AALBORG UNIVERSITY
DENMARK

Master thesis

Improving business incubation support through spin-off process analysis – Aalborg University case study

Research conducted by:
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Date of submission: 07 June 2017

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Abstract

The study was created together with organization “Supporting entrepreneurship at Aalborg University”. The research aims to increase knowledge and offers suitable managerial implications for incubation practices especially in relationship to research spin-off companies. The problem is coming from literature review which concludes that the spin-off process differ in various environments, however does specify how can incubation be supported in unlike contexts. The study is designed as exploratory case of spin-off process at Aalborg University (AAU). The institution is known for its collaborative knowledge sharing and high level of commercialization outcomes. However, AAU is located in Danish most underdeveloped regions. The data consist of interviews with USO founders and technology transferred manager, statistics and various reports conducted by OECD, EU and Danish ministry of higher education and science.

The main conclusion is that several causalities in the process might be explained by the environment and there is need for more specific incubation research which would target concrete challenges in spin-off creation based on the circumstance they operate in.

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Introduction

The study was created together with organization "Supporting entrepreneurship at Aalborg University". The research aims to increase knowledge and offers suitable managerial implications for incubation practices especially in relationship to research spin-off companies.

Technology transfer (TT) as the research agenda appeared around year 1990 in U.S.A., however slowly shifted towards Europe (Rothaermel et al., 2007). The TT main parts consist of licensing or sales however some authors argue that the university spin offs (USO) are able to create higher economic rents (Bray & Lee, 2000) and are used as the tools to bring knowledge closer to the market, as large part of the knowledge cannot be simple sold or licensed (Festel, 2012; Landry et al., 2006; Wright et al., 2006)

USOs do not have unanimous definition in the existing literature. Researcher does not find consensus on whether USO definition includes students and graduates (Smilor et al., 1990; Belini et al., 1990; Clarysse and Moray, 2004) or are formed by academic staff (De Coster and Butler, 2005; Hindle & Yencken, 2004; Steffensen, 2000) and whether TT to new company has to include protected rights transfer from university into new entity (Hindle & Yencken, 2004; Shane, 2004; Leitch and Harrison, 2005).or USO is created based on the research outcomes and knowledge transfer regardless intellectual property rights (Klofsten and Jones-Evans, 2000; Belini et al., 1990). The USO is defined as specific type of entrepreneurship which operates in a complex environment (O´Shea et al., 2008; Bozeman, 2006). The environment and context dependency was found in several studies (Locket et al., 2013; Baldini, 2010; Boleman and Cooker, 1992; Leitch and Harison, 2005).

Over the years authors came with several different definitions of the business incubators. The consensus can be found in the one which describe an incubator as program which aim is to support new venture development by offering different social and economic means to incubated companies (Al-Mubaraki & Busler, 2013; European commission, 2010). The main incubator main goal is support growth and launch of new companies through supplementing missing recsources (Deak & Podmetina, 2013; Al-Mubaraki & Busler, 2014). The incubators can be found in various forms and types (Akçomak, 2011) while the Mian (1996) describes specifically

university business incubators (UBIs) as the tools for creating new research/technology-based firms. UBIs possess certain capabilities which they might use to support USO growth as consulting, rents, access to capital and network, mentoring etc. (Borges & Filion, 2013; Grimaldi & Grandi, 2001; Rasmussen and Borch, 2010) and some specific services as faculty consultants, student workers, legitimation, technology transfer office (TTO) and laboratories (Grimaldi & Grandi, 2001; Rasmussen and Borch, 2010).

Hence it is argued that USO process which is context and environmental dependent will require specific support. There is however lack of the incubation research which focus this issue and would specify different incubation strategies in different circumstances. To fulfill the main study goal, improving USO incubation practices at AAU, it is argued that it has to be first answered the research question: **"How does a university spin-off process at Aalborg University looks like?"**

The phenomenon is examined through resource based view theory lenses (RBVT) and four stage model framework proposed by Ndonzuau et al. (2002). The RBVT theory is based on the assumption that company is able to create sustainable competitive advantage by allocating specific resources (Barney, 1991; Wernerfelt, 1984; Teece, 1999)

Through analyzing overall spin-off process at Aalborg University, it is aimed to answer several sub-questions as:

- What are the challenges at USO creation at AAU?
- Which resources do academics possess at the beginning of USO creation?
- How are the resources developed over time?
- How does the environment influence resource base?

As the methodological approach was chosen exploratory case study, which Yin (2009) defines as appropriate in cases the complex environment when the research context is not clearly defined and serves as the mean to create hypothesis for further examination. The study does not aim for generalization but is subjected towards specific context of AAU.

It is however argued that the AAU is appropriate example for single case study. The university strategy aims to become more entrepreneurial (AAU strategy and vision), while is located in Denmark's most underdeveloped area. Furthermore, the AAU is already leading Danish university regarding number of license and sales agreements per PhD but is among the last regarding USO creation. Due to applying specific strategy of licensing and selling "rights" to patent it is able to generate positive cash flow from commercialization

The data collection consist of interviews with academics who went through USO creation process, technology transfer office manager and various secondary data as OECD reports, commercialization statistics and Danish ministry of higher education and science report.

1. Literature review

1.1. University spin-offs

Technology transfer and university involvement in the entrepreneurship started to appear on the research agenda in early 1990s (Rothaermel et al., 2007). As one of the main driver for the literature boom can be considered US government policies toward research commercialization in 1980 which attracted also academic society (Bozeman, 2000). Technology transfer therefore logically experienced its peak in U.S.A., however with growing interest from European politicians, the research agenda slowly appeared also in Europe (Rothaermel et al., 2007).

1.1.1. Entrepreneurial universities

The literature cannot find clear consensus in definition of "entrepreneurial universities". Rothaermel et al. (2012) in their literature review on university entrepreneurship argues that the entrepreneurial universities differ on the level on which they emphasis economic development on the top of traditional mission as education and knowledge creation. The entrepreneurial universities are influenced by internal as well as external factors and their outcomes can be measured in different indicators as joint ventures, licensing and sales agreements, number of spin-offs, etc. (Rothaermel et al., 2012).

As the main research focus is on USOs, the following paragraphs will look into this topic.

1.1.2. Spin off definition

From the very first peak into literature review on spin off topic it can be seen that it is a complex issue. As the example can be used spin off creation framework proposed by O´Shea et al., (2008). In their work authors describe five main elements regarding spin off creation, namely, environmental structure, institutional structure, organizational resources and individual characteristics, local and governmental support and about thirty-six subcategories of different influence factors. The large number of elements and stakeholders creates challenge even in defining spin off goal, Bozeman (2000) was however able to identify six different possibilities for outcomes.

Over the years have appeared also varies spin off definitions. Some of the authors include university students into their description (Smilor et al., 1990; Belini et al., 1990; Clarysse and

Moray, 2004) while others consider academic staff involvement as the primary criteria for USO definition (De Coster and Butler, 2005; Hindle & Yencken, 2004; Steffensen, 2000)

The researchers have not found consensus even in subject of transfer into the spin-off company. Part of the academic society consider USOs just companies which include protected rights transfer from university into new entity (Hindle & Yencken, 2004; Shane, 2004; Leitch and Harrison, 2005). On the other hand several authors argues USOs can be create also based on the research outcomes and knowledge transfer (Klofsten and Jones-Evans, 2000; Belini et al., 1990)

For the sake of this study as university spin off company will be considered the one who fulfills two criteria:

a) at least one founder was at the beginning of the new venture creation assigned as an academic staff
b) spin off is created based on the research outcome and knowledge transfer which can be protected by intellectual property rights

1.1.3. Spin-off creation

One of the most frequent issues in the literature is motivation for spin-offs companies. From individual point of view O´Shea et al. (2008) include motivation as one of the influencing factors in their spin-off creation framework. Bozeman (2006) in his literature review identified motivational factors for new ventures, namely: *"opportunity costs, science and technical human capital, political, economic development, market impact, out the door" (p. 636).* The similar results in case study research done by Hayter (2011). Laundry et al. (2006) found positive correlation between degree of research novelty and spin-off creations while higher rate of academic publications did not have effect. Hayter (2011) found negative peer effect, defined as negative attitude of other academic colleagues towards the commercialization decreases motivation for spin-off activities. Smilor et al. (1990) found that the USOs created based on the pull factors as market opportunities and instinctive motivations had higher success rate the push influences.

On the other side are barriers for the USO creation. F.N. Ndonzuau et al. (2002) define three main namely *"publish or perish"* (p. 283) barrier, academic culture and inability to identify business potential.

Beside individual motivation, literature identifies also other reasoning for spin-off creation. Some authors argue that spin-offs are able to create higher economic value then other technology transfer forms (Bray & Lee, 2000). Furthermore, Wright et al., (2006) argues that USOs aim to increase rates of research commercialization and technology diffusion, as large part of the research cannot be simply licensed or sold. Reasoning behind spin-off as technology diffusion carrier can be found in various studies (Festel, 2012, Landry et al., 2006). Both studies argue that transfer of the commercially untested and radical knowledge or technology bears high risk and uncertainty. Spin-offs are in these cases tools for bringing the technology closer to the market and adjust it based on its need.

The motivation and reasoning behind spin-off creation can be divided into two large groups individual motivation and external motivation. Spin-offs are often created for the sake of technology validation in cases where new knowledge or technology can be transferred by mainstream ways as licensing or sales.

1.1.4. Management team in Spin-offs

Management team in Spin-offs form specific part of spin-off literature. Authors are looking at this topic from different points of view. Some examine role of academic inventors in spinoff companies (Lockett at al., 2003; Hayter 2011), others in the differences between them (Nyeko and Sing, 2015) and their development through spin-off process (Mosey & Wright, 2007).

The involvement of academic inventors and it´s correlation with spin-off success is not clear from current literature. Festel (2012) argues that from knowledge point of view it´s crucial that spin-off is created with involvement of original inventors. However, Lockett at al., (2003) based on their empirical analysis argues that involvement of academics in the process have no effect. More light on the topic was shed by Armano and Scagnelli (2012), who found that there is negative correlation between spin-off financial performance and the involvement of academics in the process. However, with one breadth they add that academics have positive impact on financial performance if they provide deep commitment to a new venture. O´Shea et al. (2005)

argues that scientist with extraordinary knowledge or so called “stars” scientists have higher chance to create successful USO.

The differences can be found also in various types of academic entrepreneurs. Mosey and Wright (2007) found that novice and nascent entrepreneurs face the lack of social capital especially regarding business and industry networks while more experienced entrepreneurs were already able to fill the structural holes. Borges and Filion (2013) described the social capital development and argue that nascent entrepreneurs are able to expand social capital through spin-off process. They also highlight the importance of university incubator which is able to develop academics business skills, social capital and financial network through preparation, which can often take place between actual new venture creations.

Furthermore the entrepreneurs with technical background are more likely to have profitable business then those with non-technical skills (Nielsen et al., 2015). Tietz (2012) defined social and human capital in more details. He found positive correlation between management and industry work experience of management team and financial growth.

The small revolution on this topic was done by Radosevich (1995) who introduced the concept of surrogate entrepreneurs. The whole notion is based on the hypothesis that inventors who came with the technology often don´t have the possibilities or will to leave their current positions and create companies. Furthermore, inventors with technological knowledge do not have to possess commercial knowledge and resources to do so. However, the surrogate entrepreneurs come with several issues as is transfer of technological knowledge.

The spilt of pros and cons in surrogate entrepreneurs concept can be seen also in research community which is not unanimous on the effectiveness of Radosevichs´ concept. While analyzing UK universities Lockett at al., (2003), based on compering different university environments, found that universities which applied surrogate entrepreneurship model were more successful regarding technology transfer. Ludquist (2014) also found empirical support for surrogate entrepreneur. However, Tietz (2012) haven´t found positive correlation between surrogate entrepreneurs in spin-offs and it´s economic growth. As it was argued previously, the phenomena can be explained also by different meaning of “success” in spin-offs and economic growth can be just one part of it. Clarysse and Moray (2004) in their inductive study on Belgian

spin-offs argue that appointing external CEO may have even harmful effect on the USO, especially, at its early stages.

Furthermore spin-offs operate in very complex environment (Bozeman, 2000; O´Shea et al., 2008) and therefore for some environments it might be more suitable to focus on surrogate entrepreneurs as for others.

It is difficult to find consensus in appropriate management structure for spin-offs. But it can be argued that management team has to possess certain human and social resources in order to lead successful spin off. The resources are related to commercial knowledge, technical skills, sufficient network and industry experience. The academic entrepreneurs often lack some of the skills and they have to be either replaced as for instance with surrogate entrepreneurs or developed. It´s not however clear which strategy is more beneficial and it may depend on different environments.

1.1.5. Spin off process

The technology transfer process from research findings into the viable company differ from usual new venture creation (Druhile et al. 2004**)**. F.N. Ndonzuau et al. (2002) opened the black box and described spin-off process in their conceptual framework. They identified four stages namely *"To generate, to finalize, to launch and to strength"(p. 283).* This framework is central point for this study and will be therefore described more in details in theory part.

However, in literature we can find several studies which are concerned with certain pieces of the process. The financing belongs to one of the most discussed topics, especially venture capital influence (Wright et al., 2006; Festel, 2012). The emphasis is on the same outcome expectations and capabilities to reach them. The high potential USOs with goal to reach international markets should therefore match with large VCs with international network and capital (Wright et al., 2006).

The ability to reach consensus between USOs and VC seems to be one of the main challenges. Most USOs require capital for the market validation and prototyping (Festel, 2012, Landry et al., 2006). However, VC firms are more willing to invest into the firm in the growth stage, with already existing proof of concept and market validation. It has to be added that VCs are also

more likely to invest into the spin-offs with IP rights (Wright et al., 2006). The second mismatch between VC and USOs is in different motivations (Festel, 2012).

The other financing possibilities are business angels (BA) who are usually more concerned about the entrepreneurs then market proof; however BAs often lack required social and human capital (Zucker et al. 1998).

The interesting option is therefore coming from partnerships with already established companies. The concept of stronger partnership between universities and corporations was defined by Chesbrough (2004) in his work on open innovation. The open innovation advocates for ideas and resources which are coming from outside of existing company boundaries. Some of the ideas, however, are difficult to fully implement or exploit in established settings (Crossan et al., 1999).

Carayannis et al. (2000) devoted their work to examining the strategic alliances between USOs and established companies. Their finding shows that in general this agreements lead to high satisfaction rates. Furthermore, they tend to develop from just "funding" alliances into long-term relationship. The advantages for the USOs are that the alliances, beside capital, also enlarge tangible as well as intangible resources in form of existing technologies, knowledge, supply networks, other IPs. O´Shea (2005) found significant correlation between industrial support into the TT and number of spin-offs.

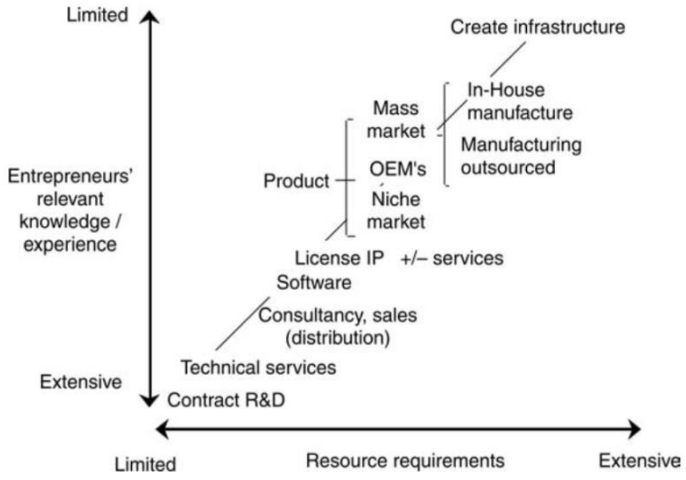
The strategic orientation can partly explain economic growth at USOs, however only conditionally. Tietz (2012) argues that only *"pro-activeness, innovativeness, and competitive aggressiveness" (p. 222)* have significant effect the company growth. Furthermore, entrepreneurial orientations pay-off only if they are supported by adequate networking capabilities (Walter et al., 2006). The importance of networking capabilities was underlined by several authors. (Mosey & Wright, 2007; Walter et al.; 2006, Borges & Filion, 2013, Lockett et al., 2005). Regarding strategic management emerging companies needs to pay attention also to closing knowledge holes by setting up right organizational learning (Lockett et al., 2005).

The USOs often requires different tangible assets just to create proof of concept as laboratories and technologies (Fetsel, 2012). However, not all USOs need the same entry investment. Several

studies found different resources requirements (Fetsel, 2012; Druhile et al. 2004; Wright et al. 2006; Landry et al., 2006).

Druhile et al. (2004) examined various spin-off types, their required resources and relevant knowledge.

Figure 1: Different USO types (Druhile et al.; 2004)



Their argumentation is based on the fact that with "low" resources types as contracting R&D and technical services, entrepreneurs requires high level of tacit knowledge within field but does not need other entrepreneurial knowledge.

Fetsel, (2012), Wright et al. (2006); Landry et al., (2006) are looking at the topic from different point of view. They argue that resources may vary based on the requirements for prototyping and technical development. Especially in cases of more radical innovations where there are higher investments in validation phase and proving that innovation may work.

USOs differ from other type of entrepreneurships. They often require proofing the concept at market settings. It may be however difficult to enquire right capital. One of the solutions is joint ventures which shows high acceptance between participants. Not just that they vary from mainstream entrepreneurship, USOs can be divided into different types which requires various extent of resources and entrepreneurial knowledge. Success of USO process is also influence by

networking capabilities, entrepreneurial orientation, knowledge level and access to tangible resources.

1.1.6. Technology transfer and spin-off creation process

Large part of the current literature is concerned around technology transfer office role in spin off process. Some academics are looking into effectiveness of TTOs (Bozeman & Cooker, 1992, Leitch & Harrison, 2005; Lockett and Wright, 2005).

Locket and Wright (2005) found positive correlation between TTO expenditure on intellectual property rights and performance of spin-off companies. While Bozeman and Cooker (1992) highlights the fact that technology transfer was more successful at laboratories and universities (U.S.) with low level of bureaucracy. Furthermore they add that the most successful project were selected based on the commercial criteria or were from beginning executed in collaboration with industry partner. Fetsel (2012) and Writght et al. (2006) later supported the success of commercial oriented spin off projects in the European cases.

Interesting finding was brought by Leitch and Harrison (2005) who second-order spin-offs. The results showed that TTO involvement in the second order spin outs i.e. new ventures create from former university spinoff, enjoyed higher success rate in terms of sales and growth. They reason the phenomenon by the fact that the second order spin-offs have higher commercial orientation and don not face same limitations as first order spin-offs. The author also adds that university support may differ at peripheral-technological areas.

As it was previously argued one of the main parts of spin-off success relies on the validation phase; however academics by themselves often do not possess required capabilities or resources. The spin-offs success often relies on technology transfer officers and their capabilities to discover commercial potential. Research therefore find consensus in need for technology transfer officers with existing experience in new venture creation who are more likely to have higher level of entrepreneurial alertness (Fetsel, 2012; Wright et al., 2006). The second requirement for TT officers is also their social ties with different stakeholders and especially venture capitalist, industry and business partners (Locket and Wright, 2005; Borges and Filion, 2013).

Wright et al. (2006) however alert that not all spin-offs should be treated in the same manner. Based on the empirical data from continental Europe and UK, authors, came to conclusion that not all spin offs require IP management and high-entry capital. Furthermore, the authors, continue their argumentation that spin offs often needs help in scaling up the prototype.

It can be concluded that TTO play important role in spin-off creations. Officers working at these entities are often the first ones who come into the contact with inventions and are the link between research and commercial world. Probably the most important capabilities of TTO are in business development, IP management and their "know who" knowledge. However heterogeneity of USOs causes that not all new ventures require the same support.

In general mostly common approach to USO research is through research based view theory. Some of the authors uses specific RBV stream focused on knowledge resources (Amesse & Cohendet, 2001; Lockett et al., 2005)**.**

In conclusion it is argued that USOs are complex research topics influenced by several different environments. And even though, throughout the research history few authors came with conceptual frameworks (O´Shea et al., 2008; Druhile et al.; 2004; F.N. Ndonzuau et al., 2002), it is difficult to proof them as a whole by empirical studies. Many of the studies therefore take case study approach. The empirical analysis focused on the separate parts spin-off and VC (Wright et al., 2006) academic entrepreneurs in incubators (Armano & Scagnelli, 2012) academic human capital (Nielsen et al., 2015)

It´s also highlighted that USO research is not able to find consensus in many topics i.e. use of external managers, financing, academic entrepreneurs, influence of TTO etc. Many of them are arguably influenced by specific environment they operate in.

1.2. University business incubators

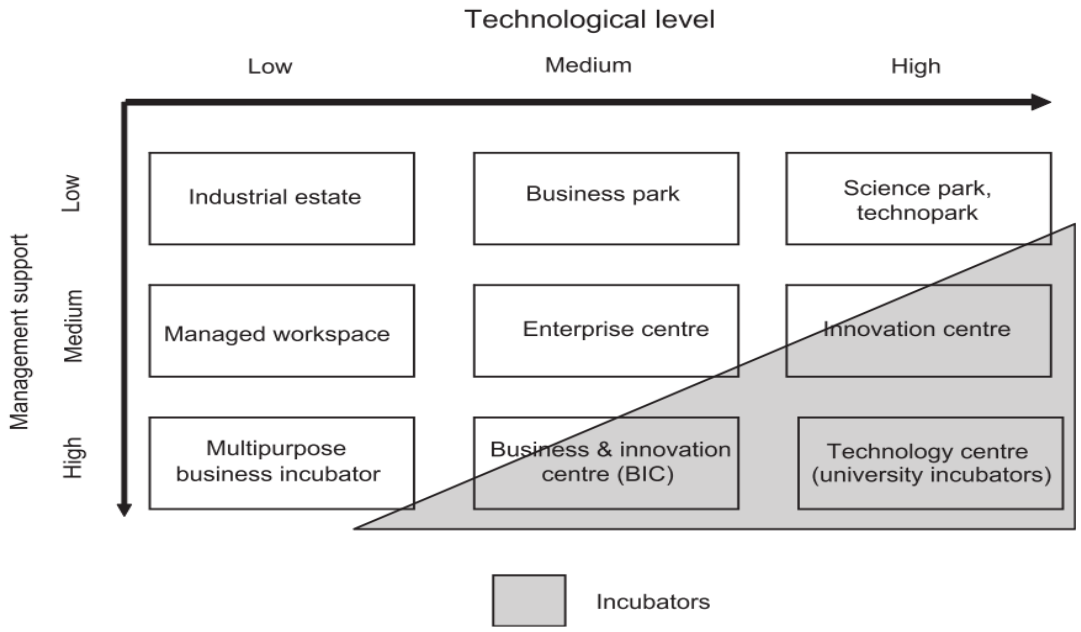
Over the years authors came with several different definitions of the business incubators. The consensus can be found in the one which describe an incubator as program which aim is to support new venture development by offering different social and economic means to incubated companies (Al-Mubaraki & Busler, 2013; European commission, 2010).

One of the main literature streams is examining economic influence of incubators on region or state. Al-Mubaraki and Busler belongs to lead researchers within this stream. In their work Al-Mubaraki & Busler, (2013) they argue that incubators may have four different effects on economy: 1. Economy diversification 2. Technology transfer 3. Employment creation 4. Growth in wealth. In their later study they confirm economic development through incubation; however they add that the effects are stronger in developed countries (Al-Mubaraki & Busler, 2014). The main outcomes in U.S. incubators are not economic indicators as job creation but higher survival rates (Sherman, 1999). Deak & Podmetina (2013) argues that the overall incubation goal, to support growth and launch of new companies, is the same regardless countries, however methods of achieving it differ.

The more specific definition depends on the type of the incubator. Literature is looking on the incubators from various points of view. Grimaldi & Grandi (2001) divide incubators into four types based on the industry they operate in (Figure 2). Namely the types are described as *"corporate private incubators, independent private incubators, business innovation centers, and university business incubators". (p.28).*

Akçomak (2011) on the other hand created incubators typology based on extend of the startups technical level and incubators management support (Figure 2). He argues that university business incubator (UBI) works within highest technical level and offers the highest support. The UBIs description is in the line with Grimaldi & Grandi (2001), who also argue for high scientific and technological knowledge in these types. As one of the most cited authors on the topic is considered Sarfraz Mian who describes UBIs as the tools for creating new research/technology-based firms. (Mian, 1996)

Figure 2: Incubator type (Akçomak, 2011)



Clarysse et al. (2015) looked deeper into UBIs various typologies. The authors analyzed activity level and required resources in European UBIs and came to conclusion that there are three different types: "*low, selective and incubator"(p. 204*. They also described two malfunction models resource deficient (high activity level, low resources) and competence deficient (high resources, low activity level). They argument is that incubators with clear strategy for one of the types will not fall into one of the malfunction parts and will be able to function within its scope.

The growing interest from research society is directed towards fourth-generation incubators or so called *"accelerator"* programs. Accelerator can be defined as *"A fixed-term, cohort-based program, including mentorship and educational components, that culminates in a public pitch event or demo-day."* (Hochberg, 2014, p.4)

Accelerators aim is to provide enhance start-ups resources by providing feedback, networking, coaching and mentoring in intense manner (Hoffman & Radojevich, 2012). The companies are able therefore able to receive input in human capital as well as external validations which at the end should result into competitive advantage.

1.2.1. University incubator capabilities

The different types of incubators have also different supports means for start-ups. Lee & Osteryoung (2004) therefore mapped critical success factors in UBIs and identified 14 different factors in 4 categories (table 1)

Table 1: UBIs competencies (Adapted from Lee & Osteryoung, 2004, p. 419)

Goal/Operations Strategy
Goal (clarity, achievement)
Operation strategy (concrete- ness, realization)
Physical/Human Resource
Easy access to facility and equipment
Common access to service space and office equipment
Networking of entrepreneurial support
Expert organization
Incubator Service
Technology transfer and research and development
Business and law consulting
Financial support and consulting
Entrepreneurial education program
Networked program
Institutional networking
Networking of tenant/offline firm
Networking of financing/business consulting firm
Government local community support

The university involvement in spin-off creation can be divided into two main groups:

1. Classic incubation in in the terms of rent, consulting, access to capital and network, mentoring, creating entrepreneurial attitude (Borges & Filion, 2013; Grimaldi & Grandi, 2001; Rasmussen and Borch, 2010)

2. Specific services related to universities such as faculty consultants, student workers, legitimation, laboratory equipment, technology transfer office, workshops and presentations (Grimaldi & Grandi, 2001; Rasmussen and Borch, 2010)

Universities furthermore have a chance to integrate new resources even though they don´t possess them on they own as universities have chance to utilize resource development by exploiting own linkages of industry allies, alumni and other academic entrepreneurs (Rasmussen and Borch, 2010). Specifically UBIs are able to provide legitimation for start-ups, facilitate interaction between new ventures and customers and through preparation develop entrepreneurs social and business skills (Borges & Filion, 2013).

Mosey and Wright (2007) found differences sector differences in support activities as academics within biological science encounter greater difficulties to network with industry partners as their counterparts in engineering and material science. One of the explanations may be that biological science bear higher risks and industry partners therefore require higher level of legitimation.

Incubator programs should be custom-made, provide network of the best professionals with emphasis on closing the ability gap and offer affordable terms with simple way of the exit. (Lalkala, 2001)

1.3. Literature review – research gap

The spin-off process is occurring in certain environment which affects it (O´Shea, 2008). There were identified several empirical conclusions which support the statement. Some of the literature came to direct conclusion of difference between different environments. Locket et al. (2013) identified differences in spin-off process regarding different UK universities. The authors argue that applying different strategies in universities led to various results. The Baldini (2010) found the different environment for USOs in Italy region. Boleman and Cooker (1992) found difference between various cultures at USA universities and their influence on USO. Because of lack of entrepreneurial culture Leitch and Harison (2005) argues that universities at peripheral areas needs to apply different supporting tools and to focus more on supporting second-order spin-offs.

Some of the indirect conclusions to area influence can be found in the Hayek (2011) who argues that negative perception of fellow academics does have also negative effect on motivation which is closely related to individual universities. The authors Wright et al. (2006) found that contact

investment from the VCs with international networks and experience boost USO performance, however they also argue that the universities which does not have the ties to international VCs should chose different strategies. Filion (2013) found that the academic entrepreneurs are able to develop their social network over time and that there is difference between novice and experienced entrepreneurs. One of the conclusions is also then in area with more developed entrepreneurial environment the academics are actually able to provide some extra resources on their own without support from third parties.

Furthermore, literature offers even some non-uniform results as in topics of applying external managers. Tietz (2012) haven´t found significant effect in using surrogate entrepreneurs Lundquist (2014) and Locket et al. (2003) found positive effect and Clarryse and Moyes (2010) argues that surrogate entrepreneurs have negative effect. Three of the studies, Tietz (2012), Lundquist (2014) and Locket et al. (200) are based on the similar empirical methodology, combination of survey and organizational data however the place of the studies vary. The Tietz (2012) conducted his study at the German Universities, Clarryse and Moyes (2010) at Belgium while Lundquist (2014) in Sweden and Locket et al. (2003) at UK. Locket et al. (2003) and Lundquist (2014) found positive effect at universities which applied policies towards the surrogate entrepreneurship while Tietz have not taken this into consideration. Beside the territory differences it may also means that to create positive effects from surrogate entrepreneur, the university simply have to apply policies which will allow it.

Based on the presented arguments it is claimed that spin-off process is environment and therefore area dependent.

The same arguments can be found also in incubation literature. Al-Mubaraki and Busler (2013) found different means of support in developed and developing countries. Deck and Pometna (2013) also argues that while the goal in different countries is the same, the means of support and its effectiveness varies in countries based on different environment. Lalka (2001) argues that the incubation support should be custom made for company needs.

The incubation literature is quite unanimous in regard of outcomes, goals and possible means of support. However, there is lack of the literature or framework which would explain which incubation strategies can be applied in various contexts.

Hence we argue that spin-offs in different environment will require different support from incubator. However, current literature does not examine this issue in suitable extend.

2. Theoretical framework

2.1. Resource based view

To analyze spin-off creation process from theoretical point of view was chosen resource based view (RBV). The theory currently belongs to one of the most influential theories with regard on unfolding, explaining and analyzing organizational processes (Barney, 2011). The RBV arose as redirecting external focus of Porters (1980) five forces onto internal environment.

Wernerfelt (1984) is considered as one of the RBV fathers. In his work "Resource based view of the firm Wernerfelt (1984) firm analysis from resources point of view over product focus. The authors defines resource barrier which allows for resources to be exploited more than one time. By focusing on resources, companies should be able to use their stronger position in one product in favor of others. He however highlights the balance between internal and external focus: *"Entry barrier without a resource position barrier leaves the firm vulnerable to diversifying entrants, whereas a resource position barrier without an entry barrier leaves the firm unable to exploit the barrier." (*Wernerfelt, 1984; p. 173).

In spin-off terminology it can be translate into example of having loyal customers (entry barrier) without technological knowledge (resources) leaves the opportunity for the competitors to enter the market, whereas having superior patent (resource barrier) without customers (entry barrier) leaves the spin offs unable to exploit the opportunity.

Wernerfelt (1984) identifies the ideal situation as the one in which the firm creates own resources which makes is directly or indirectly difficult for others to reach the same point. In this work authors does not identify what the exact resources which provide this position, he just mentions few examples as customers' loyalty, experience, apparatuses and technological expertise. In general the resources can be grouped into tangible and intangible.

The interesting point is brought in regard to technological lead. Wernerfelt (1984) here argues that followers will have easier way to reinvent the technology. The companies therefore needs to constantly improve their knowledge in order to keep resource barrier.

Barney (1991) shed more light on resource typology. Even the author has not explicitly identified required resource; he defined origins of resources which lead to competitive advantage. In the model companies are able to create sustainable advantage through internal exploitation strategies which capture opportunities and counterweight potential threats and weaknesses. He defines competitive advantage as the state when "*firm is implementing value created strategy not currently implemented by any current/potential competitors and when the other firms are not able to duplicate the benefits"* (Barney, 1991; p. 102). One of his biggest argument is that firm will not be able to create sustainable advantage with the ones which are evenly distributed among all competitors. Furthermore, he argues that the resources which company possess needs to be heterogeneous.

Barney (1991) defined four different resource characteristics of resources which can be transferred into the competitive advantage. Four characteristics are:

1. Valuable – resources needs to lead to opportunity exploitation or reducing the effects of threats.
2. Scarcity – the same resources cannot be in competitors' possession.
3. Difficult to imitate – in order to sustain competitive advantage resources cannot be easily imitated by competitors.
4. Substantiality – there cannot be replacement for the resources.

The author also adds several examples of these resources. One of the most interesting one, in regard on spin-off process, is scientist whose in the form of tacit knowledge is bearer of difficult to imitate resource. As the other example he uses is closing knowledge gap by hiring experienced managers. The last examples are social ties which are difficult to imitate or substantiate. Barney (1991) therefore enlarges understanding of resource known as physical, human and organizational with fourth dimension, social capital.

One of the most important RBV expansion came from Teece et al. (1997) and their concept of dynamic capabilities. In their work Teece et al. (1997) defined new approach to analyzing sustainable competitive advantage and wealth creation. The authors argue that dynamic capabilities are especially appropriate framework industries with rapid technological change and

turbulent market circumstances. Previous RBVT focus was on exploiting already existing resources, however dynamic capabilities refer to possibility to answer on rapid changes with innovative solutions. It involves suitable management of internal, external and organizational skills.

Teece et al. (1997) also add that dynamic capabilities usually cannot be bought but have to be built. If we use the purchase logic as transaction between two parties we may conclude that simple transfer of resources from one side to another will not be appropriate way of creating dynamic capabilities. Hence, if we apply the same login on incubation practices, we may argue that incubator cannot just transfer these capabilities to new USO but have to support its creation within new organization. In this case we can use example of identifying new invention commercial potential. If technology transfer officer is able to find market need and then simple pass the information into USO, it does not mean that he transferred also his dynamic capabilities into new venture as they were embedded in TT officer tacit knowledge. In this situation, in case of rapid change, USO will not be able to shift their resources appropriately and it might lead to company failure.

The dynamic capabilities as proposed by Teece et al. (1997) are however focused on established players on market. In many cases they can indeed explain success and also failure of the firm. As authors argue, small change in one part may influence other company divisions. The companies which are not able to adapt on this change are left vulnerable for rapid technological advances.

The first one who connected RBVT and entrepreneurship were Alvarez and Lowel (2001) who argue that the most intangible asset for entrepreneurs is to identify new opportunities, manage resources and transfer homogenous resources into the heterogeneous outputs. They claim that especially important may be heterogeneity among founders. While so called “experts” usually possess specialized technological knowledge, entrepreneurs are more generalist who is able to analyze complex situations and find potential market spots and true competitive advantage is embedded in the skills to find new opportunities.

From this point of view we may argue and explain success of surrogate entrepreneur concept. As it was mentioned earlier, external entrepreneurs should fill the gap within commercial skills. Their main task is to identify opportunities, attract and manage resources.

2.2. Knowledge based view

In 1996, Grant, introduced knowledge based view (KBV). He considers knowledge as the most important resources in the company with regard on sustainable competitive advantage creation. The KBV is considered to be extension of RBVT with attention on knowledge creation, implementation and transfer. Grant (1996) main assumptions are built on two prepositions:

a) Knowledge generation is individual motion

b) Knowledge has to be used in order to create rents

The author argues that knowledge transfer from one person to another may be ineffective due to transactional costs; therefore he puts emphasis on knowledge management. Using again example in spin-off it means that it would be ineffective if scientist wants to all knowledge on external entrepreneur and vice versa. Based on the Grants´ assumptions it is more important that surrogate manager and academic are able to recognized each other's knowledge depth and use it to create new products or services. Based on this phenomena it might be explained why USOs requires academic involvement as it would be difficult to transfer knowledge from academic to somebody else.

Grants theory is targeted on larger corporations and their organizational learning. Brockman (2010) however used the KBV and Teeces dynamic capabilities and created framework for learning and knowledge creation in new ventures. He divided start-up process into three stages and defined required dynamic capabilities, learning taxonomies and critical development. The full classification can be found in figure 3.

As previous authors (Wernerfelt, 1984; Barney, 1991, Teece et al. 1997) stated organizational learning is considered as one of the resource which may create sustainable competitive advantage. Therefore setting up right learning from the beginning in spin-off may lead, in combination, with other resources to company growth. The statement is supported also by some empirical studies which found correlation between organizational learning and higher economic profit and growth (Strehle et al., 2010; Avi, 2007). Corner and Wu (2012) were able to identify dynamic capabilities in new ventures as one of the reasoning for start-ups success. It has to be however added that Strehle et al., (2010) found that the organizational learning influence was

conditioned by existence of financial resources which support hypothesis of Barney (1991) about need for heterogeneous resources in other to create sustainable competitive advantage.

Figure 3: Learning processes in new venture (Adapted from Brockman, 2010, P. 266)

	Pre-Start-Up	Start-Up	Growth
4I Framework: Level of Learning	Individual	Multiple Individuals and Shared Groups Leads to Group Collective Action	Organizational
4I Framework: Stage in Process	Intuition	Interpretation Integration	Institutionalizing
Dominant Learning Classification	Double Loop Action Learning	Behavioral (Supported by Action Learning)	Cognitive (Supported by Action & Behavioral Learning)
Dynamic Capability Development	Entrepreneurial Alertness	Begin Development: Absorptive Capacity Transformative Capacity Strategic Learning	Further Enhancement: Absorptive Capacity Transformative Capacity Strategic Learning Balance of Exploration & Exploitation
Critical Development	Skill in Opportunity Recognition	Behavioral Learning Processes: Information Acquisition, Dissemination, & Interpretation	Heedful Interrelating
FEED FORWARD & FEEDBACK LOOPS	⇄	⇄	⇄

Understanding required dynamic capabilities and organizational learning set up may help also incubators to support these initiatives within USO. Brockman (2010) explains that in the pre-startup phase, the emphasis is on opportunity recognition, where potential founder become more aware of possibilities which market offers as well as his own use of capabilities. Even though the learning takes place largely on individual level, founder is then transferring it into new formed ventures. The best way to support it is by creating double loop learning in form of feedback/feed forward and action based learning. In the start-ups phase larger integration and interpretation of knowledge is taking place. The learning processes are moving from sub-conscious to conscious levels and learning is moving from action based to behavioral (intentional learning). If start-up phase is passed right, the USOs will be achieve higher level of integration and will work on more

collective manner which will help them to move toward growth stage. The large part of critical skills is information acquisition. Through continuing action based learning, new venture, may achieve incremental developments which may not be considered to play major role in final outcome, however they help to develop absorptive and transformative capacity. In growth phase, start-ups need to fully integrate learning processes and find balance between action, behavioral and cognitive learning.

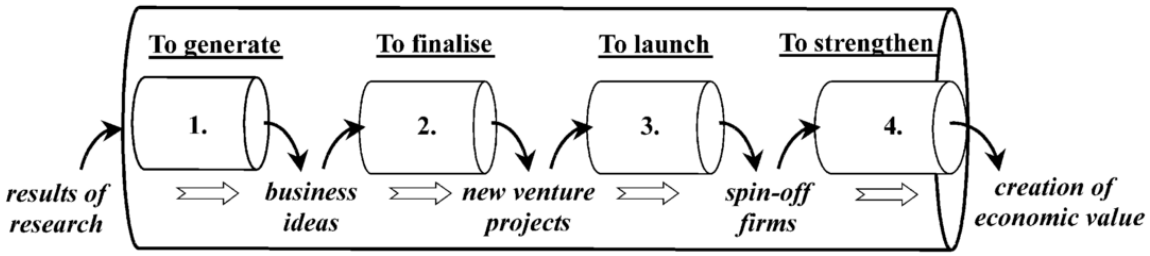
All the learning types and stages have in common one important characteristic and that's social capital. Not only in sense of network but also as soft skill as all of the learning is happening within interaction between people. As it was argued previously incubator may find ways how to support this learning. Understanding organizational learning in new ventures may help also in overall company management. As the transformative and absorptive capacities are connected to second startups stage it is argued that in this stage the academic involvement will require more time.

Ireland et al. (2003) based on RBVT combined the concept of entrepreneurship with strategic management. They argue that the biggest advantage for new ventures is opportunity recognition, however, these entities often does not possess sufficient resources to exploit the opportunities. The core of their framework is based on hypothesis that combination of risk-taking behavior (entrepreneurship) in combination with advantage seeking one (strategic management). The entrepreneurial behavior was defined previously but to clarify strategic behavior we´ll use Ireland et al. (2003) definition: *"Managing resources strategically includes the firm's ability to allocate sufficient financial capital to acquire and accumulate human capital and social capital necessary to seek opportunities and build competitive advantage."(p. 978)*. Furthermore, the authors highlight the fact that resources need to be flexible.

2.3. Spin-off creation model by Ndonzuau et al., (2002)

Ndonzuau et al., (2002) based on the inductive research of 15 different universities created four stage academic spin-off model. Their aim was to uncover process from academic research to economic value. The authors argue that the model is not straight forward and the different stages are dependent on each other's as the quality of the outcome depends on the weakest link.

Figure 4: Four stage USO model (Ndonzuau et al., 2002, p. 283)



The four stage model (figure 5) consists of *(p. 283):*

- To generate – the main goal of this stage is to identify, create and asses ideas from academic research to commercial exploitation
- To finalize - as the first stage ideas are based on scientific or engineering discovery they often miss business foundations, the second stage is therefore focused on market validation
- To launch – in this stage new venture emerges, the aim is to exploit opportunities by management and existing resources
- To strength – in the last part, the USO transfers its actions into economic value, which may be either tangible or intangible (Ndonzuau et al., 2002)

We´ll discuss all stages more in details in following paragraphs.

Stage one – To generate (p. 283)

Within this stage emerging USO faces two main challenges namely are *academic culture and identifying ideas (*Ndonzuau et al., 2002, p. 283).

Academic culture is especially identified with opposite to business one. The main university aim is knowledge creation (Shane, 2004) while business is mostly concentrated around wealth creation. This split results into three sub-challenges. The basic research is usually uninterested into commercial use, is not driven by money and therefore, has different motivation as business and academic often face "publish-or-perish" (p. 284) paradigm. The "publish-or perish" drive

defines the usual situation at universities when academics are rated and rewarded based on number of their publications in prestigious journals. This status quo creates problem also within law protection as already published findings cannot be patented. (Ndonzuau et al., 2002)

Identifying ideas face requires trust and inside flow of information and academics may be concerned about external partners evaluating their ideas. Furthermore, ideas have to be assessed on two levels. From one point technological feasibility of research which has to proof that ideas may be further developed. On the other hand ideas have to be also evaluated on commercial potential. The ideas therefore face disproportionate formula. While some scientifically strong ideas may not be exploited commercially, the less valuable scientific findings may have much higher value in business. However, all of the ideas in this stage have just basic validation and in order to create economic value needs to pass through second stage. (Ndonzuau et al., 2002)

Stage two – Finalizing new venture projects (Ndonzuau et al., 2002, p. 285)

The stage is defined by transition from unstructured idea to more concrete business strategy. While in the first stage is not clear business model and value propositions in second stage USO should slowly be able to answer this questions. Furthermore, legal protection has to define with clear owner structure. The USO project undergoes two development stages. One on the technological level, as scientific findings often have to be transferred into usable products. This transition requires material as well as non-material incentives. The second update is on business level as the main goal is to formulate business plan on how to exploit the opportunity. One of the main challenges in this stage is to secure early stage financing. As it is still early in new venture process and overall uncertainty is high. In many cases, the financing is required especially regarding intellectual property rights. *(Ndonzuau et al., 2002, p. 285)*

Stage three – To lunch (Ndonzuau et al., 2002, *p. 286)*

Just in the third stage, the overall process is moving towards actual new venture creation. The USO goal is to exploit opportunity by management team with available resources. The new ventures therefore face the challenge to obtain tangible and intangible resources. One of the main reasons for USO failure is not weak business opportunity but rather sloppy management. Moreover, academic founders have to clarify their relationship with university. It often means to restraint their ties to university and become more involved in the spin-off process. However,

willingness to quit academic environment is often small among researchers. University offers relatively stable conditions and more researchers are involved in the research institution the more difficult it is for them to quit. It is beneficial if both parties keep weak ties. The universities may allow to use their laboratories or equipment and academic often stay in touch with their former colleagues. (Ndonzuau et al., 2002)

Stage four – To strength (Ndonzuau et al., 2002*, p. 287)*

The last stage is about harvesting economic value in the terms of generating jobs, wealth, extra research funding etc.. Many USOs show high growth potential and therefore may face challenge to obtain sufficient funding for the activities or also to find skilled workforce. If USO does not find it within its current region it may relocate activities elsewhere or otherwise face threat of failure. The regional authorities therefore have to create condition which will allow USO to create economic value within its´ emerging area.

3. Methodology

3.1. Research "world view"

Identifying world view is important part may help in choosing right research approach as well as helping organize overall study. Paradigm can be defined as complex set of believes, rules, theoretical standards and methods shaped and modified by certain scientific group (Chalmer, 1982). The research community came with numerous of different paradigms, however the universally acknowledged are: post-positivism, critical theory and interpretivism (Vinden, 1999). To overcome limitations of mentioned paradigms Vinden (1999) expanded well-accepted paradigms with unconventional ones as phenomenology, symbolic interaction, ethnic studies, life histories etc.

Phenomenological approach preaches that the world is the reality as beings believe or perceive it to be (Kvale and Brinkmann, 2009). This paradigm is therefore focused on how individuals see the "reality" and how they believe it is. The researcher therefore needs to analyze the data from individuals' point of view. In comparison with for instance positivism, which believe is that reality is objective, external and academic is independent part of it, phenomenology believe is built on social ties, subjectivity and view that academic is active part of environment (Easterby-Smith et. al., 2002).

For this study was chosen "life-world" point of view. The importance of understanding incubation support and spin-off process from individuals' point of view may be illustrated on example of capital existence. The positivism approach might be to evaluate overall amount of capital in area in sake of finding conclusion if the amount of capital is "sufficient" or not. However, the existence of capital in the area does not automatically means that it´s invested in the USOs or that all capital holders are seeking to invest respectively if they are willing to invest in such uncertain types of companies as USOs, etc. Roughly speaking, in phenomological point of view capital does not exist as far as it is not connected with USO or they at least do not know about it. The described situation is quite extreme type and cannot be generalized however it illustrated main reason for choosing the life-world paradigm.

Easterby-Smith et al (2002) adds that the most suitable research approach in applying phenomology is the qualitative one.

3.2. Methodological approach

The aim of this paragraph is to explain reasoning behind choosing qualitative research as the main study approach. When choosing research approach author has from the begging two options: qualitative or quantitative approach. While quantitative research is mostly focused on theory testing, qualitative research allows examining real life issues (Yin, 2009; Denzin and Lincoln, 2003) and giving the researcher chase to understand participants' point of view (Yin, 2009; Christensen et al. 2015). Furthermore, the qualitative research also allows researcher to react more flexible throughout data collection therefore the qualitative approach is suitable for complex situation (Yin, 2009). Quantitative tools as for instance surveys are limited with predominated variables which might limit new findings. Christensen et al. (2015) adds that qualitative study usually relies on non-numerical data and therefore enables to understand individuals or certain groups of individuals. On the other hand qualitative research is limited within extend in which it can be generalized and does usually does not follow hypothesis testing procedure.

Yin (2009) specifies that the exploratory case study is appropriated method if the research context is not clearly defined and serves as the mean to create hypothesis for further examination.

As it was argued in the literature review spin-off process is indeed complex issue. It could be therefore limiting to create survey as some of the issues may not be covered by existing theories. Furthermore from our literature analysis was concluded that it´s environmental dependent. The main research target is Aalborg University which within years 2007 – 2015 had only 16 spin out [1]companies. This number wouldn´t allow creating statistically significant research using survey or other qualitative methods. Moreover, the goal of the study is not generalization, but more understanding of whole spin-off process at AAU and how it can be supported by incubator practices.

3.3. Case study

A case study is in research used to extend understanding about individual, firm, economic or other type of behavior. It allows researcher to preserve life-world context and is usually used to

[1] Appendix 1 – Commercialization statistics

answer “why” or “how” types of questions. However, in right setting it may also answer “what” types of questions, which are usually examined with qualitative tools as surveys (Yin, 2009). Case studies are appropriate method to use also in the situation in which limits between backgrounds and phenomena are not clear. In the setting when boundaries are not set case study is able to deal with large extent of variables, data relies on different sources and through prior theoretical overview guides collection and analyses (Yin, 2009).

Case study design as most of the qualitative approaches is the most suitable approach in issues with high complexity. It shows several advantages in comparison with other research methods. For instance, while history method deals with the past, case study allows the researcher to focus on still ongoing processes. Furthermore, it is suitable method in environment which cannot be controlled. Yin (2009)

Yin (2009) highlights four most important case study applications:

1. To explain the connections within real-world context which demonstrates signs of high complexity
2. To describe an intervention and real-life situation in which it occurred
3. To clarify issues in descriptive manner
4. To *“enlighten those situations in which the intervention being evaluated has no clear, single outcome” (p. 20)*

Case study however possesses several weaknesses. Yin (2009) defines several challenges coming with case study approach. The case study threat may come from researchers’ lack of methodical procedure. Even though case studies are defined by high flexibility level, sloppy work may lead into wrong findings and conclusions. Following methodological outline helps to organize study and lead academic toward trustworthy assumptions. As it was already mentioned, case studies as well as other qualitative methods are barely generalizable. On the other hand case studies may lead into general theoretical framework and not the population. Case studies also are subjected to threat of personal judgment. Researcher must at all-time keep his/her objectivity and do not lead study into expected direction. Furthermore, case study may be time consuming. The requirements for data collection and analysis are often high and as a result, researcher might get under time pressure. One of the solutions is related to already mentioned methodological outline.

Some “modern” data collection sources as internet or telephone may shorter case study time (Yin, 2009).

The case study was chosen as the methodological approach especially because it´s ability to deal with complex issues. It was already argued in the literature review that spin-off process is influenced by multiple stakeholders and subjects. Furthermore the combination with incubation support makes this topic even more complicated. The case study allows researcher to collect data from different sources and gain top view over the process. As it was mentioned, paradigm applied for this research was phenomology or so called life-world view which is highly suitable to be examined with case studies. As currently there is almost non-existing incubation support and spin-off process at AAU is relatively new phenomena, we argue that there will not be enough data for history method. Moreover, it is arguable that it is difficult and would require large amount of resources to create experimental conditions for spin-off process. To overcome main case study threats the outline of the study was created from the beginning. The created time schedule allowed research to follow proposed outline while keeping enough flexibility to cope with study complexity.

3.4. Case study design

Yin (2009) argues that the case study design is logical sequence to get from research question to answers. The research design has to find answers on the questions as what research problem is, how to create relevant data and how to analyze them (Yin, 2009).

The case study design can be overall divided into two main groups which are multiple case study design and single-case study (Yin, 2009). The author adds that multiple case study design offers robustness and is more reliable however; they also require higher resources and are time consuming. The author adds that single case study may be used in one of the following situation:

- a critical case
- an inimitable case
- a characteristic case
- a revelatory case
- a longitudinal case (Yin, 2009, p. 45 – 47)

As the overall study goal is to improve spin-off support at Aalborg University. As it was argued in problem formulation spin-off process is often tied to specific area and therefore also incubation support will vary in effectiveness in different places. It is thus essential to understand specific context within one case. However also from methodological point of view can be Aalborg University labeled as unique case. AAU as one of very few universities in Europe applies problem-based learning. The mentioned characteristics position AAU to inimitable case. Even though the primary aim of this study is not to disclose influence of these features, they will be bearded in mind during analysis.

3.5. Case study protocol

Yin (2009) argues that to increase case study reliability the researcher needs to develop protocol. The protocol goal is to keep academic on the right track through whole study and eliminate its weaknesses. The protocol consists of overall rules and guidelines for researcher to be followed and can be divided into four parts:

- Case study overview – the part defines overall research direction and formulates problem which researcher aims to solve. In this concrete case, is the case study overview covered in introduction and problem formulation part
- Field procedure – researcher clearly formulates the strategy of data collection (Paragraph 3.6.)
- Case study questions – Is one of the most important part of case study protocol. The questions navigates researcher through data gathering and help him to set borders and direction in his/her collection. The questions are in indirect relation with main research questions and sub-questions. The questions are not asked directly in interview; however researcher is searching for answers throughout data collection. The case study questions were mostly extricated from literature review and theoretical overview and consist of:
    - Why do researchers at AAU start new ventures?
    - How they identify market potential?
    - How does researcher network looks like?
    - How do academics start spin-offs?
    - Who does the spin off team consist of?
    - What are the capital requirements for pivoting product?

- How does new venture evolve over time?
- How does organizational learning look like?
- What are human capital requirements through process?

- Case study report guide – the report guide consist of three main parts the outline, the format and the audience. The outline and format in this case follow the university minimum quality requirements for master thesis. However, audience is here bilateral. On one hand are university requirement, on the other are expectations from partnering organization – AAU innovation. The researcher therefore has to deliberately keep in mind both parties while writing this report.

3.6. Data collection

In this section will clarify the data collection methods. Based on existing literature within methodology will present our arguments for using chosen methods and furthermore specify all data used in this study.

Data can be classified as the smallest entities in form of information which resulted from some experience, testing, reflection or other form (Yin, 2011). While in quantitative methods, the collected data are usually purely external, in qualitative methods, the researcher is the main instrument. Therefore, the means of what and how is reported depends strongly on particular researcher (Yin, 2009). A case study approach is subjected to specific circumstances as data collected may consist of qualitative as well as quantitative information (Yin, 2009). Qualitative data allows statistical manipulation, while main purpose of qualitative data is to describe (Yin, 2011).

Yin (2011) describes four main data collection activities in qualitative research:

- *"Interviewing*
- *Observing*
- *Collecting*
- *Feeling" (Yin, 2001 p. 130)*

The two main methods used in the study were interviewing and collecting. They will be therefore described more in details.

The author adds that each data collection methods create different kind of data. The interviewing focused on interviewees' personal explanation while collecting results into set of texts, dates or other form of written formulation. The collected data therefore rely on researcher's ability to reveal important insights, even though to capture exact real-world perspective is almost impossible (Yin, 2011). Interviews offer relatively low cost and less time consuming possibility for collection, however it is still efficient method to understand and analyze real-world problem (Kvale, 2007).

The interviews can be divided into four groups: open, structured, semi-structured and focus groups (Preece et. al, 2002). The significant part of interviews in research is conducted by semi-structure interviews (Yin, 2011). The semi-structure interviews does not follow predominant questioner, however researcher has more of the questions framework. The researcher role is not to adapt identical outline for all interviews but is able to adjust according to existing background.

The flexible context allows keeping conversational mode in comparison with structured interviews which increases chances to understand life-world meaning.

Regardless the interview type Kvale (2007) defines six requirements for qualitative interview:

- The interviewee offers large extent of natural, related and rich answers
- The respondent provide extensive answers on relatively short questions
- The interviewer is able to clarify and build up on interviewees answers
- The interview can be interpreted throughout the dialogue
- The interviewer is able to confirm his interpretations during the interview
- The interview is self-explanation story and does not need further clarification

The semi-structured or so called qualitative interviews, allows researcher to capture life-world phenomena which is main phenomological approach of this study. They were therefore chosen as main data collection method. To follow critical quality points the researcher prepared framework

of question beforehand, however interviewees were left freedom to express their experience with spin-off at AAU. Just in the case that interviewee was not able to continue talking some of the helping questions were used. In total were conducted 4interviews with. After approval from interviewees, the interviews were recorded and transcribed afterword, however it was agreed with participants that the data will be analyzed anonymously. The goal of the interview was to understand spin-off process at AAU. Therefore, most of the interviewees were researchers who actively participated in the USO creation, in total 3. Furthermore, to boarder the knowledge the part of the interview process was technology transfer manager. The goal was to involve in the interview also venture capital manager, however there have not been found any who would wish to participate.

The interviewees in new venture process had to be founders in the new venture which fulfill two main qualitative criteria selected from literature review:

c) *at least one founder was at the beginning of the new venture creation assigned as an academic staff*
d) *spin - off is created based on the research outcome and knowledge transfer.*

Collecting is defined as accruing different objects as documents or archival record related to the research. The objects may create various types of data and be in form of verbal or even numeral data, pictures etc. Collected documents does not suffer from bias reflexivity, however researcher has to be treat them carefully as they were primarily developed with different aim.

The collected data are mainly in the form of commercialization statistics and will be used to illustrate the case in comparison with other universities in Denmark and to get better overview of commercialization at AAU which directly influences spin-off process. The main use of the collected data will therefore be to support qualitative data collection and not to draw on conclusion from them. It will not be therefore used to provide statistical significant proof of phenomena and will not be classified as quantitative. The secondary sources are mainly databases of ministry of higher education at Denmark and Danish university database. The examined data consist of these categories: reported inventions, issued patents, license, options other form of agreements, spin out companies established, TTO personal, cost and revenues of

right protection. To normalize data and bring all universities on the same level will be used number of PhD students which reflects size of the university.

The other sources of collected data is internal directives at Aalborg University which describes commercialization process are web pages of interviewed companies. The collected secondary data were analyzed before interviewees to help with preparations.

3.6.1. Interviewees

Interviewee 1 – TTO manager

The manager has been in the office for 8 year. His previous education was in business and economics field and had previously experience with own new venture, as intrapreneur and also in financial department at larger corporation.

Interviwee 2 – CTO at wireless technology spin-off

The interviewee started the company based on his PhD research in year 2011. The company is focused on cutting edge wireless technology and was formerly built with team of two PhDs and two professors. The technology is currently used to provide live streaming videos

Interviewee 3 – CTO at wireless technology spin-off

The founder of second spin-off is professor at AAU. The company was created in 2013 and is currently in the stage before first larger sales contract. The spin-off improves wireless communication.

Interviewee 4 – Co-founder data-mining company

The fourth interviewee is computer science professor. He created spin-off together with his PhD student in 2010.

3.7. Data analysis

Data analysis is complicated process which may require significant amount of time. By following general rules, research is able to pass through this stage and finally come to unbiased reliable conclusions. Yin (2011) defines three main quality requirements for data analysis:

- Constantly controlling the data accuracy

- Providing complete analysis without cutting some parts
- Staying objective through all the time

To organize practical side of the analysis Yin (2011) suggest non-linear framework in which researcher should keep workflow back and forth between different parts.

1. *Compiling the data (p. 171)* – before actual analyses start, the researcher needs to organize its data in systematic way. The compiling data helps researcher to better identify usefulness of different set and at the end stronger the analysis. However the formal way of data complying relies on researchers own work preferences. (Yin, 2011)
2. *Dissembling data (p. 186)* – the researcher may choose between two different strategies. With coding and without coding. Coding means grouping certain ideas into one label based on similarities. The coding helps researcher to move methodology on advanced conceptual degree. The coded data are allows academic to sort data into similar groups. The groups can be then examined based on analogous features. Yin (2011)
3. *Reassembling data (p.190)* starts with search for patterns, in case of coding the patterns will appear in more abstract groups. The reassembling however also consists of constant questioning of validity and reliability. The researcher has to make sure that the emerging patterns make sense and are important for studies. Reassembling with data may also include "arrays" which aim to organize pattern in specific order (Yin, 2011).
4. *Interpreting (p. 207)* - is to transfer data to common understanding and to bring whole analysis together. The important aspect of the interpretation is that it´s not pushed and it mirrors the data quality. Interpreting at the end is not linear sequence but appears alongside whole analysis process (Yin, 2011).
5. *Concluding (p.* 220) – every study, qualitative or quantitative has to provide conclusion. The conclusion is connected to interpretative part and data collection. The conclusion closes the study on the top conceptual level and consists of sequence of statements. The concluding in qualitative studies however never reaches two generalization levels. At first place qualitative studies usually does not offer significant amount of variables which would allow statistical generalization. The second improper way of concluding in qualitative research is *"extreme validity"* (Yin, 2011; 221 – 226).

The analysis framework proposed by Yin (2011) was also applied for this study. The primary data, interviews, were compiled in the form of the transcription. For the transcription was used software program "inscribe". Using the software is described as welcome help especially for novice researcher (Yin, 2011). The method of dissembling data was coding. All the transcribed materials were coded into smaller groups while using software "QDAlittle". The codes were then put in higher abstract groups. The second order groups consists of 25 which were then put into 5 third level clusters arranged in the hierarchical array. The groups were then used for interpreting and in final conclusion.

3.8. Case study validity

Yin (2009) proposes several steps to increase case study validity. His main suggestion is draft review by participants, peers or other relevant persona. The kind of review is advised even in the case of anonymous components. The adjustments will increase the case study correctness and therefore improve *"construct validity" (p. 199).*

In the study case the validity was improved by reviews from supervisor peers and especially interview participants. After the interviews were analyzed and transferred into the draft it was sent to interviewees who made small changes and approved the interviewers' point of view.

3.9. Case description – Aalborg University

Aalborg University is located in North Jutland region. Regional innovation monitor shows that the North Jutland is the most underdeveloped in Denmark with lowest GDP/captive, highest unemployment but also with positive growth rates and increasing innovative performance. [2]

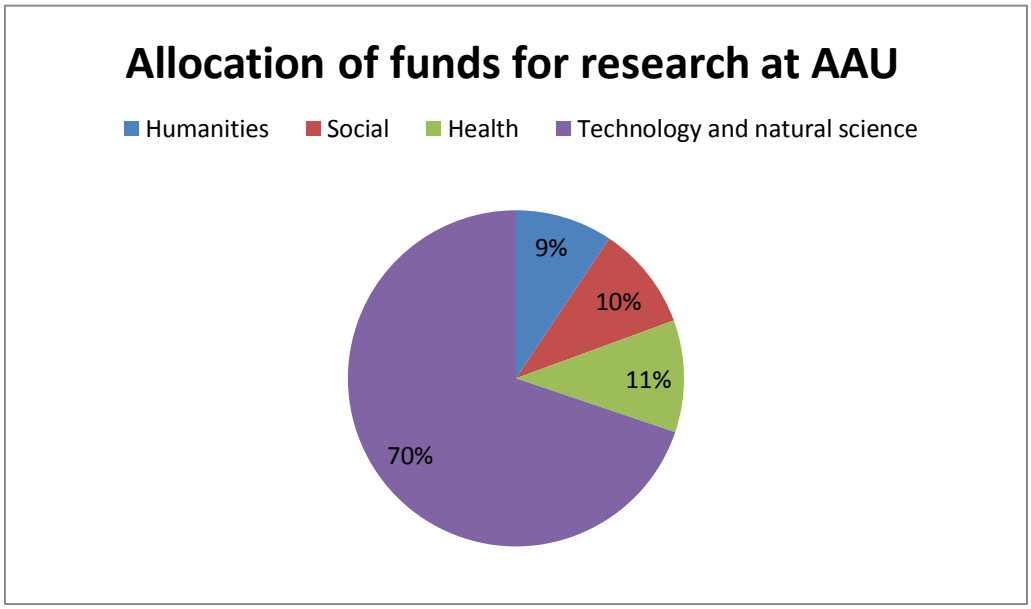
Aalborg University was founded in 1974 and operates within health, social, humanities, technical and natural science. In the Shanghai ranking of world universities, AAU was place between 201 – 250 place which is significant jump in comparison with 2014 where it was place 400 – 500. The QS rating placed AAU as number 6 in the world at subject "Electronics and electronic engineering".[3]

In 2014 at AAU studies over 21 000 student, the university employed 2008 full staff academics, 740 part-time and 1030 PhDs. The figure 5 shows that significant amount of the research is

[2] European Commision - Regional innovation monitor
[3] AAU website

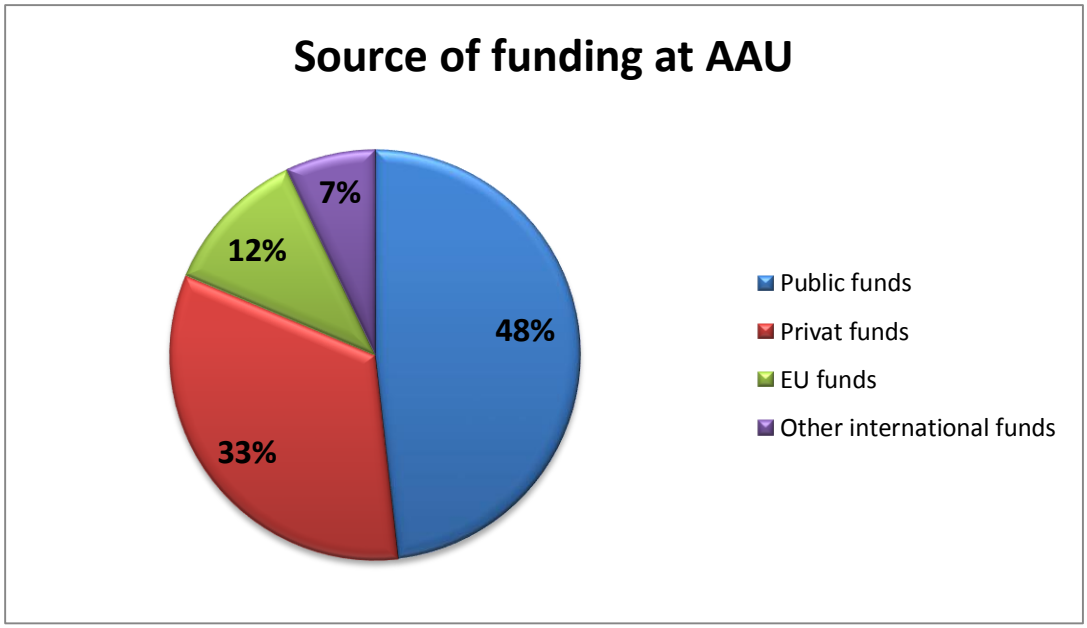
allocated to technology and natural science which receives 70 %, the health science is supported by 11 %, social by 10 % and humanities with 9 % of the fund

Figure 5: Funds allocation for reserach at AAU (own processing, Denmark statistics)



The majority of the funds are coming from public sources 48 %, while privet sector contributes with 33 %, EU with 12 % and from international cooperation is coming 7 % (Table 6).

Figure 6: Source of funding at AAU (own processing, Denmark statistics)



The AAU specific is problem-based learning (PBL). The PBL approach to education and research is through collaboration with outside parties and solving authentic problem. The PBL aims to provide students with abilities to work in the collaborations and independently.

The aim and vision of AAU in research is to strength collaboration with private businesses, increase effective knowledge sharing and external funding.

Aalborg University organizes the most of the collaboration, knowledge and technology transfer, fundraising and commercialization through its department AAU Innovation. The department is divided into six sub-organizations which each hold responsibility for different area. The organizational structure can be seen in the figure 7.

The main bearer of USO process is technology transfer office; however other departments also possess capabilities and responsibilities which influence it. For instance SEA supports entrepreneurial courses at AAU and is organization behind incubator (targeted for students) and network center supports industry collaboration.

The master thesis therefore does not aim to create policies for specific departments but is looking at the problematic from more abstract perspective.

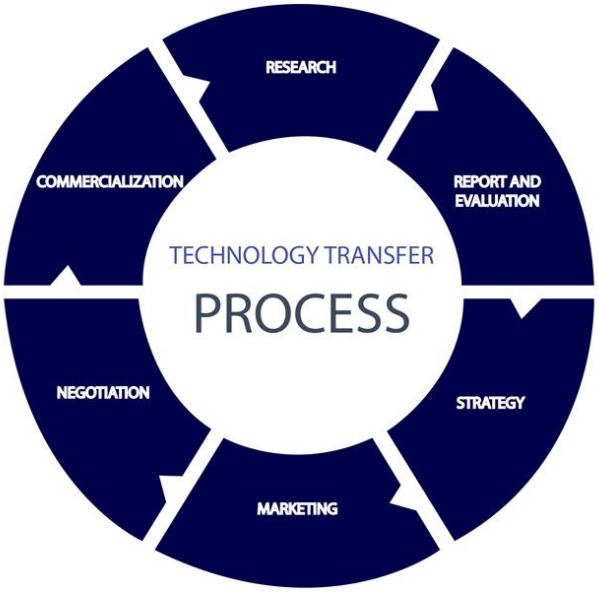
Figure 7: Organizational structure at AAU Innovation (Adapted from AAU.DK

4. Analysis

4.1. Technology transfer at AAU

The formal commercialization process at AAU is held by technology transfer office and is divided into six steps which can be seen in the figure 8.

Figure 8: Technology transfer process (Adapted from patent.aau.dk)



The process start after the research is conducted with report and evaluation step. If the research results are clarified as the invention TTO office will do novelty search if it fulfill potential criteria for patent application. The process is done together with patent agency which decides if the results can be protected by IP.

The technology transfer at AAU is subjected to law: "Act No. 347 of June 2, 1999" which states that the Aalborg University as the researchers´ employer has the right to acquire inventions which were created in relationship to ones work. The AAU employees has therefore obligation to report all inventions related to their work. That in some instances may include also inventions created in the free time if the invention was related to employees main work description and also inventions which came out from private collaborations. However, most of the relationships are

edited in contract agreements which researcher needs to sign beforehand. If the university decide to take the rights it also bears responsibility for covering the costs related to IP protection. [4]

The commercialization in Denmark as well as Europe can be still classified as rather new process. Especially compared to USA where the similar act was established in 1980 under the name Bayh–Dole Act or Patent and Trademark law.

The liability of newness may result into misunderstandings as during the interviews TTOM as well as I4 stated that the exact boarders of what has to be reported are not that clear in practice. The TTOM states:

"...that´s the grey area on how to realize that something is completely new so you have to have culture principles"

and I4 adds:

"...every paper we make we can make a patent out of it we could it´s not worth it line but we could so it should be when you think you have something special right, and they agree that this is not. We could report 20 per year but we don´t because it´s too much work and so you just have to report the inventions."

This processes and the law covers just the research outcomes which may be protected by the intellectual property rights.

In the case the invention may be secured with IP rights the TTO office will start with the market research on the commercial potential. The market research consists of market analysis, discussion with the network partners and the investors. After the phase, TTO will make decision if university will keep the rights of they will be followed on the inventor. Through this phase the researcher is not allowed to publish paper, article, abstract, submit PhD thesis or do any other action which would threaten the possibility to patent the invention[5].

It follows that the university holds the primary right to decide what to do with the inventions. The internal directives shaped by the Danish law counts on three possibilities.

[4] AAlborg University - Aalborg Universitets vederlagsregler
[5] Patent Office AAU

1. The university bears the right for the commercialization process
2. The inventor (researcher) is allowed to lead the commercialization process
3. In the case that the invention was created in collaboration with private sector, it´s agreed beforehand in the contract who´ll have the right for commercialization. [6]

The remunerations and ownership are therefore directly related to commercialization method. If the university leads the commercialization process the equity is divided between university and inventor in ration 2/3 to 1/3. It is also possible that the equity is not paid back in the cash but in the shares. If the inventor holds the rights for the commercialization the equity is divided vice versa in ration university / researcher = 1/3 to 2/3[7].

The AAU strategy in IP protection is that the university in the most cases does not bear costs for patents but is looking for the business partners who cover the costs and patent process. It is the same procedure also in regard of creating USOs. The strategy is also reflected in invention shares which depend upon negotiation with business partner. Regarding USO TTO manager states:

"We can invest IP and get shares and payment and we done that a lot. But we are moving little bit away from that it causes a lot of problems for us actually to be co-owners of companies. We can handle it but it uses a lot of risk"

The main criterion for leading the process and/or patenting is therefore proof of interest. The university will proceed with patent application only if they find viable commercial partner. In many case, as it was already argued, the university will license the right for patenting which means that the business leads the patenting process. The TTOM in the interview explain two other circumstances when university decides to lead patenting process. One is potential of the technology:

We will in some cases proceed to PCT (A/N: PCT = The International Patent System) if we feel there is the technology that is immature but we feel there is still traction with companies to develop it"

[6] AAlborg University - Aalborg Universitets vederlagsregler
[7] AAlborg University - Aalborg Universitets vederlagsregler

The other circumstances in which university will take on patenting are high research competition within certain field. TTOM explains:

"High competition among research not just in university but also companies it is of interest, because so much money can be funneled into the discovery of those drugs for example, so that on its own shows that would be commercial potential and interest maybe high."

The TTOM explains the patent process and the reasoning for patenting-by-industry strategy. After the initial patent application the patent and the application can be improved for the first 12 months, therefore the main focus is on technological development of the patent. Later in the process the patent continues to PCT and after 30 months the patent holder has to decide in which countries will be patent issued. The larger amount of countries equals significantly higher costs as each country may charge from 200 000 to 400 000 DKK. Even in the case university will proceed to patent application without business partner it usually does not continue after 30 months with selecting specific countries due to cost issues. The IP usually do not cover software which is difficult to protect. In some cases there is possibility to patent mathematical algorithm but not whole software. TTOM:

"But software is not so well protected as patents. The competition in company on large scale is able to be inspired by what you've done and change it enough that they do not compromise your right but they do something critical"

The second phase is about preparing strategy. The strategy is made with close discussion with researcher and the decision criteria are based on inventors' intention, costs for developing the prototype, technical stage and scalability of the invention, possible commercialization outcomes, the invention value and verifying the commercial interest from business partners.

In the second phase the TTO decides if the commercialization will go through licensing or USO. One of the main criteria are the inventions potential, however, AAU prefers to license the inventions.

The USOs are created in the case if the technology is in the sense too radical and none of the partner shows the interest. TTOM on USO criteria:

"…it needs to be something that we can develop, the product that can be extremely totally new, something that has not been done before and that is often the primary reason, because in this situation you would be really lucky to find the company to actually develop something like that often you are forced to make company and develop the product there…"

Both wireless companies I2 and I3 explain the same reason for starting the company. Their inventions in wireless communication are suitable for 5G communication while most of the current operators work within 4G. They hope that after the 5G will come on the market they will have technology already developed however meanwhile they are looking for solutions within current networks.

I2 on innovation level:

"… there is the hope that the technology will pick up in resining for 5G cellular networks and people will see that they need this technology…" he continues on temporary use: *"… on short term and we´re looking on how we can monetize and capitalize on what we have today and Wi-Fi broadcastings one way to do it solves the problem, it´s not the best use of the technology is not where technology shine but it´s good use of technology…"*

I3 faces similar challenge:

"…we are saying that auto reliable communication will come in 5G and we´ll be very good but we can use some features in Wi-Fi, so we have to wait 4 years before you can take something we have now.. "

The I3 furthermore expresses his belief that the technology fit in profile of disruptive innovation. As the example he explains that with new technology the company is able to provide similar outcome for several € as the military equipment which costs few hundreds €.

The I4 express his belief that the product they were able to create was significantly faster and better than competitors what actually made it hard to sell.

However even in the case of USO creation the university prefers to license the technology to the new formed company as TTOM explains:

"We would rather license technology to spin-out company, it might be upfront it might be royalty and could be that they cover patent costs and we have less royalty but it could be buy-out close. If they need to buy the IP then we would be willing to sell it of course so we are rather flexible."

The process then moves to marketing phase. After the strategy is settled the TTO market the technology to relevant business partners or investors. In the case the research was held in the collaboration, the research partners usually have the primary right for the commercialization. In other scenario the TTO holds meetings with different partners and discuss the potential use of technology. All the meetings are protected by non-disclosure agreement. [8]

If the TTO succeed in their marketing effort, the process moves to negotiation phase. The university and the partner are trying to find consensus on technology use condition and payment situation. The spin-off is created in the case of favorable market and technology potential. The negotiation phase is done in close cooperation with grants and legal department.

The early involvement of investor/business partner is then reflected in the shares and reimbursements. Two of three interviewees stated the company was formed with investor's major share – 51 %. Which let university 49 %, and that was divided between inventor and university in ration 1/3 to 2/3 (the third interviewee – I2 - haven´t disclose the information). In the case of more than one inventor, the shares are divided upon agreement.

I4: *"...we were two inventors and since the PhD student did most of the work we agreed on 75/25 split between two of us we..."*

The shares ration then influences also financial incentives. Especially in case of university which does not have means to invest in the company and increase their own shares, only if the AAU is able to contribute with next IP. The academics however may have buyout clause which allows them to increase the ration. The share ratio therefore shrinks for the university with every follow up investment.

I3: *"I have the right to buy some on top of that because when new investor comes in the university shares goes down and also my share, unless I buy something*."

[8] Patent Office AAU

The TTOM even expressed his believe that in these setting the motivation in being company founder is not because of monetary incentives:

"...if we (A/N: we = university) don´t have new IP rising that we can keep investing and keep us from getting totally diluted. At some point it´s not really interesting to be founder of the company we are no founder in that sense but we have the founding technology..."

The whole process is closed with commercialization which is realized with signing agreement on the use of technology. The TTO however continues with the effort to create joint-research projects between inventor and the business. The collaboration aims to bring product closer to the market and for the researcher to have possibility to continue in the field.

4.2. Commercialization outcomes in Denmark

In this section will be described overall commercialization outcomes at Danish universities. At first it will be described overall Danish context using OECD report and Ministry of higher education and science report. The second part of the data will be used to analyze situation at Aalborg University in comparison with other institutions. The aim is to delineate overall environment for the commercialization. The data primary consists of databases and statistics available from Danish ministry of Higher education and Denmark. To overcome differences in the universities size, the data will be normalized by number of PhDs which was chosen as the variable representing size of the universities regarding research.

The report on Danish innovation and commercialization shows that the Denmark belongs to the world leaders in R&D spending as total percentage of GDP. Especially, together with other Nordic countries as Sweden and Finland and Iceland are rated among top five in the world. The spending leads especially into high level of citation per captive and attraction of EU funds and international partners. However, Denmark lacks behind especially in the terms of commercialization and spin-off activities. The report argues that it is due to short tradition in these practices as the commercialization at Danish universities started after year 2000. [9]

The OECD adds that at the Denmark is very low percentage, 11 %, of patents owned by the universities. Also that Denmark is 4th in the world regarding publishing papers in co-writing

[9] Danish ministry of higher education and science (2014) - *Research and Innovation Indicators*

between universities and the industries (years 2006 – 2010). Furthermore, while continental Europe tends to create more new ventures per research expenditure then USA, it significantly underperforms on incomes from them. The report also reveals that in the some countries in the Europe as Germany and Sweden the corporate spin-offs tend to have higher success rate then USOs [10]

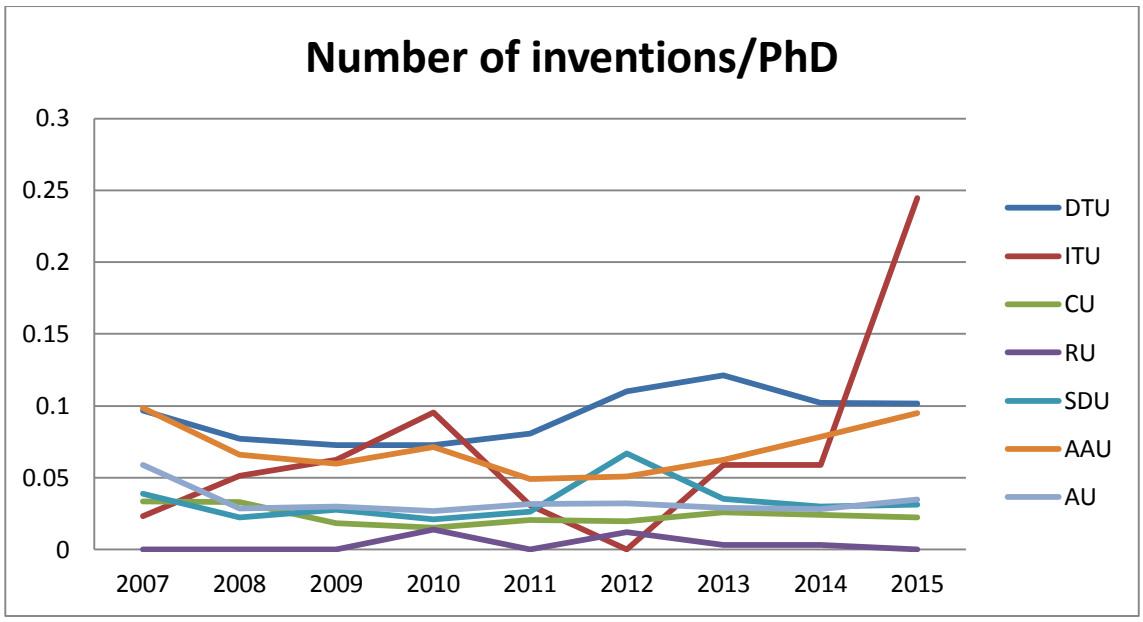
At the look on Danish universities, the Danish technology institute (DTI) is leading university regarding the number of reported inventions with 143 in 2015 and Aalborg University is second with 90 reported inventions. [11]

The same order holds still even in the case that the data are normalized with the number of PhD students (figure 9). Except of the year 2015 where IT University achieved 0, 25 reported inventions per PhD student. This is however cause by small number of PhD student and exceptional year at IT university regarding reported spin-offs. In general Danish Universities hold stable position regarding reported inventions, again with exception of IT University. The Aalborg University recorded fluctuations in year 2010 and 2011. In 2010 it had 0, 07 reported inventions per PhD which dropped to 0, 048 inventions/PhD. Since 2011 it had steady growth and almost doubled the number of inventions.

Aarhus and Sout Denmark (SU) Universities has median around 0, 03 inventions per PhD student while Copenhagen University (CU) has median 0, 02. [12]

[10] OECD (2014) Commercialising Public Research
[11] Appendix 1 – Commercialization data and statistics
[12] Appendix 2 – Modified data

Figure 9: Number of inventions/PhD at AAU (own processing, Denmark statistics)



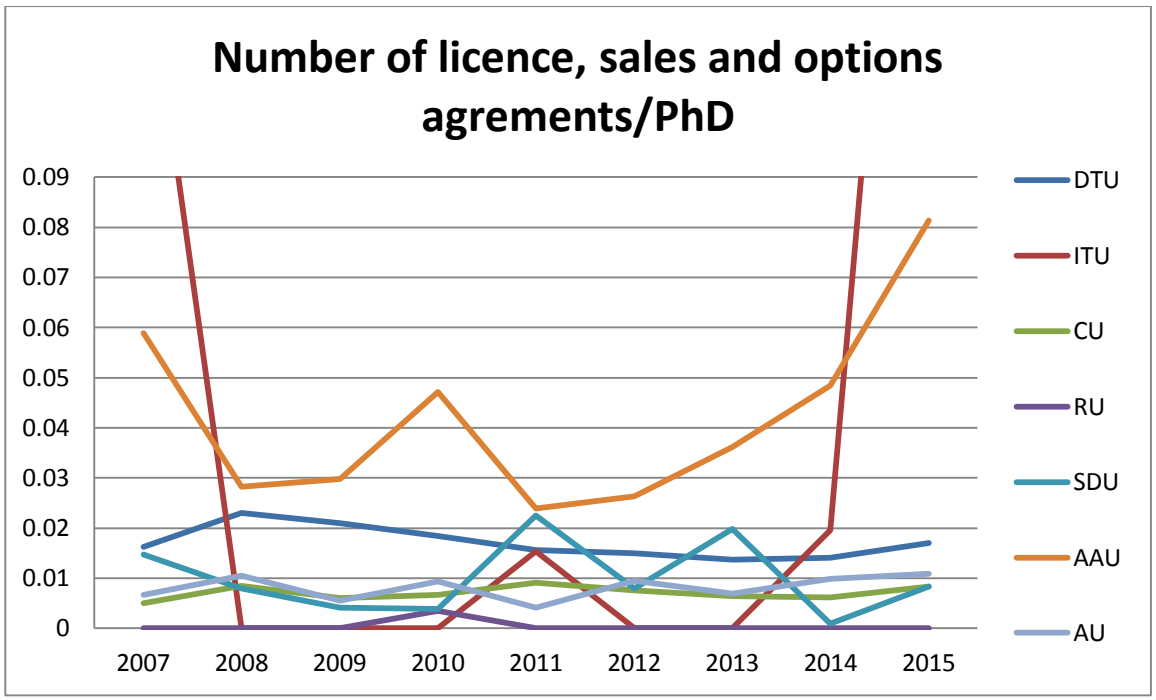
The situation is different if we look at the number of inventions which are transferred into the license, sales and option agreements (LSOA). The Aalborg University had in the year 2015 three times higher number of LSOA (77) then second Danish Technical University (24)[13].

The difference is even bigger if we compare it as the number of LSOA per PhD student (figure 10). Again without IT University, AAU had in 2015 almost five times higher number of LSOA (0,081) then second Danish Technical University (0,017). South Denmark University and Copenhagen University had similarly 0,008 numbers of LSOA and Aarhus University had 0,01. Roskilde University was able to have LSOA in year 2010 and that was 0, 003 LSOA/PhD. Aalborg University had again stable growth from year 2011 where in comparison with year 2015 had 3,5 times lower amount of LSOA.

One of the reasons behind higher number of LSOA was disclosed by TTO manager as well as I2 and I3. They all mentioned that it may be influence by large number of standards in industry where the university researchers operate. This may result into the easier compatibility between research and industry.

[13] Appendix 1 – Commercialization data and statistics

Figure 10: Number of LCAO (Own processing, Denmark statistics)



The large number of LSOA is usually not coming directly from IP protection; however is it was argued previously the AAU license the right to patent for companies. In 2015 AAU started 12 patent applications and issued 2 patents. [14] The TTO manager adds the around extra thirty patent applications were issued already by businesses. Furthermore, the final patent applications did not come directly from inventions reported the same year. As TTO says:

"…it's not necessary those 90 inventions that 42 patent applications cover because many of them could be years ago but we had patent strategy for each but we don't just blindly rush into patenting…"

Number of LSOA is represented also by net profit from commercialization, calculated as revenue of LSOA – cost of protection. The figure 11 reveals that AAU is able to keep stable income from LSOA in all measured years except of 2008. As it can be seen in table 2 which shows sum of net revenue/loss in years 2007 – 2015, only Aalborg University and Copenhagen University are able to keep positive net revenue from commercialization. In measured year AAU is able to produce cumulative profit over 17 000 DKK per PhD. While Aarhus University has the worst number producing loss 21 721 DKK per PhD and followed by Danish Technical University 15 541,59

[14] Appendix 1 – Commercialization data and statistics

DKK per PhD, South Denmark University 14 793 DKK/PhD, IT University 14 393 DKK and Roskilde University 6 760 DKK.

The TTO manager adds that part of the licensing income comes from specialized architecture software which AAU operates. The significant difference can be however seen at the cost side. For instance in comparison with DTU, which spent in 2015 DKK 26 683 000 on IP protection AAU spent only DKK 1 287 000[15]. The costs are influenced by different strategies which university undertake on commercialization.

The OECD argues that the revenue statistics in commercialization are often misleading and incomplete as the larger part of the income from the university consists of following investments into the research.[16] The same argument was used also by TTO manager at the interview. The part of the AAU strategy is to attract follow up investments from private sector on research to develop technology.

Table 2: Cash flow from commercialization in thousands DKK (Own processing, Denmark statistics)

University	DTU	ITU	CU	
SUM	-15,541.59	-14,393.85	958.15	
University	RU	SDU	AAU	AU
Sum	-6,760.99	-14,793.04	17,534.50	-21,721.02

The net revenue at AAU however does not come from USOs. In measured year, AAU was able just once receive source of revenue from USO in form of the equity sales in year 2014 and the amount was DKK 1 401 000. In total Danish universities receive over DKK 33 million as returns from USOs. However, DKK 28 million was received by Danish technical institute in years between 2008 and 2010. Beside that South Denmark University sold USO in year 2008 and 2009 for DKK 2,8 million and in year 2011 for DKK 1 mil. Interestingly only Aarhus University was

[15] Appendix 1 – Commercialization data and statistics
[16] OECD report (2014) - Commercialising Public Research

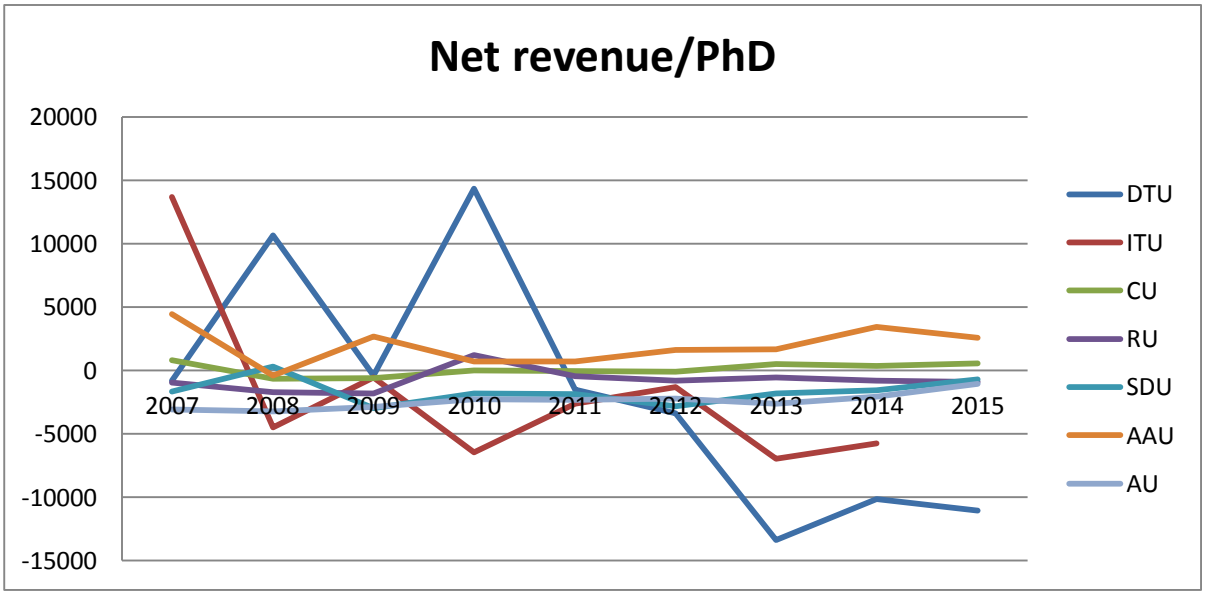
able to generate any USO income based on § 12 paragraph. 2 of the Patent Act, i.e. inventors were leading the commercialization. [17]

The statistics from AAU regarding USO outcomes may be also here misrepresentative. As it was mentioned earlier, the AAU uses strategy in which it licenses the technology to USO. The financial outcomes therefore are not shown in the spin-off revenues but are hidden among licensing income.

The USOs sales at DTU explain fluctuation in figure 11 in year 2008 to 2010. In both years 2008 and 2009 DTU received over DKK 5 mil from USO sales while in the year 2010 it was DKK 17 million.

The OECD report also argues that it is global phenomena that usual income from USO is from equity sales and the small part of successful companies generates the most of the income. [18]

Figure 11: Net revenue/PhD (Own processing, Denmark statistics)

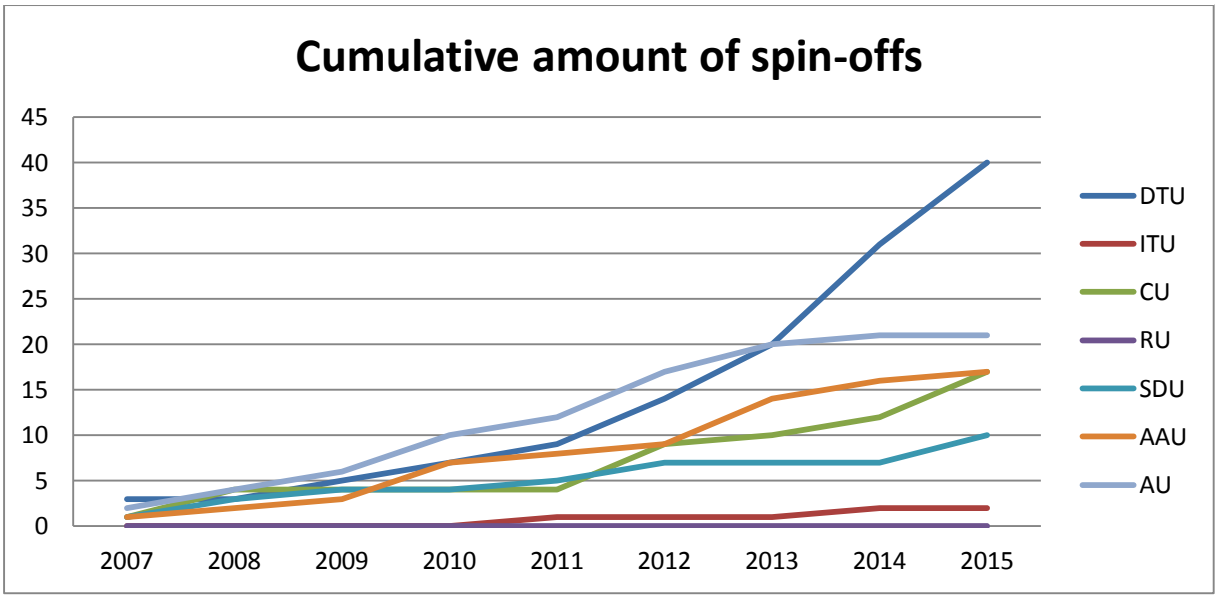


[17] Appendix 1 - Commercialization data and statistics
[18] OECD report - Commercializing Public Research

The cumulative amount of total spin-offs shows that the DTU is leader in Denmark. Since 2007 it started 40 spin-offs. The second most common USO creator is AU with 21 companies. AAU and CU create 17 companies and SDU 10.

All in all just four USOs were built based on the § 12 paragraph. 2 of the Patent Act in which, inventor leads new venture creation. Two the companies were set up at AU and two at CU. The AAU has taken over all of the USO creations on its own. [19]

Figure 12: Cumulative amount of spin-offs (Own processing, Denmark statistics)



4.3. Stage model of academic spin-off creation (Ndonzuau et al., 2002)

4.3.1. USO team formation

Even though forming team is not in the framework it will be first explained the process of teambuilding which then helps to analyze several causalities in spin-off creation.

In the I2 USO the management team was straights forward process from beginning. It was formed by two PhD students and their professor from AAU University together with other

[19] Appendix 1 – Commercialization data

professor from MIT. The PhD students lead prototyping and after finishing their studies went to company full-time while professors stayed at their academic positions. Both founding professors have had previous experience in commercializing and cooperation with the industry.

I3 at the beginning started with external consultant from AAU innovation office, however he mentioned it did not work out well. After certain time AAU innovation office found him partner who became CEO. The new CEO has had industry and entrepreneurship experience within wireless communications. The founding professor have from the beginning stayed at the CTO position, however as he mentioned the time he has is limited to 16 hours a month due to his academic work.

The most complicated team formation was mentioned by I4. At the beginning the team was formed by professor and his former PhD student with support from external consultant at innovation office. The post doctorate then went back to Belgium and came to Aalborg after receiving prototyping grant. However because of disagreements between post doctorate and external consultant the post doctorate left the project quite early in the process. The investor after 10 months led the recruiting process of new CEO where the academic inventor was invited to participate. The professor remained just in the consultant position and he mentioned that due to decreasing motivation he was less and less involved.

4.3.2. Stage 1

Academic culture

From the analysis is concluded that all academics in USO creation showed positive attitude toward commercialization. The TTOM who expressed overall attitude by academics as follows:

"That´s different as there are people, but there are a lot of investors very interested to see the research and discoveries made into use I think, you can do both. It´s not either the one thing or the next the thing"

However the situation may change if the researchers are under pressure either by other research groups doing same research or by publishing their papers. The university has in this situation clear strategy as TTOM says:

"...for us it´s balance in university cause publications ways much heavier then patenting."

The interviewees furthermore stated that it´s helpful that TTO is able to react quickly and flexible which still allows them to continue in academic research without large interruptions. Furthermore, I3 and I4 stated that they already had previous experience with commercializing and issued several patents. I2 as PhD did not have the experience before however one of the founding members was experienced professor who faced this issue several times. All three founders however considered commercializing as common part of AAU environment. The I3 says that the university was one of the most supporting part in commercialization.

The different involvement possibilities were however seen in more experience academics in comparison with PhD students. I2 explained that at the beginning he received PhD research fund and beside worked in the company while his co-founder went full time after PhD into the company. I2 went directly after finishing project full time to company. He furthermore stated that even through full involvement in company he and his co-founder sometimes publish research papers and therefore take the position of academic entrepreneurs. The two other professors in founding team stayed at their academic positions while working for company on the side. The same is true in the I3 and I4. Both are experienced professors who stated that it would be difficult to leave their current positions and they are tied closely to university. As I3 states:

"...at the university I have group of 15 people like PhDs etc ... there are lot of projects running so I can´t just sign out even decreasing one day per week would be a problem"

The I4 states that at the beginning USO was founded with his PhD student who received proof of concept funding. That allowed PhD student to work full-time in USO and continue as academic entrepreneur while I4 used spare time after his research duties. Both I3 and I4 therefore took the position of entrepreneurial academics.

Identifying ideas

Interesting enough all three USO founders stated that they saw commercial potential of the technology even before going to TTO. I2 research goal was to implement different science

research from USA University into technological solution. The I3 and I4 started with science research but quickly saw technological potential of their inventions.

Furthermore all I2 and I4 stated that from early beginning the customers showed interest especially in technology. However, most of the time was the barrier that the technology was underdeveloped or that it wasn´t customized. I2 says:

"…we had a lot of interest because of the technology…bunch of big companies were interested and evaluating it but from the commercial perspective it wasn´t really success because we never really got to integrate it into any of the products…".

I4 states:

"We talked with IBM in Belgium and they were really interested and they wanted to try something in their lab"

One of the interviewees however several times during interview stated that, the USO process was too slow and they weren´t able to keep up on customer´s expectations.

"…it was just promising but the company (USO) was slow and if things could have been fixed within one or two months customer would had bought it and then it took too long time to develop things…"

The I3 expressed that at the beginning the invention was too radical and nobody showed the interest, however with growing awareness of 5G the USO attentiveness also grew.

While academics were able to notice technological potential of inventions, the business potential lies on the TTO shoulders. The TTO office therefore consists of people with different business, legal, patent background however as TTOM states all of them have to have business development sense.

The TTOM on his own has background in business and administration, worked as intrapreneur, financial department for larger corporation and has tried entrepreneurship in IT sector on his own. He adds that he needs to use this experience in day to day work. The TT helps with initial business identification as well as business plan preparation. However, from certain stage the USO has to take over the responsibilities on its own.

4.3.3. Stage 2

Protecting ideas

In all three interviewed companies AAU had rights for inventions. Based on the strategy the patenting costs were however covered by local venture capital which in return received majority shares. Two out of three cases the patenting process went without complications. Just in one case mishandling by patent agent (patent process started too late, change of patent agents). The interviewee adds that at that time he wasn´t part of all communication with patent agent so some things cannot be said with exact certainty.

Developing the ideas

The TTOM express the high importance of technology development within first year from sending the patent application as after this time the patent cannot be changed or improved.

All the companies used different strategies in this stage. One of the interviewee states that the initial software was written his and his co-founders PhDs and after initial funding they were able to focus on developing the product. He states that the strategy at that time was technology focused. The idea was to develop it on the level where some of the major player would do buy-out.

"...we were not actually selling our own products we had enough funding that we could focus on building and we hoped that some of the major players will be making the move and basically acquire the technology..."

He further explains that the funding helped them to focus on technology development however soon they realize that it isn´t right strategy.

"...after 4 - 5 years we decided that was probably not going to be sustainable and that we have to make business on our own and that was really chief strategy. "

He adds:

"we are not married to the technology that we sort of started company... people they don´t care at all how we make it work it just have to actually work and that´s sort of where we are now we are solving the problem rather than providing the components"

The participant furthermore several times explains that one of the biggest issues which company have faced is customer discovery and follow up business development. Even though the USO was able to initiate customer attraction and interaction, however the USO was not able to identify exact business opportunities. As it was mentioned earlier they changed the model from technological development to more customer focused after 3 – 4 years.

However the other interviewee explained more complicated process. The plan at the beginning was that the technological development will be covered especially by PhD student with support from professor. The business development should be handled by external consultant at innovation office. However, the participant states that the responsibilities were not clear and the consultant was slow to follow the process and with limited time for USO. The professor and PhD student were able to create initial contact with potential customers and had extensive network; however they were stopped by external consultant who claimed that it was his responsibility to do so. The consultant was not able to keep on promises and the overall process had no progress. It led to PhD as well as professors demotivation with PhD finally leaving USO.

"...the problem is that the model takes away the responsibility from the ones that knows something, that takes away the drive..."

After certain period the investor started recruiting process and chosen CEO with industry experience. The academic stayed in the consultant position and for technological development was hired software engineer. The examinee did not have any influence on recruiting process however he expressed his believe that the software engineers did not have sufficient quality to develop product. The professor stated that the whole process took away all the drive from him and PhD student. He furthermore expressed believe that the process was too slow for computer science as the first lines of codes are not worth much and any successful system needs to be modified several times.

"...what you have is worth experience but the initial source code is not worth so much, patents are sort of the same, what is important is get to the market and then you get some patents along the way but if you have no business there is no point... the point is that the second time you know how it should be done. The first time systems are useful but there are not really solid if you reconfigure the system you can build it better from scratch..."

In other case the prototype technological development was covered by his students. The technological development was not that much of an issue as the interviewee was able to recruit engineers among his students and network. However he expressed his believes that the VC investors´ pressure to create revenues can be harmful for fundamental development.

On the other hand the business development issues were expressed by the participant who had difficulties to transfer from technological perspective with ill structure idea into viable business model. He adds that they changed the direction multiple times since basic development. The situation has shifted with new CEO, who was able to create first level of organizational learning in new venture.

"…we made market analysis and we tried to classify industry and we made broad selection and we made mistake because some industry were not interested after we talked with them. So I think to more than hundred different companies from different areas until we found it…"

The strategic choices the led to second round funding from private company specialized in chosen sector. More on the investment will follow up in next section.

Financing

All three mentioned companies had same local VC as first round financing. I2 and I3 stated that the investor contributed especially with the money. In some cases they helped with network and offered services as accounting and marketing help but the services were paid.

The I2 previously received research grant for PhD however he mentioned that along the research he and his partner were able to develop prototype which led to first investment investment. Even the follow up investment came from the same investor.

The I3 mentioned that for two years the company was running on no external investment. The VC came in 2011 and in 2015 they were able to receive investment from private company. The I3 expressed overall satisfaction with second round investor as beside money they were able to offer specific know-how and network which helped to lift company.

USO created from I4 was also finance by local VC. At the beginning was however prototyping grant for PhD student. I4 wasn´t involved in process of choosing investor. The VC beside money also found new CEO in their network.

The TTOM states that the university is involved especially in pre-seed funding:

"I´ll do business plans and pitch training we will also take venture discussion and pitch for the inventors we would rather not do that because it should be the person that is going to do process but in the pre-seed phase it´s not very clear process."

The TTOM also explains the process of pre-seed funding:

"…we´ll use for investor within that technology, skills, track record and look into who are possibilities…it could also be a companies and investors together and we like that a lot but it´s typically pre-seed investors and it will take mostly public investors cause it´s very risky you need to know as investor know that you´ll lose out 95 % of the investment but last 5 should bring it all back"

The TTOM in follow up communication that one of the biggest spin-out successes of AAU resulted from close collaboration with established company. The spin-out is position in medical segment and after the initial research, the R&D agreement was made which resulted into establishing joint venture between university and established company.

4.3.4. Stage 3

Access to resources

The financial resources were analyzed in previous section. The interesting point in the study is high level of social capital not just in academic sector but also in private one. I2 explains that he and his other PhD cofounder has network especially in academic sector however the other two founding professors have large social capital. He express that they are able to derive the benefits from their network also in USO. Furthermore, they extent their network by publishing academic papers and visiting trade fairs which attract potential partners.

I3 states that due to his extensive experience in commercializing research and collaborating with the company he was able to create ties with private sector. Furthermore, the external CEO has previous experience in the industry and together with their board of directors are able to create sufficient social capital pool.

The same is stated from I4 who prior the academic carrier had experience from industry. The I4s network was also supplemented with PhDs network. He states that the lack of industry partners was not an issue in the company.

None of the interviewees stated that they would need any special laboratories. But it is caused more by the nature of the product.

5. Conclusion

Even the study goal was to improve USO incubation practices at AAU, the main research question was **"How does the USO process at Aalborg University looks like".**

After the research is conducted the process starts USO process at Aalborg University starts with reporting the invention. The act is required by law, however due to short commercialization duration in Europe it is still grey area on what exactly the researcher have to report. All of the inventions are evaluated by technology transfer office which also makes the decisions over strategy for either licensing sales or USO creation. The AAU was evaluated as one of the best universities in Denmark regarding licensing and sales of inventions. Regarding USO creation, if university decides to create USO it was in all case leader of the commercialization which also means that it has right to keep 2/3 of equity. The strategy is however that the AAU usually does not bear the costs for patenting but license the options to patent. The whole process takes up to 30 months and in interviewed companies one of three experienced issues with patenting.

The strategy is successful for the university in the terms of lower cost however as the technology transferred to USO is usually technologically and businesswise underdeveloped, it results that investor who covers patenting costs also become majority shareholder. For the inventors it means that their shares in the USO shrinks and together with the university may become diluted, which results in low or in some cases no financial incentives even in the case of success.

Due to experience with commercialization academics showed positive attitude towards it. Furthermore, the USOs started because of market opportunities which resulted from close collaboration with external partners. The opportunities however came from technological potential more than business needs and were at the beginning developed with state supporting funds.

The high commercialization outcomes influence the social capital of academics. As the inventors are actively involved in the process, the academics are able to create extended network of industrial partners.

The positive LSOA outcomes however also negatively influence the USO creation. One of the main reasoning for USO is higher economic rate (Bray & Lee, 2000) but in this case AAU is

able to create positive cash flow from commercialization and USO creation is therefore used as secondary options in case that the invention is too radical to be licensed. The USOs are created with main aim to bring technology closer to the market. Moreover there is almost non existing support for the USOs which are not protected by IP.

The circumstances results in two outcomes. The university is able to create limited number of USOs and as some of the existing theory suggests, the technology focus creates IP protection but not "natural" business protection.

As Bockman (2012) suggest main entrepreneurial competences are built though action learning or in other words by experience. The lower number of USOs therefore also means the lower number of people involved in the process. As one of the main issues of Denmark in general is lower ability for commercialization outcomes. The situation is even more complicated in the case of USOs which are just secondary tools for commercialization. The AAU therefore applies surrogate entrepreneurs strategy. As the least effective strategy, seems to be use of external consultant. In one case it even led to into loosing key technology persona and demotivation among team (Clarysse and Moray, 2004). The surrogate entrepreneur strategy was considered as success in the case where external entrepreneur had previous experience both in entrepreneurship and industry.

The technology development difficulties occurred if the inventors have not been actively participating in USO. The issue has its roots in knowledge based view (Grant (1996) and has been previously found in some of the empirical studies (Festel, 2012). The lack of the entrepreneurial capabilities results into non-existing first level of new ventures organizational learning (Brockman, 2012).

The difference was found in perception towards balancing academic and entrepreneurial world. While two senior academics had positive perception of the entrepreneurship, they wouldn´t be able to leave their academic positions. The PhD and post doc showed much higher flexibility in shifting the positions from academia to the business.

The other difference was beheld between the companies in wireless communication and computer science. While the wireless communication expressed longer time need for technological development due to product novelty, the computer science USO reported that the

product would be able to access the market faster. The university however has just one spin-off model for all USOs. The difference in time and resources required can be found also in existing literature.

The pre-seed local investor contributed especially with finances and some network. (Insert literature). The higher satisfaction was found in the case when the private investor was supplemented by private, already established, company. The private company was able beside money to supplement also know how, laboratories and other resources. The same was found in (Carayannis et al., 2000)

None of the companies entered fourth stage and therefore it was not included in the analysis.

6. Discussion, limitations and recommendations

On the casa of Aalborg University we argue that the environment influences USO process. Not in the sense of different stages however in sense of unique challenges and resources which USOs are able to develop. AAU has entrepreneurial vision and therefore researches are able to develop own industrial social ties however due to lack of experience, operate in entrepreneurial underdeveloped area. It is claimed that the effective incubation support will be therefore different as the one in worlds top entrepreneurial environments as Silicon Valley or Tel Aviv.

The main implication of this study for further research is therefore call for more specified incubation practices which would supplement specific USO needs. One of the options would be to create matrix typology based on type of university from classic to entrepreneurial and type of area university is located in as for instance from entrepreneurial underdeveloped to developed and match the matrix with required support.

The interesting point was brought several times during interview and that was level of standardization at AAU. The literature however does not mention this as potential influence on commercialization or USO creation.

One of the main limitations is cause by the study methodology which does not allow generalization. The further research should therefore focus on providing statistically significant results. Furthermore, the case study does not provide "success" stories either as universities which implemented effective incubation strategies or prosperous USOs. The following exploratory studies might therefore focus on targeting cases which already proved themselves. The study results might be strength by comparison with other university which should highlights the differences. One of the potentially best comparisons would be DTU. The both universities have similar outcomes in sense of inventions per PhD but have different strategy towards USO creation and overall commercialization. Furthermore while Aalborg operates in the Denmark most underdeveloped area the DTU is in the heart of capital.

The other limitation is in width of data. Even the smaller number of interviewees was supplemented by secondary data, it would be still appropriate to have primary data from different shareholders e.g. surrogate entrepreneurs, VCs etc.

It is however argued that the study provide sufficient quality to at least partly challenge further direction of business incubation research.

6.1. Recommendations for AAU

6.1.1. Stage 1

Business needs as starting point

The technology transfer process at AAU starts after scientific or technology discovery i.e. invention. The literature however suggests that the USOs achieve the best results if they start out of business needs. The incubator may therefore take the active role in searching for business possibilities which can be then turned into research and further USO. One of the possible forms, to support this process is ideation online platform also called open innovation 2.0 (Grove, 2008).

PhD and post docs as entrepreneurs

It is argued that the AAU can be characterized as university with underdeveloped entrepreneurial environment but strong industrial ties. These characteristics are mirrored in the USOs. Hence more experienced academics possess extensive social capital but lacks entrepreneurial alertness skills. The same is however true with using external entrepreneurs who has just industry experience but not entrepreneurial ones (Clarysse and Moray, 2004). The academics on the other hand are reluctant to leave their current position. As the solution may seems to be targeting PhDs and post docs who co-develop inventions. The PhDs are more flexible towards changing their position, have required knowledge and entrepreneurial skills can be taught (Brockman 2012). One of the incubator capabilities can therefore prepare through training sessions PhDs for role of incubators (Grimaldi & Grandi, 2001; Rasmussen and Borch, 2010). The experienced academics in the external position may supplement required social ties and extra knowledge while still keeping their current jobs.

Support USO creation without IP

Brockman (2012) argues that the entrepreneurial alertness is the skill which requires action based learning. The spin-offs without IPs require less starting capital. Even if the USO will not

succeed, the incubator will be at least able to extend human capital with entrepreneurial skills and technological knowledge in the region.

Different models

The study as well as literature (Fetsel, 2012; Druhile et al. 2004; Wright et al. 2006; Landry et al., 2006) shows that the USOs differ, in required time and resources for the development. It is therefore argued that the incubator should find more flexible approach and different models on how to support USOs.

6.1.2. Stage 2

Prototyping center

The main requirement for investment was technical feasibility. Furthermore, the USOs lack the most business validation. Furthermore, local investor is not able to offer required knowledge for this part. It is argued that incubator should specialize as prototyping center which will be able to support products and services creations which will be also feasible for market. Incubation literature suggests that the university has certain capabilities to support prototyping as student, graduate workers, help with receiving grants, consulting.

6.1.3. Stage 3

Focus on ambidextrous USO with industry

Tushman and O´Reilly (1996) introduced ambidextrous organizations as solutions on radical innovation challenge. They defined them as the organizations with separate physical space and culture but same board. The study shows higher satisfaction with established companies as investor the same cases can be found in the existing literature. The argument of the open innovation is also due to local investor who in all cases supports the companies with finance however seems to lack specialized knowledge. The established companies may therefore supplement resources while spin-off focuses on new venture main advantage, opportunity recognition. The incubation research however does not deal with this issue as how to support these organizations or even if there is required different support.

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Appendix