource base.

Callon (Callon, 1980, Callon, 1994) identified the different roles an intermediary can take in initiating change in a local system. When acquiring social resources the role of the TTO as the community builder seem to be very important, as a lot of contacts acquired through gatherings and introductions. Another way the TTOs role as a community builder can be carried out is by linking different local actors. One of the ASOs in my study had good use of the TTO as he acquired social resources from another actor within the TTO’s local community. As it is shown on figure 3, the social resources goes from the surroundings via the TTO to the ASO. Further explained the venues and events of the TTO is what links the ASO to social resources.

Another important source of social resources was past companies and the TTOs own network, which they had acquired throughout their lifespan. We can say that this falls under the bridge (Stewart and Hyysalo, 2008) role of TTOs . The illustration on figure 3 shows that the social resources in this case goes directly from the TTO to the ASO. Similar to the findings of Nosella and Grimaldi (2009) partnership between the TTO and the this network needs to be of a certain strength in order to do this.

One interesting observation that was made was that collegial networks such as professional unions and industrial associations were found to be very important. The previous research on social resource acquisition favored entrepreneurs with pervious business owner experience when it came to acquiring social resources (Mosey and Wright, 2007). However, both the entrepreneurs that made good use of collegial networks in building their social networks had no previous business experience. It was therefore not their entrepreneurial experience that but their status and network within their field of research.

In other ASOs the entrepreneurial experience seemed to be more relevant as most of the ASOs with experienced surrogate entrepreneurs was relatively self- driven when it came to acquiring and having the right network.

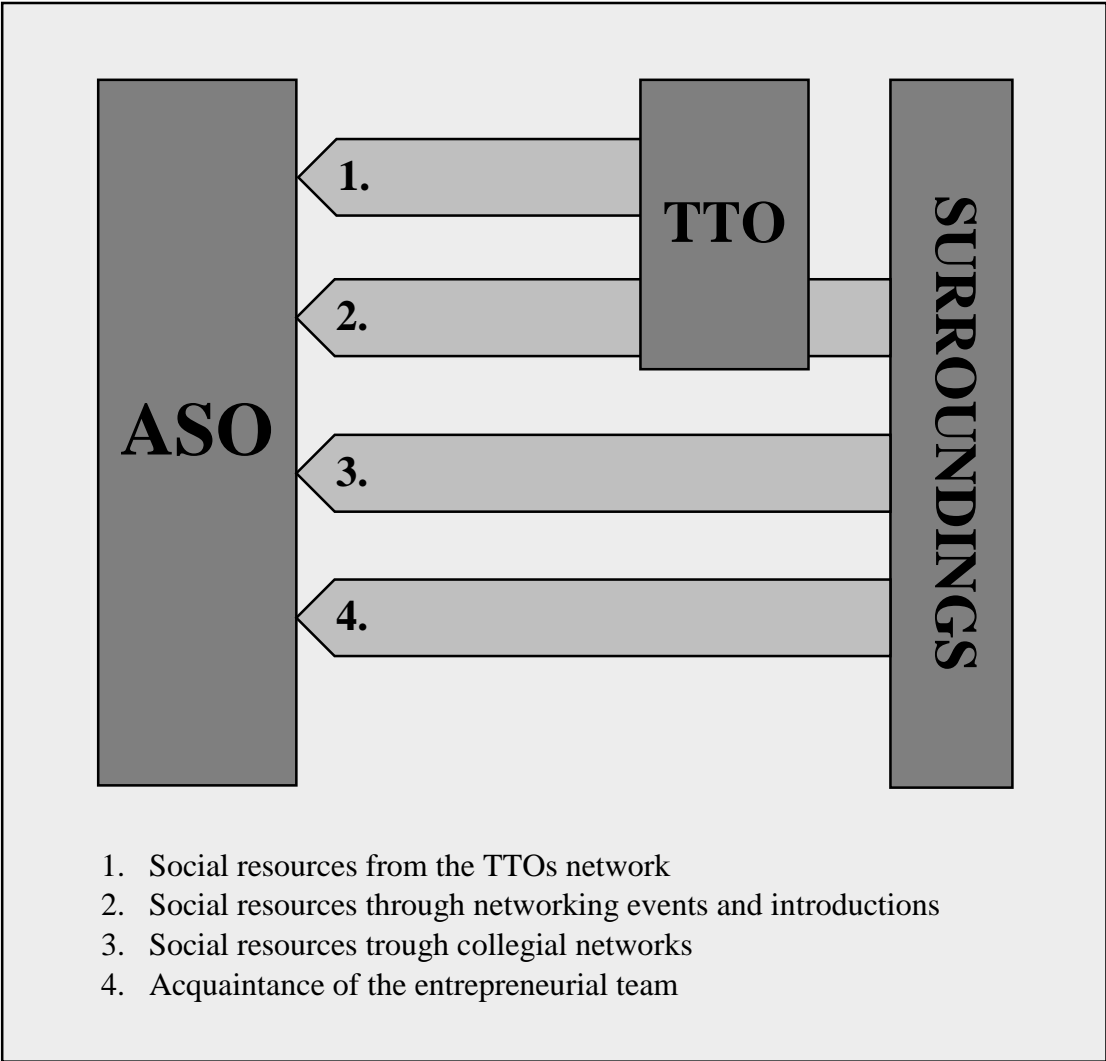


Figure 3: Social resource acquisition.

### 6.3.3 Financial resources

Acquiring financial resources might be the task where the ASOs get the most help from the TTOs. Both TTOs interviewed highlighted funding as one of the most important tasks of a TTO. There are several ways that a TTO can assist the ASO acquire funding. Many of the companies answered that their TTO initially invested their own money in the ASOs. Most of the ASOs interviewed also received funding from FORNY through their TTO at an early stage. As several of the public research and innovation grants demand a deductible the initial money invested

was especially important to get access to more grants. According to TTO 2, they use their position as a FORNY actor deliberately to get access to more funding from the research council.

*“In the Research Council we have been defined as a FORNY actor, which means that we have access to an annual budget to work with ideas and establish new companies. We deliberately use this to seek further funding from the Research Council.” (TTO 2)*

The TTOs might also give help to the ASOs in acquiring grants from the research council and Innovation Norway. In the ASOs that were interviewed, this help ranged from writing applications, talking to connections in the relevant actors and pointing the ASOs in the right direction.

Some TTOs are stakeholders in different economic arrangement or investment funds that were established to give financial aid to the ASOs. A couple of the interviewed ASOs had arrangements with their research institute or University that made it so that the research institute or University paid their salary. As we mentioned earlier some of the members of the team in ASO 7 worked 50% with the ASO and 50% with the University Hospital. In addition to enable the researchers to become entrepreneurs while continuing their careers at the hospital, this arrangement made a significant contribution to the ASOs economy. ASO 5 had a similar arrangement, but in this case, the researchers worked full time with the ASO while the University paid their salaries. TTO 2 had made an investment fund in cooperation with the county to give financial aid to their ASOs. The TTO of ASO 5 had a similar fund in cooperation with the University, while TTO 1 was in the process of making a similar investment fund.

TTOs might also help the ASOs to acquire funding from venture capital funds. Both the TTOs interviewed said that they usually exit the project completely or partially when a venture capital fund invests. TTO 1 highlighted the importance of raising the value of the company before acquiring VC-money, as they wanted a higher return of investment. TTO 2 stressed the fact that they wanted a VC-partner that they could trust and therefore highlighted the importance of guiding the ASO through this process.

Similar to the gatherings we mentioned in the subchapter about social resources, the TTOs of some of the interviewed companies hosted events for ASOs to meet potential investors. Both ASO 3 and 4 found potential investors at this type of event. It is worth mentioning that the events that were mentioned in the interviews were being hosted at a TTO that did not have financial resources to invest themselves.

The need for help from the TTO in acquiring financial resources seemed to be dependent on the skills and abilities of the entrepreneurial team. The ASOs that had CEOs or team members with the right skills and experience were far more autonomous in acquiring financial resources from grants and investors than the ones that were more unexperienced in this field. The CEO of ASO 6 had previously been working with fundraising and thus did not see the need for the TTO to help them with acquiring capital from investors:

*“...my previous job have been raising capital, so maybe we have less use for it than a scientist that starts a company. Then the need for contributions from the TTO could be greater.” (ASO 6)*

Primarily, when acquiring financial resources directly from the TTO the resource-dependence theory come in to play again (Preffer and Salancik, 1978). The TTO usually acts as a usual investor and take equity for their investment.

Secondly, the TTO as a community builder (Callon, 1980, Callon, 1994) is also important for ASOs to get access to financial resources. Two of the ASOs that I have interviewed had been participating in an event where potential investors could meet the ASOs. Another community building-task that were carried out by several of the relevant TTOs was to make local investment funds and arrangements that contributed to the ASOs financial resource base. As shown on figure 4 there are therefore two ways that financial resources flows from the TTO to the ASO. One is directly from the TTOs own financial resources and the second is from where the TTO is a stakeholder.

Thirdly, the TTOs might help the ASOs acquire financial resources through acting as an advisor (Watkins and Horley, 1986). The TTOs might help the ASOs to apply for grants. In relation to venture capitalists the TTO usually pointed the ASOs to relevant VCs, they also provided support for the ASOs through the investment process. The financial resources will in these cases go from the surrounding via the TTO, as shown on figure 4.

Finally, as with the social resources and human resources, the ASOs ability to acquire social resources themselves, rely on the skills and abilities of the entrepreneurs.

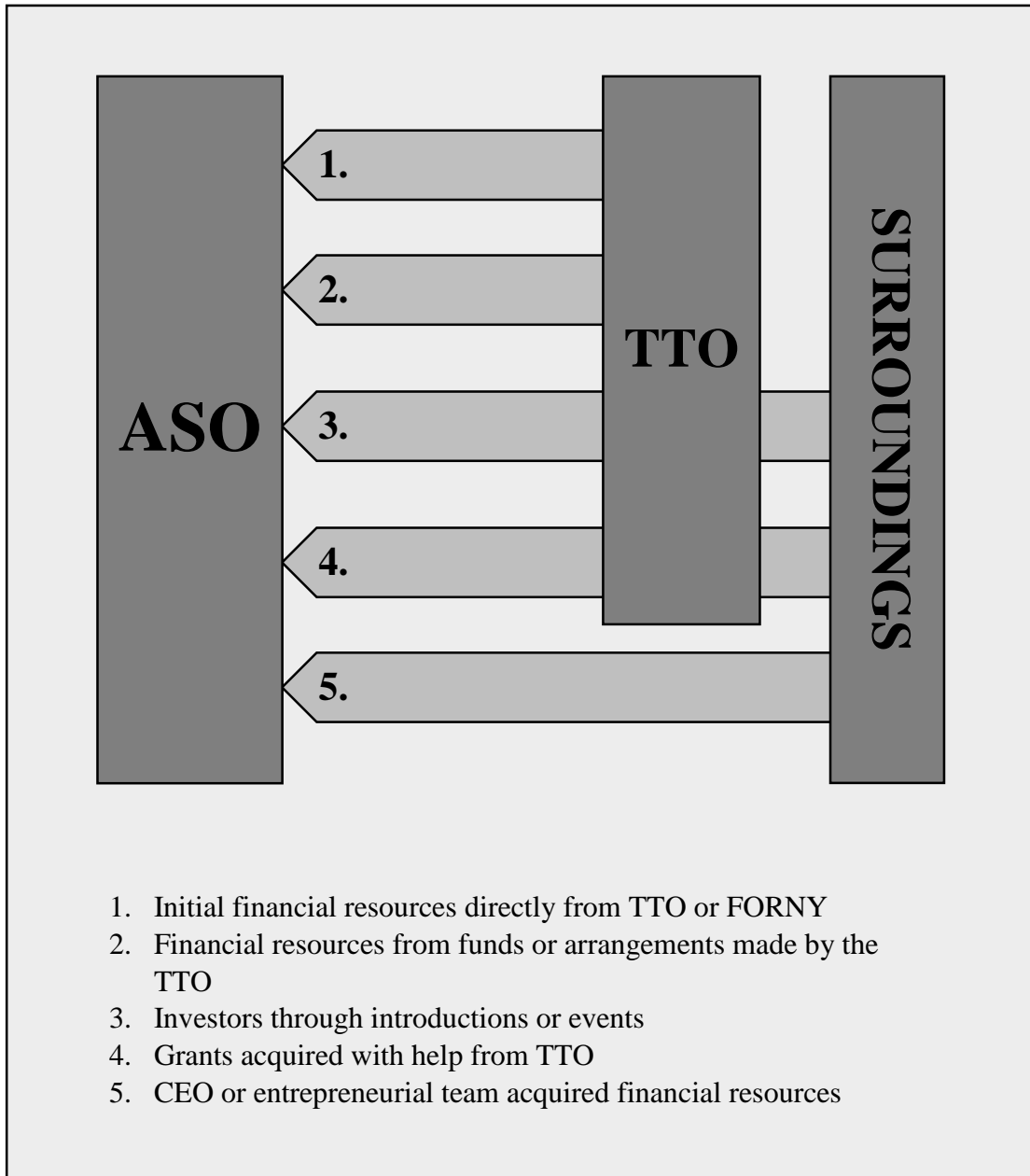


Figure 4: Financial resource acquisition to the ASO

### 6.3.4 Technological resources

To describe how ASOs build their technological resource and how TTOs are helping this process is not as easy as describing this process with other resources. With human, social and financial resources I have mainly focused on how this resources are acquired from an ASO's surroundings. To describe how the TTOs are helping the ASOs is a bit more complicated as a technology or product is usually the starting point for an ASO. Therefore, I will focus on how the technology is adapted from a University to an ASO. Further, I will focus on how the TTO



assists the ASOs to strengthen this technology and thus the strengthen the technology resource base.

All ASOs have technology or products that is developed on a University, research institute or University Hospital; we can therefore state that the most important source of technological resources is the mother institutions or researcher/inventors. The ASOs we interviewed that held patents had all gotten help with these patents from the TTO. The most obvious way for a TTO to assist the inventors or the University with patents is to help them to apply for these patents. ASO 1, 2, 5 and 6 were all started by researchers, contacting the TTO requesting assistance on patenting their technology. ASO 6 also highlighted the importance of the TTO still managing the patents after the company was up and running:

*“...an important job they do is the administration of patents and doing that job thoroughly.”*  
(ASO 6)

The route to commercialization might not be clear to researchers working at a university or research institute. According to ASO 6, the TTOs therefore have an important role as “innovation ambassadors”, making sure that researchers know about the option of commercializing and sometimes convincing the researchers that the best option might be to commercialize the technology:

*“They may be a sparring partner to get academics to take key grips; to get researchers to patent instead of publishing, checking out market opportunities etc.”* (ASO 6)

Several interviewees also stated that the TTO might have a stake in the development of the technology. While researchers know how to make a product, they might not have the necessary knowledge of market. Several of the interviewees highlighted market orientation as an important task for the TTOs. ASO 5 stated the following:

*“You cannot conduct business without tightly integrated it with the technology. It makes no sense The TTO should not need to do the lab work, but you have to control the researchers. If you do not keep researchers in the belts, they will arise riot.”* (ASO 5)

Several of the ASOs had also gotten help from the TTO to acquire the necessary infrastructure that were needed to develop the technology like lab equipment etc.

TTO 2 also brought up their role as a broker. Connecting the ASOs with stakeholders needed to develop the technology and connecting the industry with research community in order to develop new technology.

To summarize there are basically three ways that the TTOs are helping to develop the technology; as an advisor (Watkins and Horley, 1986), as a bridge (Stewart and Hyysalo, 2008) and as a broker (Hargadon and Sutton, 1997).

The TTO can act as an advisor towards the research community before the researchers decide to patent the technology (Watkins and Horley, 1986). This is very important, as a prerequisite of the ASO ever being founded is that researchers choose to engage in commercial activities. Another important task is that the TTO helps gather information from the market and affect the technology in accordance to standards and needs. As we discussed earlier, researcher may not have the commercial experience to interact with the market (Siegel et al., 2003). I also discovered that the innovativeness of ASOs were far superior in comparison with their counterparts but for the innovativeness to be fully utilized, it needed to be combined with network capabilities (Walter et al., 2006)

Secondly, another important task that was reported was getting access to resources like lab equipment etc. that were needed to further develop the technology. TTOs frequently used their contact network with research institutes and universities to act as a bridge (Stewart and Hyysalo, 2008), and channel these resources to the ASOs. This is especially important for ASOs as they usually are high tech companies with the need for huge amount of R&D.

Finally, the TTOs role as broker (Hargadon and Sutton, 1997) was brought up. One of the TTOs highlighted the importance of them acting as TTO on behalf of several institutes and that the ASO benefited from being able to access resources and knowledge on other institutes in order to develop their technologies.

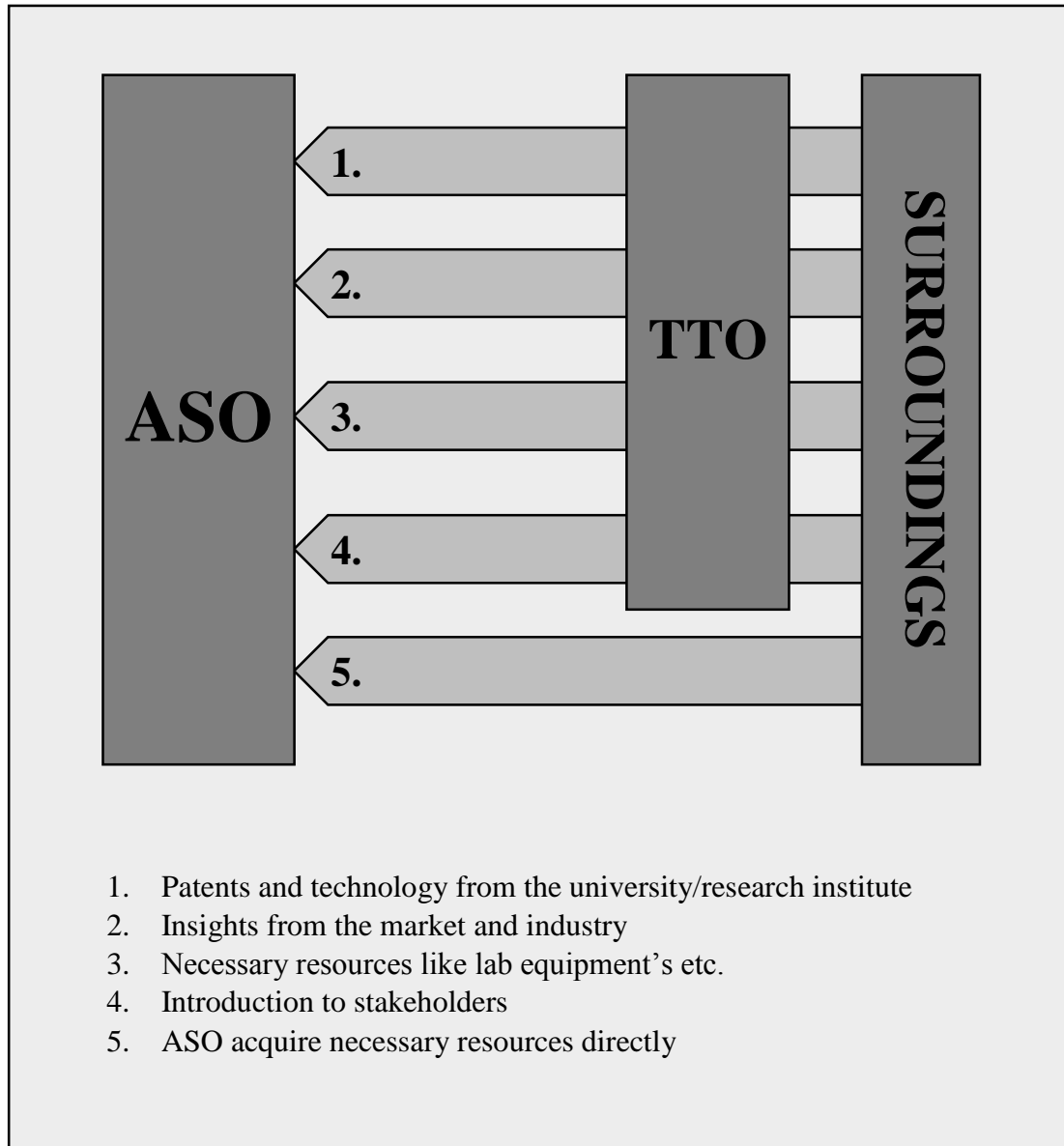


Figure 5: Technological resource acquisition.

### 6.3.5 Other resources

Some of the resources mentioned in the interviews might be hard to fit into the framework of (Mustar et al., 2006). Some of the ASOs were provided office and workspaces from the TTO with all the necessary features like ICT-infrastructure and other necessary equipment. Another resource that were brought up were administrative services like accounting, design services etc.

One can argue that the theoretical framework should be expanded to include physical resources (office, ICT-infrastructure etc.) and administrative resources (accounting, designers etc.). Still, these resources can easily be acquired for ASOs that have strong financial resources and human

resources. ASOs might also choose to include accounting skills and designing skills in their human resource base. When the TTO provide the ASOs with these other resources one can also say that the TTO contribute to enhance the financial resources, as the ASO do not need to acquire these resources in a different way and the burn rate of the company will slow down.

# 7 Discussion

## 7.1 The importance of human resources

As we discussed earlier in the methodology chapter there is an interconnectedness between the resources. For example, social resources might become important stakeholders in developing the company and investing in the ASO.

As we discussed earlier, the framework developed by (Vohora et al., 2004) indicates that some resources are important for gathering other resources.

In my study, there is a clear difference between the ASOs that have an experienced CEO compared to the ones who have an academic, unexperienced CEO. The CEO of company 6 came into the company as he were looking for business ideas and asked the TTO to find a company that would suit his skills, experience and networks. Throughout the interview, it was found that the ASO was very independent in comparison to other ASOs that used an inventor or researcher as the TTO. The same can be said about 1, 2 and partly 5 which all used surrogate entrepreneurs, while company 3 and 6 had used researchers as their CEO and were both relying more on the TTOs. The results indicates that having a person with the right capabilities in the team will make it much easier to acquire resources. Actually both company 1, 2, 5 and 6 described their operations as somewhat independent to the TTO, all these ASOs had acquired social, financial and develop and further develop technological resources themselves.

Another interesting finding is that for ASO 4 and 7, their skills and status within their academic community was the decisive factor in acquiring social resources. This shows that putting togheter a team is a much more complex question than the dilemma between an experienced entrepreneur vs. an academic entrepreneur.

Another key resource was financial resources. Financial resources are instrumental as they can provide access to other resources (Brush et al., 2001). According to our study the same can be said about human resources.

Financial resources and human resources can be used to acquire all the other resources including themselves. TTOs that initially focus on acquiring financial and human resources might save time and effort on a later stage.

## 7.2 TTO as an innovation intermediary

As we discussed in the theory chapter, innovation intermediaries can take four roles in helping ASOs develop their resource base; advisors, bridges, community builders and brokers (Callon, 1980, Callon, 1994, Hargadon and Sutton, 1997, Stewart and Hyysalo, 2008, Watkins and Horley, 1986). In the following chapter I will discuss how TTOs acts as an innovation intermediary to develop the resource base of ASOs.

### 7.2.1 TTOs as advisors

TTOs role as advisors when it comes to resource acquisition can be described as influence the ASOs to make the right decisions and do the necessary actions in order to acquire the needed resources (Watkins and Horley, 1986). This is especially important for teams where the inventor/researcher acts as a CEO as they frequently lack the necessary business experience (Siegel et al., 2003)

TTO 2 highlighted the importance of training the team through advising The interviewee preferred the team to be learning by counselling rather than setting up a training program.

The TTO might also use their knowledge to help the ASO make strategic choices regarding resource acquisition. As we discovered earlier Vohora et al. (2004) introduced a framework of stages that an ASO went through and certain obstacles that needed to be overcome in order to advance from one stage to another. TTO 1 highlighted the importance of timing resource acquiring to match the different stages and obstacles:

*“What is important for us is to look at various milestones and see when we need the different competences. It might work to have a scientist as general manager in a development period but when you approach, the market there is a need for a more experienced CEO.” (TTO 1)*

### 7.2.2 TTOs as bridges

We found that the TTOs indeed are helping ASOs by channeling necessary resources towards them. Both the TTOs had usually used one of their own employees as CEO in the beginning of a venture, to start building the company and acquire resources. At a later stage, the TTOs used their network and skills to channel resources into the ASOs.

The TTOs as bridges are most relevant for acquiring human, financial and technological resources. Human and financial resources revolves around finding and acquiring resources, whilst social resources are more dependent on approaching partners and on the capabilities of the entrepreneurial team.

### **7.2.3 TTOs as brokers**

Broking revolves around connecting different stakeholders to enable new technology and opportunities (Hargadon and Sutton, 1997). Through my research project I have seen two different examples of broking.

ASO 2 highlighted the broking role as important for them to develop their technology. As the relevant TTO acted as TTO for several research institutes, it was possible for them to utilize resources and knowledge on other institutes than the mother organization.

TTO 2 also highlighted their role as a broker for the industry. They were frequently in contact with the industry, putting them in contact with relevant scientific environments to enable innovation.

For a TTO to act as a broker, three requirements seemed to be necessary. Primarily, the TTO has to have a network within the industry, whom they are frequently in contact with. Secondly, the TTO need to have a clear profile. ASO 6 highlighted this, as the relevant TTO had a status within an industry and was therefore frequently contacted by relevant stakeholders. Finally, it seemed like the TTO acting on behalf of several institution was a huge advantage for the ASOs as this gave them access to knowledge, resources and other scientific environments.

### **7.2.4 TTOs as community builders**

(Callon, 1980, Callon, 1994) identified the role an intermediary can take in initiating change in a local system. Through my research project I have identified several areas where the TTO acting as a community builder give the ASOs access to resources.

One measure task that was identified was to create gatherings and arenas where the ASOs could meet different stakeholders and get access to partners and investors.

Another measure that was made by several of the TTOs was to create local investment funds, arrangements and support functions for to help the ASOs get access to resources.

Finally, where the TTO acted on behalf of several institutions, the TTO acted as a hub for the cluster, connecting the institutes and giving ASOs access to resources, knowledge and scientific environments.

### **7.2.5 TTOs as moderators**

In addition to the different roles I explored in the theoretical framework I identified a fifth role that the TTOs could take in helping the ASOs acquire resources.

In the chapter on resource-based view we identified several reasons why it can be especially difficult for ASOs to get access to new resources. The main reason might be the liability of newness. As ASOs frequently lack experience, do not have access to a consumer base and can't point to a history of performance they may have a hard time getting access to resources (Stinchcombe and March, 1965)

I also explored the resource-dependence theory which states that company A's dependence on company B's resources is equal to company B's power over company A (Preffer and Salancik, 1978)

With the liability of newness and the resource-dependence theory, combined with the fact that most ASOs have a very limited initial resource base (Mustar et al., 2006) I can say stated that the ASOs not only have a hard time getting new resources, but also vulnerable in the process of acquiring these resources.

The TTO might act as a moderator, making it easier for ASOs to get resources and enhancing the power of the ASO when interacting with other stakeholders.

There are basically two ways that this role can be executed. Primarily, the TTOs might add weight and credibility to the ASOs. Several of the ASOs highlighted the advantage of being associated with a certain TTO.

Secondly, the TTO might help the ASOs negotiating with potential partners and investors as well as handling contracts and agreements with these stakeholders. This can make the ASOs less vulnerable in the process of acquiring resources.

## **7.3 The resource base of a TTO**



As I revealed in my analysis, in addition to acting as an innovation intermediary, resources are often acquired directly from the TTO. This is often done in the initial phase of the development of ASOs.

To be able to offer resources to the ASOs, TTOs need to build a resource base of their own. Both the TTOs that were interviewed highlighted the importance of owning their network and being able to connect new ASOs with this network.

Several of the ASOs also mentioned that the TTO had invested initial money in the ASOs to get them started. ASO 6 stated that he felt the TTO should invest more in them and that TTO should have more money to invest.

Finally, many of the ASOs interviewed had surrogate entrepreneurs acting as a CEO. TTO 2 said that they usually had a pool of people with entrepreneurial experience, which they rotated.

In my project I have focused on how the TTOs are helping ASOs acquire resources and have not discovered how TTOs are building their resource base. However, some implications can still be made based on what I have found: TTO should focus on building their own resource base. Efforts should be made to build a relationship with industrial partners, as they might become useful in future projects. TTOs should also attract people that are willing and able to become CEOs of future ASOs. Finally, TTOs should have more money to invest in ASOs.

## **7.4 Relation to theory**

### **7.4.1 Resource-based view**

This research project was done using a resource-based view framework from (Barney, 1991, Mustar et al., 2006). From what I have found most of the resources that ASOs need to grow can be fitted into the framework of Mustar et al. (2006) with human, social, financial and technological resources. Some other resources that were brought up like office space, administrative resources etc. can be replaced or acquired by the resources in Mustar's framework. We can therefore call the resource groups in the framework essential resources.

For resources to be combined, they first have to be gathered. The gathering of the resources is. The study does therefore not focus that much on how resources are combined to get capabilities and create competitive advantages. Still, some implications can be done; in the literature review

we discovered how innovativeness needed to be combined with network capabilities for the innovativeness to be fully utilized (Walter et al., 2006) This was confirmed from several of the ASOs interviewed as they pointed at the combination of their experienced team and their technology as their most important asset.

### **7.4.2 Resource-dependence theory**

From resource-dependence theory we learned that: organization A's power over organization B is equal to organization B's dependence on organization A's resources. Organization B will therefore try to acquire these resources in order to gain power and be independent (Preffer and Salancik, 1978)

In the relationship between the TTO and the ASO, the theory is only partly accurate. In an initial phase ASOs are very dependent on the TTO as the TTO holds many of the needed resources, someone from the TTO will often step in as a CEO on certain occasions. However, the TTO will deliberately work to build independent companies and thus giving up power of the ASO. Usually, there is a distinct strategic decision for when the TTO will back out of the project. (Preffer and Salancik, 1978)

The theory will apply in the relationship between the ASO and other companies. However, the TTO may act as a moderator, and thus confuse the power balance between the ASO and the other company. Future studies should explore this more thoroughly.

### **7.4.3 Innovation intermediaries**

I have successfully discovered that TTOs takes the role of advisors, bridgers, brokers and community builders in order to give ASOs access to the resources that are needed. I have also identified a fifth role a TTO might take in helping the ASOs on resource acquisition; moderator. The role as a moderator makes the ASOs less vulnerable in the process of acquiring resources.

## 8 Concluding remarks

The purpose of this study was to find out how TTOs are helping spin-off companies on acquiring resources. Hence the research question:

*How does the TTO help build the academic spin-off-companies' resource base?*

To answer the research question a theoretical framework was developed, using resource-based view, resource-dependence theory and theory on innovation intermediaries. The literature review also included additional theory as well as empirical studies, to further explain and find evidence of the theoretical framework. Finally, seven academic spin-off companies and two technology transfer offices were interviewed. The results from the interviews were analyzed.

I have successfully managed to map how resource acquisition is done by academic spin-off companies and how TTOs are helping them in the process. The results are illustrated in figure 2, 3, 4 and 5.

By interpreting the results from the analysis I also identified 5 different roles the TTO as an innovation intermediary can take when helping ASOs acquire these resources; advisor, bridge, broker, community builder and moderator.

Resources may also be acquired directly from the TTO. It is important that the TTO builds its own resource base. The TTOs should make efforts to build their industry network, attract potential surrogate entrepreneurs and have financial resources to invest in the ASOs.

Finally, ASOs can acquire resources without the help of the TTO. This is more or less dependent on the experienced, skills and capabilities of the entrepreneurial team.

This study gives an important contribution to the knowledge about TTOs as intermediaries and how the TTOs are helping ASOs. Nevertheless, the results should not be generalized as the analysis is based on a relatively small selection of interviewees and mainly correspond to the Norwegian context. Political, cultural and organizational factors might be different in other contexts. Similar studies done in other contexts might therefore give different results.

## **8.1 Implications for TTOs and policy makers**

The study may also be a basis for policy makers and scientific environments that are getting involved in spin-off creation. Table 2, 3, 4 and 5 shows how resource acquisition is done by ASOs that are in partnership with a TTO.

The ASOs ability to acquire resources independently is highly dependent on the experience, skills and capabilities of the entrepreneurial team. In the strive to build independent companies, the TTOs should therefore primarily focus on acquiring strong human resources.

The output performance are frequently used as a determinant when measuring the efficiency of the TTO. In the case of academic spin-off companies, the inputs from the TTOs to the ASOs and how these inputs are meeting the needs of the ASOs are more relevant as a determinant. The findings of this study enhance the understanding on how TTOs are helping the ASOs and could be used as a basis of a quality assessment system.

## **8.2 Implications for ASOs**

My study may serve as a framework for future studies on TTOs in relation to ASOs.

The framework on which roles a TTO as an innovation intermediary could take in helping ASOs acquire resources should be more thoroughly explored, especially the role as a moderator.

In addition, some studies might focus on how TTOs are building their resource base and how this resource base can be utilized to help ASOs.

Finally, future studies should focus on how resources can be combined to achieve competitive advantage and how the TTOs are helping the ASOs with this.

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# 10 Appendix

**Appendix 1: Interview guide ASOs (in Norwegian)**

**Appendix 2: Interview guide TTOs (in Norwegian)**



# Appendix 1 Interview guide ASOs

## Into

- Ønsker velkommen
- Tidsbruk
- Kort presentasjon av meg selv og oppgaven
- Anonymitet, hvis ønskelig

## Innledende spørsmål

- Fortell kort om deg selv
  - hvem er du?
  - hvilken bakgrunn har du?
  - hvilken rolle har du i selskapet?
- Fortell kort om selskapet
  - Hva gjør dere?
  - Hvordan er selskapet bygd opp?
  - Hvilket stadie er dere på?
  - Hvilke utfordringer har dere?
- Fortell litt om relasjonen til TTO
  - Hvor involvert er TTOen?
  - Hva hjelper TTOen dere med?
  - Er det noe dere savner?
  - Eksempel

## Human resources

- Hvordan er teamet deres bygd opp?
- Hvilke egenskaper mener du er viktig i et grunderteam?
- Hvordan har dere utviklet teamet?
  - Har dere jobbet bevisst med rekruttering?
  - Hvordan har dere jobbet med rekruttering?
  - Hvor kommer teamet fra (eksternt, internt)
- Hvordan har TTOen hjulpet dere med å utvikle teamet?
  - Rekruttering
  - Kursing
  - Styremedlemmer
- Hvordan ser dere for dere at TTOen kunne hjulpet dere?
  - Er det noe dere savner?

## Social Resources

- Hvordan er kontaktnettverket deres?
  - Mange kontakter

- Spesielt viktige kontakter
- Kunder
- Partnere
- Hvordan har dere gått fram for å få kontaktnettverk?
  - Bevisst «Networking»
  - Spesielle arenaer
- Hvordan har TTO hjulpet dere med å bygge kontaktnettverket
  - Kunder
  - Partnere
  - Burde mer ha vært gjort?

### **Financial resources**

- Hvordan er økonomien til selskapet?
- Har økonomi vært utfordrende?
- Har dere hentet ekstern funding?
  - VC/business angels
  - Offentlige midler
  - Intern funding fra TTOen eller Universitetet/forskningsinstituttet
- Har dere gjort forsøk på å hente ekstern funding?
  - Hvorfor ikke?
- Hvordan har dere sikret ekstern funding?
- Har TTOen hjulpet dere med ekstern funding? I så fall, hvordan?
- Er dette noe dere gjerne skulle hatt hjelp med?
- Kommer dere til å hente mer funding på et senere tidspunkt?

### **Technological resources**

- Fortell litt mer om teknologien?
- Hvor er teknologien utviklet?
  - På Universitetet
  - I TTOen
  - Begge deler
- Hvilke drivere har vært viktig i utvikling av teknologien?
  - Løse et problem
  - Fulle et behov
  - Nyskapning
  - Annet
- Har TTOen vært delaktig i utvikling av teknologien, i så fall hvordan?
- Har dere endret teknologien etter dere ble med i TTOen? Hvordan har den blitt endret?
- Har dere samarbeidet med eksterne for å utvikle teknologien?
- Er dette noe TTOen burde være mer delaktig i? Hvordan?

### **Avsluttende spørsmål**

- Er det andre ressurser som ikke er nevnt som dere mener er viktig?

- Hvordan har TTOen hjulpet dere med å hente disse ressursene?
- Har TTOen hjulpet dere med å bygge ressursbasen på en annen måte enn det som er nevnt? Hvordan?
- Er det annet som ikke er sagt som du mener er relevant?

# Appendix 2 interview guide TTOs

## Intro

- Ønsker velkommen
- Tidsbruk
- Kort presentasjon av meg selv og oppgaven
- Anonymitet, hvis ønskelig

## Innledende spørsmål

Hva er profilen på deres TTO?

Hva mener du en TTO skal være for spin-off-selskaper?

Hvordan jobber dere med spin-off-selskaper?

Eierskap?

Forhold?

Hvordan hjelper dere spin-off-selskaper?

## Human resources

Hvordan hjelper dere spin-off-selskaper å utvikle teamet deres?

Rekruttering?

Veiledning/kursing?

Styremedlemmer?

Eksempler

## Social resources

Hvordan hjelper dere selskapene med kontakt med kunder/samarbeidspartnere?

Nettverksbygging?

Behandling av kontrakter/NDL?

Eksempler?

## **Financial resources**

Hvordan hjelper dere selskapene med funding?

Investerer dere selv?

Søknader til Innovasjon Norge?

Andre investorer?

Eksempler?

## **Technological resources**

Hvilken rolle spiller dere i utvikling av teknologien?

Patenter?

Markedsorientering?

Gi de tilgang på samarbeidspartnere/ressurser som kan hjelpe de til å utvikle teknologien?

## **Avsluttende spørsmål**

Er det noe av det overnevnte du mener en TTO ikke skal ha ansvar for?

Hva er de viktigste ressursene for et spinoffselskap?

## **Relevant spin-off-selskap**

Hvordan hjalp dere dette selskapet?

Hvordan er forholdet til dette selskapet?

Noe spesielt med dette spesielt med dette selskapet i forhold til andre selskaper?