Exploring Team-Formation And The Evolution Of Network-formations Of High-Tech Academic Spin-offs

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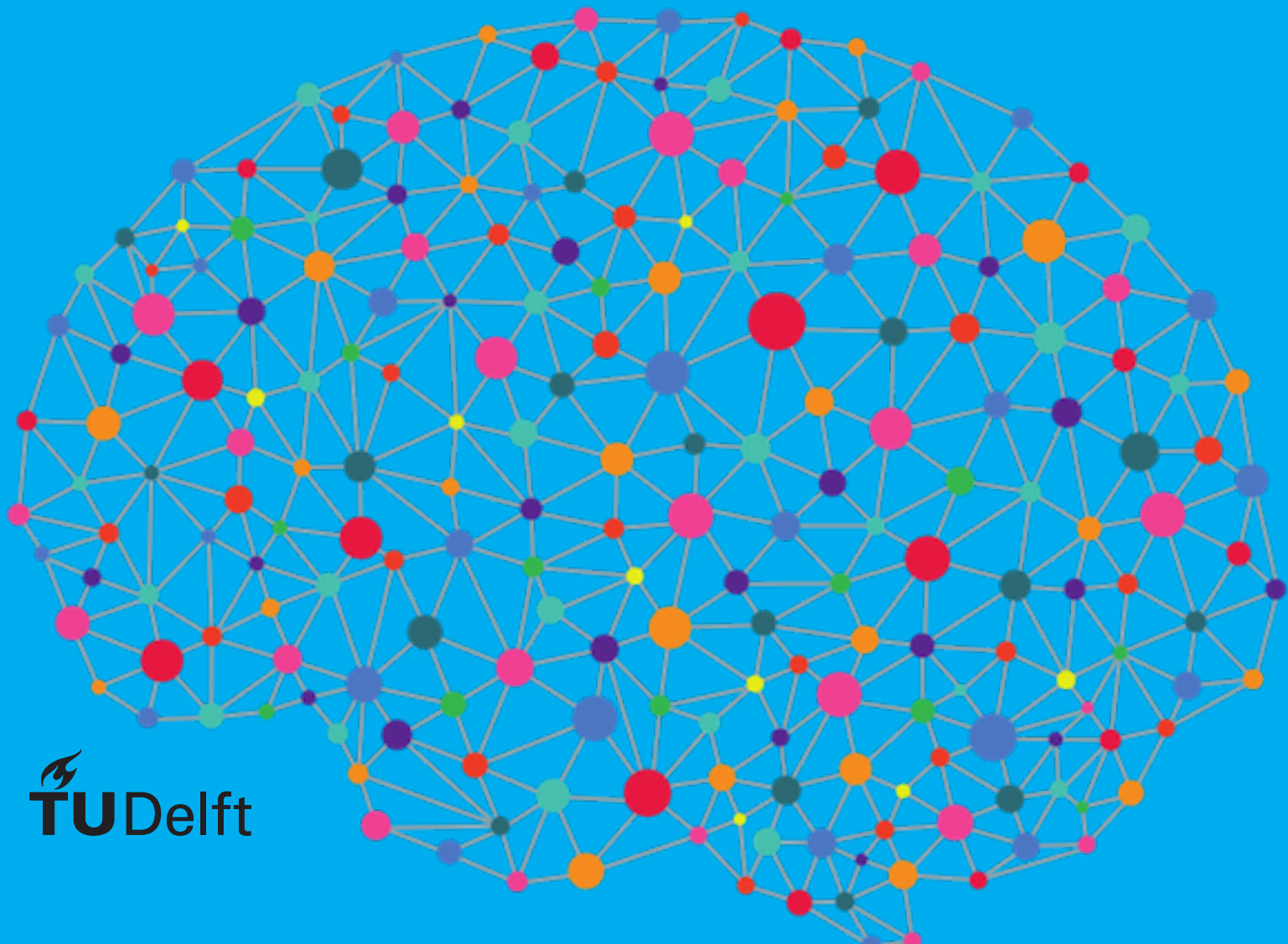

TU Delft

Exploring Team-formations And The Evolution Of Network-formations Of High-Tech Academic Spin-offs

Master thesis submitted to Delft University of Technology in partial fulfilment of the requirements for the degree of MASTER OF SCIENCE in Management of Technology. at the Faculty of Technology, Policy and Management

by

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Contents

Executive Summary

As our modern society keeps changing, the role of universities as a source of creating opportunities for academic entrepreneurs to transform their scientific knowledge into a viable business is becoming significantly important. Even though academic institutions and universities have played a big role in the transfer of knowledge into commercialized solutions ever since they were established (Shane, 2004), in the past, more often than not, such inventions have taken place in non-commercial environments. But the commercialization of specific scientific or technical knowledge through novel high-tech academic spin-offs entails unprecedented entrepreneurial challenges (Vohora et. al., 2004). Thus this paper contributes towards the scholars' and academic entrepreneurs' understanding of how teams within high-tech academic spin-offs are able to identify, acquire and assimilate novel and needed external knowledge and resources, and how they transform and exploit those resources to fuel the company's growth. In other words,due to the uniqueness and novelty of the High-tech academic spin-offs they are relatively under-explored (Lazer and Katz, 2004, Khodaei, 2015) and indicating that studying team effects on networks and growth is a very new area. So this paper makes an attempt to explore the how teams and networks in high-tech academic spin-offs evolve the company grows and how each of these parameters affect each other. As has been observed through our multiple case studies *accessing necessary and critical resources is a big challenge faced by these specific firms during their initial development/growth stages* (Sullivan and Ford, 2004).

By employing Resource-Based theory, Human Capital and Social Capital theory, we investigate how entrepreneurial teams use networks in order to meet varying resource needs in order to grow. Results illustrate how evolution of team formation transform their corresponding network formation that could lead to the accessibility of new, necessary and relevant resources in ways that could impact the growth of these high-tech academic spin-offs. Consequentially, our findings show how founding members and other team members use their network connections to serve as one of their principal means of identifying, acquiring and assimilating these resources in order to grow. However, we have found that different growth stages of the spin-offs indicated different resource dependencies, so we observed how teams and networks change so as to meet the changing resource requirements. This led us to the interesting conclusion that this is a circular process in a loop. Along with that we have also found how companies operating in different geographic locations or dealing with significantly different product lines have tightly packed heterogeneous network channels with homogeneous network partners within each channel leading us to the fact that they are market leaders in niche markets, whereas, for companies operating in the same geographic locations and/or dealing with similar product lines have interconnected links with/between multiple network partners from different network channels, leading us to the fact that these companies operate in highly competitive markets with complimentary services to each other and due to the abundance in availability of partners.

Thesis Outline

Table 1: Outline of the thesis

Chapter 1 – Introduction	This chapter presents the background and problem within the research domain of this paper, while developing the purpose of the study through designing relevant research questions.
Chapter 2 – Literature review	Here we delve into the pertinence and the practice of other theories within the literature associated with networks and teams of (high-tech) academic spin-offs. Also discussing the important aspects found within high-tech ASOs such as social capital, human capital and resource based view. One of the main purposes of this chapter is to find a research gap within such literature which would eventually be the purpose of this paper.
Chapter 3 – Methodology	The methodology justifies and presents the choices made in terms of research approach, research design, research process, sampling, quality criteria, etc. In other words, this chapter justifies the reasoning behind all the steps taken and processes used to collect, process and analyze the data.
Chapter 4 – Presentation of data: Results	The results section presents the empirical data collected from the 5 cases, along with providing further information on the same. We made attempts to provide the audience with descriptive information about teams and networks of the high-tech ASOs from each of the cases along with visual representations of the processed and relevant data. Next, the analysis section presents and provides the insights from the gathered data. In other words, explores the data from the multiple cases to portray the effect of evolution of team-formation on the network-formation.
Chapter 5 – Discussion and Conclusion	We try to zoom back to see how the data collected provides insights that reflect back to the theories in the literature. Later we conclude the research work by taking a stab at the contributions made, the limitations of the work and possibilities of further research.

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1 Introduction

"What you know is who you know"
Herminia Ibarra, INSEAD

1.1. High-Tech Academic Sp in-offs and its challenges

As our modern society keeps changing, the role of universities as a source of creating opportunities for academic entrepreneurs to transform their scientific knowledge into a viable business is becoming significantly important. Even though academic institutions and universities have played a big role in the transfer of knowledge into commercialized solutions ever since they were established Shane (Shane, 2004), lately these institutes have been providing even more supportive measures towards the further development of these academic spin-offs (Djokovic & Souitaris, 2008). In the past, more often than not, such inventions have taken place in non-commercial environments, but the commercialization of specific scientific or technical knowledge through novel high-tech ventures entails unprecedented entrepreneurial challenges (Vohora et.al., 2004).

High-tech Academic Spin-offs (ASOs) represent one such efficacious vehicle that help the transfer of specific scientific/technical knowledge from the universities into products or services by fueling the commercialization of these nascent and uncertain technologies while supporting their creators and inventors Fischer(Fischer et.al. 2014).

The uniqueness of these high-tech academic spin-offs and the lack of experience of their academic entrepreneurs, lead to the "liability of newness" Vohora et.al., 2004, Stinchcombe(Vohora et.al., 2003; Stinchcombe, 1965;). 'Liability of newness' or the 'entrepreneurial challenge' as coined by Brush, Green(Brush, Greene Hart, 2001), is associated with the need to acquire external resources to overcome initial barriers to the growth and development of these start-ups. More often than not, during the early stages of growth, these barriers limit the ASOs' ability to establish themselves particularly as strong contender in the market, and to make sustainable profits. Moreover, (Scholten, 2006), in his study, mentioned that the significance of the "liability of newness" is more prominent with such start-ups especially due to their novelty of their products and services. To grow from on phase to the next ASOs need to overcome this challenge.

Other than the liability of newness, high-tech ASOs also face some more fundamental problems, such as the liabilities of smallness, lack of critical resources, and the lack of commercial skills that the academic entrepreneurs may have in order to commercialize their scientific and technological knowledge into a profitable asset. According to (Wright et al. 2012) academic spin-offs in general are uncommon and atypical enterprises, which, during their early stages, often lack a business plan, struggle with raising capital and other such important resources. Moreover, ASOs within the high-tech

industries mostly deal with cutting-edge technologies which often require huge amounts of resources to develop in order to eventually be commercialized (Shane Stuart, 2002). Even though universities do possess some of these resources like technological research expertise and access to highly skilled personnel but they lack some other necessary resources such as leveraging competencies and external network with investors and industry experts (Perez & Sanchez, 2003; Wright, Clarysse, Lockett, & Knockaert, 2008; Fischer et.al., 2014). Secondly, disparities between the objectives of the main actors such as the university, the founding team members, the management team, and the investors may also unfavourably influence the ASOs' ability to grow from one development phase to the next (Vohora et. al., 2004).

1.2. Resource Acquisition: A Necessity for Growth

According to (Scholten, 2006), support from parent organizations can help these spin-offs to deal with the liabilities of newness and smallness. Consequentially, the academic entrepreneurs of these ASOs can focus more on their primary task of transferring their knowledge into developing products or services and strategies to penetrate the market. Activities that can be supportive and complimentary to these ASOs are management support, financial support, infrastructure, and access to business connections, etc. Although, the lack of business acumen or commercial skills amongst these academic entrepreneurs precedes to a dearth of critical resources as a result of incompetency in acquiring such resources otherwise necessary for the growth of these academic spin-offs (Soetanto, 2009). In addition to that, unfortunately, in most cases the spin-offs' capability to produce the required resources internally as well as unearthing resources from external entities is difficult (Aldrich, 1999; Soetanto, 2009). However, parent organizations, adding capable team members, and use of existing and/or external network connections can be some important sources for the acquisition of such capabilities and resources.

1.2.1. Networks as resource acquisition channels

According to the network evolution literature, founding members and start-up teams create and add networks to their firms according to the firm's corresponding resource needs (Hite et.al., 2001). Resource needs is a transient entity. It has been seen that as firms evolve through different stages of growth, the nature of their resource needs and resource acquisition change (Sullivan and Ford, 2017) and becomes more and more challenging (Arenius and Laitinen, 2014). In addition to that, (Brush et al., 2001) pointed out that network connections are a crucial tool that can lead to critical resources significant to the ASOs' initial growth stages. Preexisting network connections of the founding team members (Sullivan & Marvel, 2011) and the network connections created by the founders and other team members can be a significant pathway in essential resource in order to identify and evaluate valid business models and plans which can provide access to developmental information necessary during the initial growth stages of ASOs. Drawing on this context, management team members and their business networks can help identify and assess the potential of the scientific findings as business ideas and also provide access to knowledge and other resources necessary for the creation but also for further development of ASOs. Moreover, relationships that are created by tapping into such co-operative networks lead to be mutually beneficial for both the spin-offs and their counter-parts. Relationships with diverse partners lead to opportunities with regard to both cooperation and attainment of skills which in turn improves the firm's innovation capabilities and performance (Beers & Zand, 2013).

1.2.2. Relevance of teams in building networks

Although, different support activities have different roles in the creation and development of ASOs, it has been established that teams are responsible for building dynamics capabilities (Sirmon et al., 2007; Holcomb et al., 2009) that play an important role within ASOs indicating, building, and acquiring knowledge and resources (Wright et al., 2007; Zahra et al., 2009) by building networks connections as channels for acquiring these resources and knowledge. Absorptive capacity is regarded to be one such important dynamic capability (George and Zahra, 2002; Jansen et al., 2005), which constitutes of processes that help firms acquire and exploit crucial knowledge and resources. A study by (Khodaei, 2015) delved deeper into how higher absorptive capacities of management teams can be an important factor for the growth and performance of high-tech ASOs. Higher absorptive capacities are associated with higher overall dynamic orga-

nizational capabilities of firms, especially, during their initial growth stages. These capabilities are a factor of how effective and capable the teams within these ASOs are in identifying and absorbing external knowledge otherwise necessary for the growth of these ASOs (Zahra et al., 2009).

1.3. Research Questions and Objective

Extrapolating the ideas from the above mentioned perspectives of acquiring and exploiting crucial knowledge and resources through network connections specifically built by the team members during the initial stages of growth and how these networks have evolved due to the changes in the team members, we study how the team-formations have evolved and its effects on the network-formations of ASOs. It is addressed through an exploratory empirical investigation by observing the changes in the network-formations inflicted by the team members from a sample of high-tech academic spin-offs in order to help those ASOs gain necessary resources to sustain and survive in their respective markets.

1.3.1. Research Questions

Main research question:

How does the changes in team-formations affect the network-formations of High-tech Academic Spin-offs in order to grow?

The following two sub-research questions will serve as milestones leading towards answering the main research question.

Sub-research questions:

1. *How does the teams within the High-tech ASOs evolve?*

2. *What changes occur within the networks of those High-tech ASOs?*

and consequentially,

2. *What effects does these changes in teams and networks have on the growth of High-tech ASOs?*

This leads us to the main objective and associated research questions.

Objective*: *To analyze the role of teams within high-tech academic spin-offs to better identify and pursue opportunities by building network connections in order to grow.

1.4. Research Framework

In this section, we discuss the constructs used in the research framework presented in Figure 1.1. The following Chapters 3-5 present empirical analysis of the evolution network-formations inflicted by the team members of different ASOs, that ultimately acts as the fuel for the growth of these academic spin-offs. These concepts have been discussed in further details through the lenses of different theoretical perspectives from past literature in Chapter 2.

1.4.1. Team-formation

Teams evolve through the addition of new members and abatement of some members. Adding team members is as an important method of seeking necessary resources and interpersonal attraction (Rasmussen et al., 2015). Thus the decision to include new team members is important as it can substantially change the existing social and human capital (Forbes et. al., 2005) of the firms. The same study by (Forbes et. al., 2005) has noted that the addition of team members can be defined by the resource based perspective which could be related to the firms resource requirement of a particular skills set or the experience or characteristic trait of the added team member.

According to (Khodaei, 2015), the literature associated to start-ups and entrepreneurship has focused on domain specific experience in two specific categories: *Domain specific research experience* and *domain specific industry experience* (Agarwal et al., 2004; Kor, 2003; Shane and Venkataraman, 2000).

Domain specific research experience

Domain-specific research experience provides the entrepreneurial team an access to technical and scientific expertise in varied research areas (Murray, 2004; Shane and Stuart, 2002), which fosters to the possibilities of opportunity identification (Shane, 2000). A study by (Clarysse and Moray, 2004) indicated that teams with prior scientific research experience usually have explicit knowledge that can be useful in identifying and screening pertinent external resources and knowledge otherwise necessary for the development of spin-offs.

Domain specific industry experience

It is associated with the spin-off team's business acumen relevant to specific industry domains. As noted by (Agarwal et al., 2004), this sort of expertise can be an indicator of the team's ability of identifying, evaluate and pursue opportunities in high-tech markets. In other words, it accounts for 'on the job experience' of the ASOs' management team members.

Team Characteristics

Previous literature on entrepreneurship has identified the importance of the roles founding members play in performing entrepreneurial endeavors (Sardeshmukh et al., 2011) that potentially lead to the success and/or growth of their firms. (Sarasvathy, 2001; Shane, 2003) points out that entrepreneurs, especially academic entrepreneurs, have to be proactive, be capable of making quick decisions under uncertain situations where resources are limited, and must be willing to not just work harder than most employees but work smarter than all else.

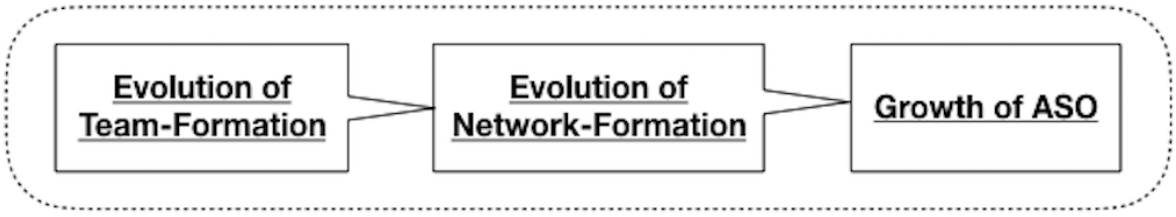
Over the past three decades, literature related to entrepreneurship have focused on the positive role of teams in the entrepreneurial process (Timmons, 1975; Kamm et.al., 1990). As noted by (Yoon, 2018), growing start-ups with limited resources is difficult, so, more often than not, start-ups tend to rely on their team members and their entrepreneurial characteristics. Hence, to recognize new opportunities, firms must encourage such traits (Covin and Lumpkin, 2011). These traits of innovative, risk-taking and proactive behaviour of team members in general depict how absorptive firms will be to external resources and how willing they will be to take action to acquire critical and necessary resources (Miller, 1983). Various studies have established a steady relationship between such characteristics and how firms perform, especially in hostile and/or highly technical sectors (Naman, 1993), for instance in high-tech academic spin-offs.

Networks

(Sullivan and Ford, 2017) indicated that acquiring resources to be a pivotal barrier that entrepreneurs have to face during initial developmental phases. Networks of the founders and their team members serve as one of the main tools for identifying and acquiring critical resources. Nonetheless, resource requirements vary at different growth stages of such startups, fostering changes in teams and networks of these firms.

This study thus makes an attempt to explore the dynamics between team-formation and the evolution of network-formation of high-tech academic spin-offs ultimately to fuel the company's growth, with the following research framework as a baseline for the research.

Figure 1.1: Research Framework



2

Theoretical Background

This section will present the different theoretical perspectives used as a basis for underpinning our framework. We look into past literature discussing how teams and networks evolve together.

It has been established in past literature (Sullivan and Ford, 2014) that networks act as one of the primary tools of identifying and acquiring necessary resources for start-ups. However, as startups grow and develop their resource requirements change, fostering a change in their network-formation, in order to meet the changes. Equally important point to ponder on is the vital role that entrepreneurs and their team members play in manipulating the firms' networks in order to meet the changing resource requirements in order to grow. Growth of these companies can be in various forms such as larger market penetration or moving to a new geographic location, introducing a new product line, scaling up etc. First, we will start by discussing the importance and role of founders and team members in building, maintaining and/or transforming their networks to access necessary resources for growth using past literature. Then we will make an attempt to bridge the link between teams, networks and growth using relevant literature in the following subsections of this chapter.

2.1. Importance of teams

There is an increase in acceptance of the idea that internal resources is a source of competitive advantage (Fischer, 2014). This enlightens a concept related to human resources' that team members are strategically important to a firm success. Later in the following sections we discuss the capabilities and/or competencies that the team members bring to the start-ups. For now let's elaborate a bit more on the formation of team and their evolution from a human capital perspective.

The genesis of high-tech ASOs lies within universities and research institutes (Pinaki et. al., 2014; Clarysse et al., 2005). Evidently, research lies at the core of every academic spin-off (Vanaelst et. al., 2006). The specialized knowledge acquired through research is then commercialized through the creation of a new firm. It is a challenging decision for any researcher to create a spin-off since the researcher has to enter a commercial community that is distinct from their field of expertise. According to a few studies (Vanaelst et. al., 2006; Clarysse et. al., 2004; Vohora, 2004), that is why, initially, academic spin-offs usually screen-out the distinct and necessary sources for gathering resources needed for their firm to succeed: team members and their existing network connections. This section deals with one such crucial source of gathering necessary expertise and resources- 'Teams'(Forbes et.al, 2005).

It is important for academic entrepreneurs to accept that much of the efforts to build a startup relies heavily on their teams rather than just an individual entrepreneur. According to a study (Kauffman, 2016), approximately 50% of the new ventures start with teams, wherein the entrepreneurs build the teams by bringing in people from their core networks who become the initial team members (Kauffman, 2016; Ruef 2010). 95% of entrepreneurs in the process of creating spin-offs have formed teams to tap

into networks that are potentially rich in relevant resources (Kauffman, 2016), that could aid their spin-offs with crucial information regarding prospective opportunities and access to well-connected entrepreneurs and skilled individuals. Moreover, while searching for initial fundings, one of the most important factors that potential investors ponder on in order to evaluate the investment potential is whether the venture has a well-balanced team that possesses the right complimentary expertise or not (Birley, 1996; Vanaelst et. al., 2006).

2.1.1. Team-Formation: Through Human Captial perspective

Human Capital as defined by (Forbes et.al., 2005) consists of the organizational team members and the level of capabilities that the team members possess.

Naturally, human capital also varies with the quantity of the founders. Even with a potential for disagreements and conflicts between multiple founders (Scott et. al., 1991; Casson, 1982), firms that are founded by a team of people are prone to better growth than firms with a single founder. Studies have shown that a new venture with a team of founders creates the possibility of division of labor, specialization of capabilities and knowledge, moreover, it allows firms to benefit from extensive networks (Soetanto, 2012; Lechler, 2001; Scott et.al., 1999).

According to a study (Khodaei, 2015), the prior knowledge of the spin-off's management team is considered as an internal knowledge resource. As stated by (Vohora et al., 2004) the growth of academic spin-offs depends on their human capital, which is based on the management team's prior knowledge (Shane, 2000; Murray, 2004), effectiveness to learn new skills and develop new capabilities (Zahra et al., 2009; Khodaei, 2015), and to build new network connections rich in resources (Grandi et.al., 2003).
(Chandler and Hanks, 1994) established that founders with prior managerial or industrial experience are better at solving obstacles faced by new firms. Having prior experience of starting a new business, entrepreneurs have more knowledge of how to deal with the liabilities of newness (Eisenhardt and Schoonhoven, 1990). Spin-offs with entrepreneurs who have prior experience may already have partners from their existing networks that may be useful. These existing partners can be contacted to seek help in solving obstacles faced by these spin-offs. Overall, resources can be gained more effectively as experienced entrepreneurs may already have a network connections that they can tap into to provide necessary resources (Soentanto, 2012).

Teams in high-tech ASOs with a high level of capability can develop effective and efficient networks that support their own growth. (Khodaei, 2015) pointed out that the management team plays a prominently significant role in obtaining resources and absorbing new knowledge effectively using their prior knowledge and industry experience in order to improve the performance of these spin-offs, in other words, building dynamic capabilities for the firms (Wright et al., 2007; Sirmon et al., 2007)

2.2. Evolution of teams

Teams evolve through the addition of new members and abatement of some members. Adding team members is as an important method of seeking necessary resources and interpersonal attraction (Rasmussen et al., 2015). Thus the decision to include a new team member is important as it can substantially change the existing social and human capital (Forbes et. al., 2005). Moreover, interpersonal attraction supposedly dampens emotional conflict within teams and thus within networks, whereas, the resource-seeking facet of this process relates to the complementary skills and knowledge that a new team member brings on to the table. Thus studying team-formation is crucial (Forbes et. al., 2005).

(Aldrich, 2007) stated two principles of team formation: Rational Process Model and Social Psychological Model. The first one emphasizes on selecting team members solely based on practical and instrumental criteria, for e.g., skills and experiences (Aldrich, 2007). The second model emphasizes on the interpersonal fit between team members so as to have smooth functioning among group processes (Aldrich, 2007).

According to Kauffman findings (Kauffman, 2016), teams are homophilic i.e., individuals in teams tend to associate themselves with similar type of individuals (for e.g., age,gender, race, etc) and with similar characteristics and personalities (Aldrich et.al., 2003; Ruef 2010). Moreover, a study (Hinds et. al., 2000) indicated that having worked with someone increases the likelihood that someone would choose to work with

them again (Lazer et.al, 2004) considering the experience was positive and mutually beneficial.

High-tech ASOs in general depend quite a lot on pre-existing and homophilic connections of their team members, thus the network of connections they acquire and additional team members they bring in bear a substantial semblance to their prevailing relationships (Vissa, 2011). Moreover, their selection of associates is also affected by their geographic location (Ruef, 2010). Except, international immigrant entrepreneurs who form teams and networks based on transnational networks (Portes et.al., 2002).

Moreover, (Baptista et.al. 2015) in their book indicated that the team of founders in a High-tech ASO can decide on hiring either surrogate entrepreneurs, managers or external researchers from their pre-existing connections in academia. They hire depending on the current specifications of the market and business needs. In addition to that, these ASOs being as specific as they are in their ideas and purposes, hiring a talented management team will not only speed up but also pave the path for development of the venture.

According to the (Vanaelst et. al., 2006), teams change as spin-offs evolve through the different stages of their existence. The same study had also found that new team members brought in different kinds of experience, ideas and distinct network connections compared to the initial team members. Teams are not immutable units because they evolve over time and there are changes in their composition, ergo, they are considered *significant units of analysis* (Vanaelst et. al., 2006).

2.3. Network-Formation

In this section, we delve into exploring what networks are, how they are formed, how do they evolve over a period of time.

Within and between spin-offs, networks serve as important channels through which ASOs can access necessary information and resources that supplement the existing knowledge and resources (Kauffman, 2016; Newbert et al., 2013; Semrau and Werner, 2013). It is a general consensus that firms with team members having a more developed network, in terms of the quality and number of ties, have more potential to succeed in comparison to those having less developed networks (Burt, 2000; Rasmussen et al., 2015).

If a spin-off develops, the networks from extended connections become helpful in a multitude of ways by providing advice, practical forms of support and they also convey resources such as - material (e.g., access to venture financing) and perceptual (e.g., the legitimacy of an affiliation with a prestigious other - collaborations) (Kauffman, 2016; Aldrich et.al., 2013).

Moreover, findings from (Erden et. al., 2004) suggest that different academic spin-offs provide important inputs to other firms' innovative activities either in the form of knowledge transfer or through the supply of sophisticated products. High-tech ASOs acquire external knowledge and combine it with their internal stock and provide other firms novelties developed within these firms. In this process, a problem emerges because High-tech ASOs evolve from non-commercial environments and have to overcome substantial obstacles on the way to become a profitable organization. This is where the role of network formation comes into play the most.

During initial developmental growth phases, academic spin-offs generally seek support through their parent organizations, peers, prevailing networks such as friends, family, and former colleagues. Eventually, the creator of these spin-offs seek to create relationships with other entrepreneurs, businessmen and/or organizations as necessary so as to learn from their new associates and connections, while trying to implement effective ways to run a new venture.

2.4. Social Capital Perspective

How social capital is defined differs in different papers. In a 1995 study by Greve, only the network structure is brought into light, whereas (Berg et al ????). talk about the resources that could be accessible by using the network. On the other hand, social capital is seen as how a set of relationships at the collective or individual level make that collective or individual more productive (Lin, 2001; Lazer et. al, 2004).

(Burt, 2000) indicated an analogy comparing society as a market where people build connections and exchange a multitude of information and ideas in the pursuit of their interests. Whereas,

human Capital is the driving force for building various relationships that turn the social capital into a competitive advantage. Thus relationships are the foundation of organizational capabilities that are an important source of sustained competitive advantage because they capitalize on individual differences and are relatively immobile since they are embedded within a firm's culture (Lengnickhall et. al., 2003).

Unlike other types of capital, social capital is not traded on the open market (Nahapiet & Ghoshal, 1998). It is described as distributed capital that is embedded within the network (Lin, 1999). Where many argue that it is acceptable to interpret the terms capital and resources equally (Fischer et. al., 2014), Adler and Kwon's in their 2002 paper, presented how social capital can either act as a substitute for, or a catalyzing parameter to resources. Using these concepts, an analogy can be drawn implying social capital to be as a telephone line between two entities, where, the conversations are the social resources and the connection as the social network. On the same line, Fischer et. al in their 2014 paper describe capital to be the tool of communication and resources as benefits gained from it.

According to a few other studies (Putnam, 1995; Soetanto, 2012), social capital has also been defined as 'the characteristics of a social organization: such as networks, norms and social trust' that facilitate coordination and cooperation for mutual benefit. Moreover, according to Bourdieu, 1985: 'social capital is the total amount of resources received by an individual or group due to their network connections of more or less institutionalized relationships of mutual acquaintance and recognition'. Ghosal et.al.,1998 proposed that social capital can be defined as 'some of the actual and potential resources embedded within, available through and gained from the network of relationships accrued by individual or social units'.

Evidently, social capital has been seen as many things but there is a wide consensus that social capital is a valuable asset whose value emerges from the access to resources through the social relationships of an actor (Granovetter, 1983; Soetanto, 2012). In our case, learning through social networks allows High-tech ASOs to accumulate specific and necessary knowledge and resources (Soentanto, 2012).

Social Networks

Social networks (Fig. 2.1) have been defined as personal networks of team members that are potential channels for providing knowledge, information and resources beneficial for the growth of ASOs. (Birley et.al., 2003) have pointed out that the most important connections of new ventures are generally dominated by social networks, and these networks are defined by the personal connections between entrepreneurs and their partners. Social networks initially develop through social relationships but eventually the networks are used to discuss business matters (Soetanto, 2012). On the contrary, networks could also first start as business connections, but later become a strong social and informal connection.

Since this context can be deliberated as a "network," Social Capital Theory can be considered to be concurrent with the "Network Theory" (Burt, 1992). Drawing on this point of view, new team members incorporate their commercial links or connections, increasing the spin-offs ability to access new networks that could lead to funding, customers or other valuable resources (Florinet et.al., 2003).

2.5. The Link Between Teams & Networks

More than 50% of the spin-offs were a by-product of teams, with team members primarily seeking out team mates and business connections from their core networks (Ruef 2010). (Stinchcombe, 1965) revealed the critical role team members play in bringing resourceful network relationships. As spin-offs grow, the networks created by the addition of new team member(s), results to be beneficial in a multitude of ways accounting for crucial business advice, resources, and other practical forms of support (Kauffman, 2016; Aldrich, 2013).

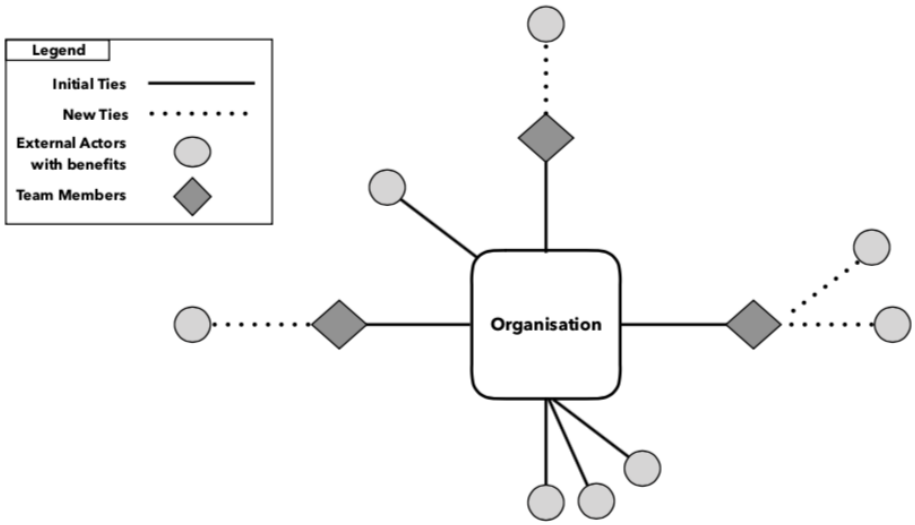
Moreover, human capital theory, social capital theory, and the resource dependence perspective all have normative implications for entrepreneurial team member additions (Forbes et. al., 2005). Basically, these theories commonly imply that teams should draw in individuals with having the capacity to produce returns or to acquire resources (Forbes et. al., 2005). The following statement from one of the respondents of the interviews can be seen through a lens that nicely combines all the three main theoretical approaches - the social capital theory, the human capital theory and the resource based view

- "*We hired him because he had close connections with the venture capital community. It is anticipated that we were going to need to raise capital funds, moreover, he was a person who was also a great fit within our company culture and values.*"

According to human capital theory, the individual who amplifies benefits over expenses should be chosen, otherwise no addition should be made (Rubbens, 1993). In addition to that, social capital theory proposes that the addition of new team members should be based on an individuals' ability to get important connections and use existing affiliations effectively.

Lastly, from the resource-dependence perspective, teams should foster connections with individuals who are most capable of improving resource accessibility. However, such accessibility should be attained with the least budget and without adding new members. For e.g., a CEO can be included in a firm's board of directors' committee.

Figure 2.1: Social Network Structure



2.6. Inferences from the literature review

Relatively, a handful of prominent papers such as (O'Reilly et. al., 2007, Forbes et.al., 2003) ponder on the role of team members' in developing new ventures. Most studies related to strategic network research are based on analyzing network-formations and their impacts within and between incumbent firms (Aldrich, 2007). According to Lazer et. al. 2004, a large number of literature on both consequences of networks and team evolution is available, whereas, literature on network evolution is growing. There is literature (Khodaei, 2015) on the influence of the management team's absorptive capacity with regard to the growth of ASOs. Moreover, literature on the effects of network-formation on formation of new team is available. However, literature that deal with the effects team evolution on the evolution of networks in High-tech ASOs is relatively under-explored.

Research on the genesis of the formation of relationships among High-tech ASOs is scarce, and even fewer or none, that consider the role of management team formation in the evolution of network-formations (Lazer et. al, 2004) of High-tech ASOs.

However, according to Lazer et. al. 2004, doing research in a team-network setting could be problematic because to understand the causality between team evolution and network evolution, temporal dynamics must be considered (Lazer et. al, 2004). The temporal dynamics of teams and networks describe how in High-tech ASOs different team members coordinates to create and/or change network-formations.

To understand the causal relationships between teams and networks, Lazer et. al., 2004 suggest four analytically distinct stages:
1) Use of pre-existing network before the team is formed;
2) The role of the management team in network formation;
3) The creation of network while the team continues to work;
4) The network created after the team stops to seek network.

According to (Lazer and Katz, 2004), the literature focused this particular topic is still in the nascent phase. This points us towards a few knowledge gaps. One of them being willingness of individuals and organizations to commit their time and resources to the team or the network, which mostly boils down to be a result of causal effect relationship with the risks and labour associated with spin-offs or startups for that matter (Kauffman, 2016). The second knowledge gap is about the effect of changes in team-formation on the evolution of network-formation of spin-offs, which serves as the purpose of this paper.

3

Methodology

This section is an intermediate step in the logical sequence of connecting the research questions of this paper with the empirical data, the resulting analysis and conclusion. This chapter presents and justifies the choice of the research approach used, the research process, data collecting procedure, sampling, etc. This is to clarify the research process and the structure used to gather and analyze data.

3.0.1. Research Approach

Due to the qualitative exploratory nature of the research, this paper will conduct an ancillary study focused on the effects of the changes in team-formation on the network-formation of high-tech academic spin-offs from within a sample of 5 companies, over a period of 5 years [2012-17].

Since theories and models germane to the dynamics of team-formation and network-formation combined is a complex and under-explored research area (Lazer and Katz, 2004), and since studies regarding the causal-effect relationship between team-formation and network-formation of academic spin-offs are also scarce (Vanaelst et. al., 2006), **an inductive research approach** will be adopted for this paper.

Based on the literature and the indulgence of multi-organization scenario, the use of comparative case studies seemed appropriate to gain insights into such phenomena (Eisenhardt,1989) over a specific time period. We therefore mapped the evolution of team-formation and network-formations of five different High-tech ASOs using a longitudinal research approach. *To enhance external validity*, we selected cases from diverse settings. Thus the analytical framework for this project will be that of **multiple case study**, as it's commonly done for research projects relating to university and companies (Eden et.al, 1996; Stensaker, 2013).

Moreover, based on the literature review it seems that different team members and their roles change at different times through the spin-off's processes indicating that the networks also change over time in order to keep up with the changing resource needs of the firm. Thus a longitudinal approach is necessary to capture these dynamic effects and reduce problems of retrospective biases (Pettigrew, 1990). A visual representation of this approach is illustrated in the form of a research model below (See Fig. 3.1).

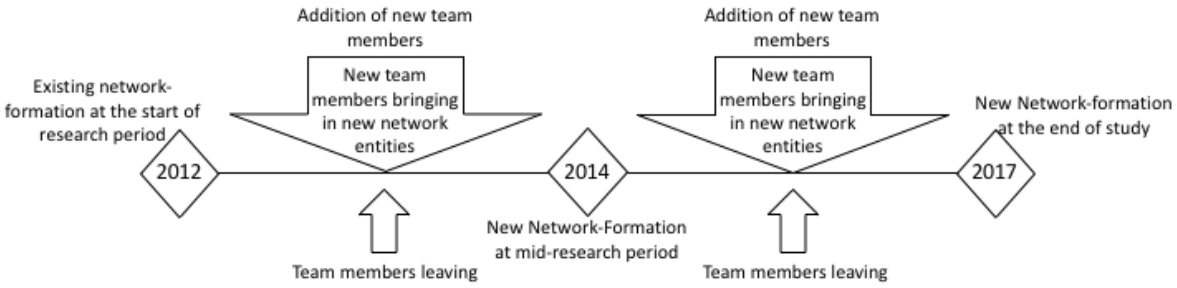


Figure 3.1: Visual representation of the research approach

• Case studies are at the heart of this research paper so as to illustrate certain topics within our investigation bubble, considering the nature of this research is an exploratory one.
• Due to the variety of the companies involved in the population data set within the secondary data, a judgmental non-probabilistic sampling approach was used to choose the final research sample from a population of 95 companies. So, in order to, bring in some *degree of generalization*, multiple case study strategy seemed to fit the purpose of this research which enabled the enlightenment of the phenomena as they have no clear single set of outcomes. *On the other hand, the idea of generalization of results using qualitative methods could be argued against, and it is agreeable that it would be difficult to do so. We further discuss this topic of argument later in the conclusion chapter.* Moreover, this study is about the phenomena in their natural contexts, where the researcher has no influence or control (Yin, 2014). Nonetheless, considering all odds, a qualitative longitudinal multi-case study research approach seemed to be an appropriate choice for this paper due to its exploratory nature.

Multiple case studies are used when the research is using more than one case. This creates the possibility of comparing the findings from a variety of cases (Saunders et al. 2009). (Yin, 2007) argues that a multiple case study is preferable instead of a single case study as it showcases a wider view of the same intention. This clearly resonates with our research approach. A multiple case study design has thus been adopted in this paper with the intention of comparing and contrasting findings of the data collected from the 5 different companies. Another reason for considering multiple case study design was because that this paper takes into consideration the uniqueness that each of the 5 companies within our research sample possess. *It also allowed us to see what is unique with each case and if there is any pattern that appears frequently (Bryman & Bell 2011) through out the different cases.*

3.0.2. Data Collection & Sampling

This paper comprises of exploratory case studies aimed at gaining knowledge and insights about team and network formation of high-tech academic spin-offs. The data was collected using judgmental non-probabilistic sampling technique by conducting interviews using semi-structured open questions for a sample of 5 High-tech Academic Spin-offs. In actuality, there was a total of 6 interviews conducted with 6 different companies with TU Delft and Yes!Delft incubator as their parent organizations. For one of the companies, we used a pre-test interview questionnaire set. Conducting the first interview with the pre-test questions led us to make adjustments for our final interview questions. It gave us important insights that proved to be useful for

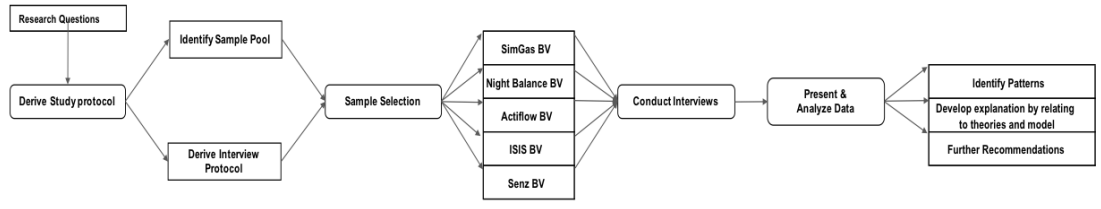
conducting the final interviews. During our first interview, it was realized that gathering sensitive information about developmental stages of competitive start-ups could be a difficult task. There were a couple of important things in play. The interviewees during the first interview were hesitant to give away any sort of information regarding their developmental stages and their network connections. They were also persistent to know as to how this research is going to help them with their current situation. It was evident that to collect any information from them building rapport and clarifying the research objective to them very clearly were necessary steps. So the data from the final 5 interviews (with complete set of usable, necessary and relevant data from the period 2012-2017) were used towards the fulfillment of this research. However, we make an attempt to use some of the usable information from the first (pre-test/trial) case, as it seemed to indicate a specific insight regarding the dynamics of network formation of ASOs which will be discussed in the later sections.

In order to gather longitudinal data, there was a need for a narrative approach. So we asked the interviewees to elaborate on the main activities and events as they occurred in a chronological order (Polkinghorne, 1988). Moreover, ASOs in general have long development phases (Rasmussen, 2015), therefore, we explored the data for three different timelines 2012 - 2014 - 2017. This presented the opportunity to capture any intermediate changes or evolution if any within the positions and roles of the team members in creating network relationships. Sequentially, pertinent open questions were used to obtain the data during the interviews. In defense of this approach, according to a study (Czarniawska,1998), this type of interviewing technique allowed us to delve deeper into the events as they actually occurred while avoiding personally opinionated perspective which otherwise could have been influential to the data gathered. Moreover, we also encouraged the interviewees to speak as freely as possible about the most important activities related to their team and network formations. In other words, what was happening in their respective companies, as in, who was added to the team, what roles did the team members play in expanding their teams and building networks in order to access necessary resources to grow the company. This led us to study the evolution of teams and networks of these high-tech ASOs in a holistic manner.

By collecting data at multiple stages of the spin-offs (including data from early stages as in 2012), and using triangulation methods for data validation through different data sources helped reduce the issue of retrospective bias, and made it possible to gain near real-time data ((Pettigrew, 1990; Rasmussen et al., 2015). The data was validated in a multi-fold fashion: *Interviewing active and involved entrepreneurial team members*; *desk research using LinkedIn company profiles, data scrapping through company websites, news and press releases of the respective companies*; *using free online marketing tools to scrape data about funding series, investments, etc.* We then triangulated all these data for the primary data set and finally cross-checked with the secondary data set.

When the data from the 5 cases reached their credibility threshold (Vohora et al., 2004), the data collection was completed for the purpose of this paper. The credibility threshold for this paper was demonstrated by the time-line when new network relationships were formed as a result of any changes in the team members and their efforts in forming new networks.

Fig. 4.3.1: Research Process



*Framework adapted from Case Study Research by Yin, 1994

Figure 3.2: Overview of the research process

3.1. Quality Criteria: Validity & Reliability

Improving Construct Validity:
- Using *triangulation, multiple sources of evidence* (Interviews, LinkedIn Employee Database, Company Websites) were used in the data collection phase, so as to have a check for researcher bias (Flick, 1992; Peräkylä, 1997).

Internal Validity:
- Constant feedback and reviews on the literature review, interview process and techniques have been received from a multi-supervisor research committee for this paper (Yin, 1994).

External Validity:
- Using replication logic for multiple case studies during the research design phase, for e.g., 6 cases from within our spin-off population sample - by choosing cases from different domain or industries (Eisenhardt, 1989; Parkhe, 1993). - Scope and delimitation for the research design were mentioned so as to arrive at analytical generalizations rather than statistical generalizations of the achieved results for this research (Marshall, 1989).

Reliability:
- Congruence between the research questions regarding changes in team-formation and findings of the research has been carried out through iteration and reviews from superviosry committee (Yin, 1994).
- Regular and constant feedbacks by communication with the supervisory committee regarding the methodological decisions regarding this paper (LeCompte, 1982).
- Finally, assuring meaningful parallelism and cross checks of both research data & results were done across multiple data sources viz., Interviews, Company websites, LinkedIn, SPSS data sets for primary data, etc.

4

Presentation of Empirical Data: Results

4.1. Case Overview

The five spin-offs were assigned pseudonyms A, B, C, D and E. The cases were selected mainly based on the following three key criteria:
1. The ASOs were involved in high-tech market sector.
2. The ASOs originated from TU Delft and/or had YesDelft incubator as one of their parent support organizations.
3. The ASOs are/were active during the research period of 5 years from 2012-2017.

Based on these criteria, *Table 4.1* presents the general information about the five cases from the primary data set. Insights from the interviews helped us curate crucial information regarding the instances of the evolution of team-formation over a period of time to understand how these additions rendered new

Table 4.1: Case Overview

**CEO-* Chief Executive Officer | **CTO-* Chief Technical Officer | **MD-* Managing Director | **CIO-* Chief Innovation Officer | **TU Delft-* Delft University of Technology | **Yes!Delft-* High-tech Startup Incubator

	Company-A	**Company-B**	**Company-C**	**Company-D**	**Company-E**
Roles of Founding Members	2co-Founders CEO President	2 co-Founders CEO CTO	2 co-Founders CEO CTO	2 co-Founders CEO MD	3 co-Founders co-CEO co-CEO CIO
Experience	Industry experience & Research experience	No experience	Some industry & Research experience	Research experience	No experience
Support	TU Delft & Yes!Delft	TU Delft & Yes!Delft &	TU Delft & Yes!Delft &	TU Delft & Yes!Delft	TU Delft & Yes!Delft
Sector	Energy & Sanitary solutions	Medical solutions	Fluid Dynamics solutions	Space & Satellite solutions	Consumer products
Market Demography	Global	Global	Netherlands	Netherlands	Global
Location	The Hague	The Hague	Breda	Yes!Delft Campus- Delft	Yes!Delft Campus- Delft

networks and partnerships leading to the accessibility of various forms of resources which helped the ASOs grow.

The interviews were conducted with entrepreneurial team members who have been part of the respective companies since or close to their inception. *Table 4.2* will provide the basic information about the interviewees. The interviewees were selected based on the following factors:
1. Association with the respective company throughout the period 2012-17.
2. Have or had played a role in building network connections.

Table 4.2: Interviews: Basic information

**BDE*- Business Development Executive/Manager | **F1or2*- Founder 1 or 2 | **RBC*- R&D + Business Consultant

	Company A	**Company B**	**Company C**	**Company D**	**Company E**
Interviewee's Role	BDE 1, F1	F1 & 2	F1, RBC	F2, BDE1	BDM 1
Employed since	2011	2009	2005	2011	2005

4.2. Case Description

The following subsections will take the opportunity to narrate each of the cases in a descriptive manner. Using the data collected from the interviews, the narrative will try to provide detailed observations about the changes in the team members along with the corresponding changes in the network formations of each of the five high-tech academic spin-offs. Each case description also provides visual representations of their respective network evolution maps. These maps indicate a timeline and pathway of each and every network connection created, along with the team members responsible for forming those connections.

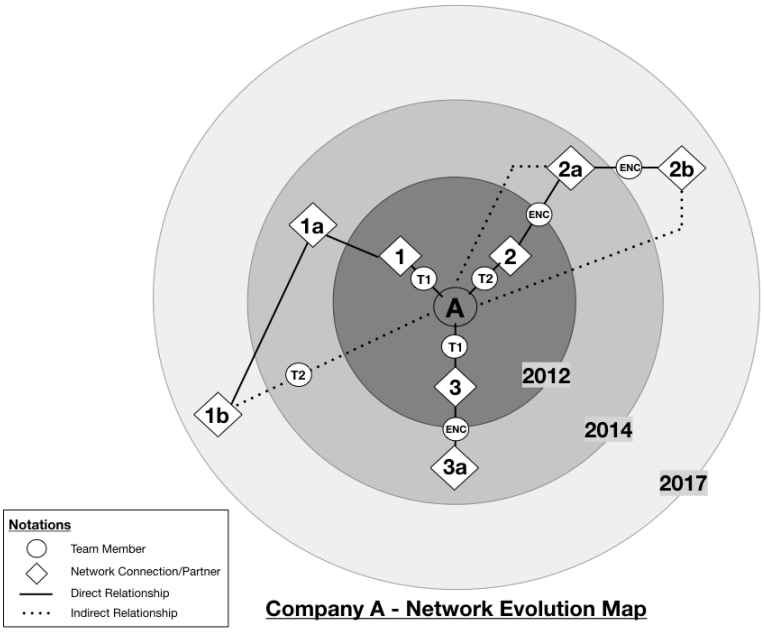
4.2.1. Company A

Company A was founded in 2009 by 2 brothers who were TU Delft graduates. It is headquartered at the city of Hague with operations in three continents. Their original business idea was to create a business dealing with socially responsible and sustainable Bio-gas products and services. They envisioned a highly scalable Biogas system that would provide clean energy and fertilizer to millions of people in Africa and Asia. They sought out domestic users as their main potential clientele. The founders did find a market potential, had a highly scalable product, had some past industrial and research experience, however, they had no experience or skills related to marketing, scaling or doing business in Africa or Asia. In line with this, one of the founders emphasized during the interview how he felt it was important to fill the skill and knowledge gap by adding more team members.

As soon as they realized the need to grow, they started to rapidly bring in new team members with the help of the incubator, and by tapping into their own pre-existing network from their past jobs. "*One of our most valuable hires was our Business Developer..she is currently working as our Global Business Head (GBH).*", mentioned by one of the founders (addressed as F1A from now on) during the interview.

As was observed, both F1A and the newly hired Business Developer (BD), were focused on activities such as opportunity exploitation through strategic planning and development. For instance, they were facing a problem of 'dealing with local bureaucracy' during the initial stages of scaling their business in Tanzania. As a result, the BD came up with ideas to tap into her own business connections from her past work experience in Africa in order to create Joint Venture partnerships in those regions. Within a year, Company A, started growing fast, capitalizing their partnership with a local business entity in Tanzania. This partnership benefited Company A to better understand what the exact needs of their clients in those regions are, and how to market to them. While, Company A handled most of the business development, R&D, Design, Finances, Planning, etc.

Figure 4.1: Fig. 4.1 Network Map - Company A



During the research period, the size of the network varied from 3 to 7 partners just abroad. The BD pointed out one of the crucial facts about how having partnerships helped them swerve through a barrier that was detrimental to their business. She mentioned that during mid 2015, they faced with some legal challenges and bureaucratic issues in Rwanda (one of their biggest production facilities) which halted their production i.e., ultimately reducing sales. This issue continued for a couple of months. Even after realizing the loss, they were still unable to do anything to revert it. The BD mentioned, "..we would have probably been able to subside this issue if we (our business team) were present there to handle and negotiate a deal between the local authorities." So then, they decided to bring in an External Networking Consultant/Lobbyist (local in Rwanda) who was be able to deal with the local authorities and start production again.

Both the interviewees mentioned that throughout the initial stages of growth, they were in constant communication with their team members and partners. They emphasized on the point that without a constant rate of communication (as much as 3x-4x a week in 2012, to 2x a week in 2014, to 1-2x a month in 2017) between the teams in the Netherlands and different regions in Africa it would have been very difficult to handle production demand and supply, ultimately sales. F1A candidly pointed out that it took them close to 4 years to basically establish their company. In retrospect, he said that those 4 years were extremely beneficial for them in developing the necessary capabilities that eventually led them to build a network of partners without whom they wouldn't have been on the map of African bio-gas industry for this long.

Figure 4.1 provides a visual representation of the network evolution map of Company A. The letter "A" enclosed within a circle in the middle of the concentric circles indicate the company pseudonym. The map comprises of three concentric circles representing the three different timelines of data collection 2012,2014 and 2017. The box shaped entities represent the partners added. The circles indicate the team members. Any circle leading up to a corresponding box represents a team member who is responsible for the creation of that specific network connection. The bold straight lines connecting the different entities in the map represents that a direct relationship is present between two entities and the dotted lines represent that an indirect relationship is present. A direct relationship is indicative of the situation when a new partner is added the the network with the help of a team member, whereas, an indirect relationship is indicative of the situation when an existing partner brings in a new partner within the network without the

involvement of a team member. For example, in Fig 4.1 the entity '1a' is linked to '1b' through a dotted line, indicating an indirect relationship because the '1a' is an existing partner who brought in '1b' maybe in order to meet changing resource requirements or to seek crucial business intelligence insights, etc. On the other hand, entity '1' and Company A are linked via a bold straight line representing a direct relationship which was created by a specific team member 'T1'.

4.2.2. Company B

Company B was founded in 2009 by two TU Delft alumni. The business idea was based on commercializing their research about sleep position therapy originated at the university. Their largest potential customer base was people with sleep apnea issues that caused them to have sleep irregularities, daytime sleepiness, high blood pressure and heart conditions.

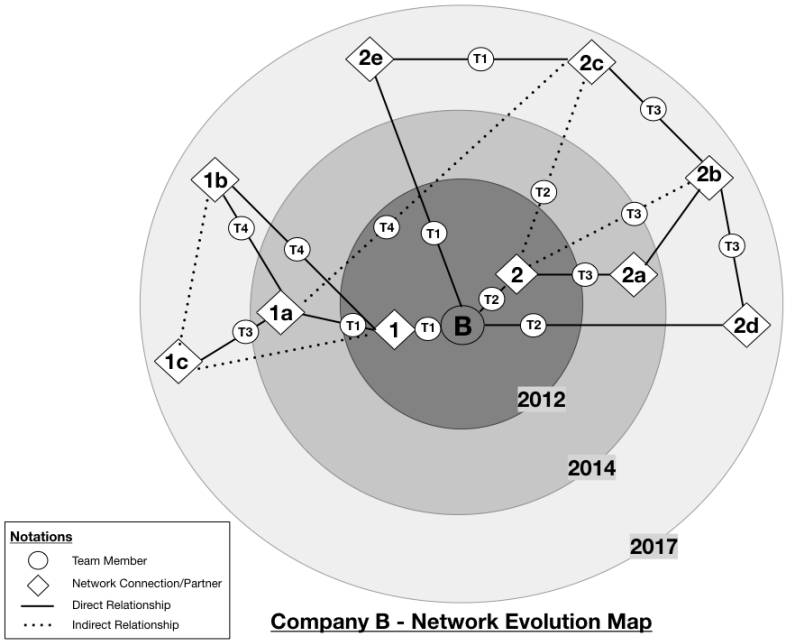
Both the founders (F1B & F2B), were recent graduates when they started this company. Evidently, they lacked industry experience. However, F1B was more entrepreneurial and risking taking which led her to acquire strategic business acumen needed to market, scale, patent the product. Whereas F2B was involved with product design and development, complimentary capabilities of F1B helped Company B to acquire seed funding around 2011-12. However, F1B expressed her concerns regarding investors seeking milestones achievement on a regular basis, which translated into task distribution between these two founders. With the increase in workload, they realized that they weren't able to focus on long term relationship building with necessary research partners, distributors and hospitals in order to develop their product and have sustainable revenue generation. They decided to grow their team size and bring in people with the right connections and skills with medical advisory boards, hospitals, suppliers and distributors.

With the help of their facilitator/incubator they sought out new team members, and with coordination with the university and teams' network connections they sought out medical board advisors, etc. Partially due to the pressure from investors and partially due to their easy to scale product in a market where millions suffer from sleep related problems, in mid 2012, F1B hired an experienced sales executive and a business development executive to build a team that could scale up to different geographic locations. In F1B's words, "..our market accessibility grew tremendously after we started building a team and distributed responsibilities. But you know what the funny thing was? It was how things changed for us, initially, we used to face pressure from investors to build a team and reach pre-determined milestones but then having a team that made different markets accessible to us brought new challenges of having to make strategies and partnering up so as to penetrate those sectors".

Although F2B wasn't available for the whole interview he introduced himself momentarily. During which he expressed how F1B's entrepreneurial skills and passion towards reaching their product to millions of sufferers globally led Company B to the stage they are at right now (indicating the year 2017).

Both F1B and F2B shared the same notion about how critical partnerships were created as their team grew. It seemed important to clarify the term "Critical Partnerships" they had used during the interview. In F2B's words, "by critical partnerships I meant the relationships that our team and F1A built and nurtured, without those connections it might have taken us ages to reach a huge percentage of our client base". The entrepreneurs realized it quite early on that a big percentage of their sales will come from recommendations from doctors. So it was evident that they needed to build relationships with hospitals. F1B mentioned that, "this was actually realized during a meeting with one of our investors (VC1). They basically recommended an External Management Consultant who had extensive network connections within the medical boards across several hospitals". Eventually, this proved to be one of the most valuable relationships ever built for Company B. Continuing with their success in almost every step of the way, F1B exploited her connections with two other venture capitalists that had shown interest in Company B and actively invested on medical equipment and medical technology companies, leading to series A & series B funding of $12.5 Million respectively in 2013 and then in 2016-17.

Figure 4.2: Fig. 4.2 Network Map - Company B

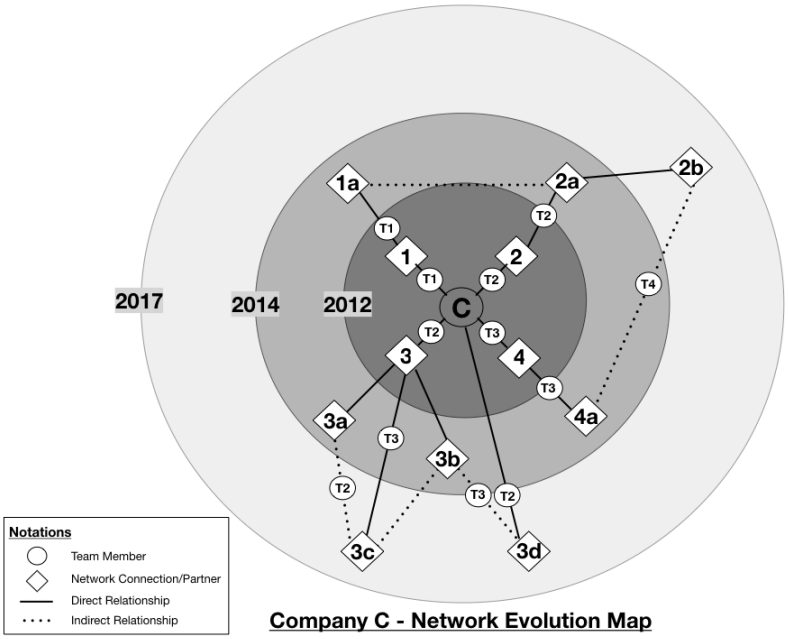


4.2.3. Company C

As a highly technical company with almost no market credibility that provided a unique and intangible services of flow analysis of automotive and aerospace vehicles, it was very difficult to market. Customers had hard time seeing the value in investing in an outsourced solution that big automotive or aerospace companies already possessed. With the help of their facilitator, they soon realized that in order to make enough sales to generate sustainable income, they needed experienced consultants who had both prior experience in selling such intangible products and has pre-existing network connections with potential organizations and companies that dealt with similar products and market sector.

Although, initially dismissed, their R&D /Business Consultant (RBC) came up with an idea of a unique revenue model, along with his ability to convince customers to see value in their products which ultimately took the company to a new level. The contacts and partnerships that were established around 2012-13 with the help of Yes!Delft and their consultancy team led by the 'RBC' were absolutely critical for their survival. According to one of their founders, they are still (indicating the 2017 timeline) reaping benefits from those contacts. Due to the nature of Company C's products, their company thrives on partnerships and alliances rather than just selling to B2B or B2C clientele. They provide services that are not comprehensive products that one could go buy in a store. Their products are part of wholesome products that supplement the complete product. Thus the dependency on strategic partnerships and alliances with other companies is embedded in their business model. The original goal of this company was to become an expert flow analysis consultant for automotive and aerodynamics industries. But with the realization of their unique revenue generation model through utilizing external relationships/partnerships, their goal shaped into becoming a global leader in building physics and flow analysis of any sort of structure, vehicles, chemical processes, etc. *"currently, with the combined strength of a variety of technical experts, and a resourceful, agile and creative management team, we have acquire a steady stream of industry partners and strategic alliances fueling our revenue generation, which currently, by the way, is at a all time high.*

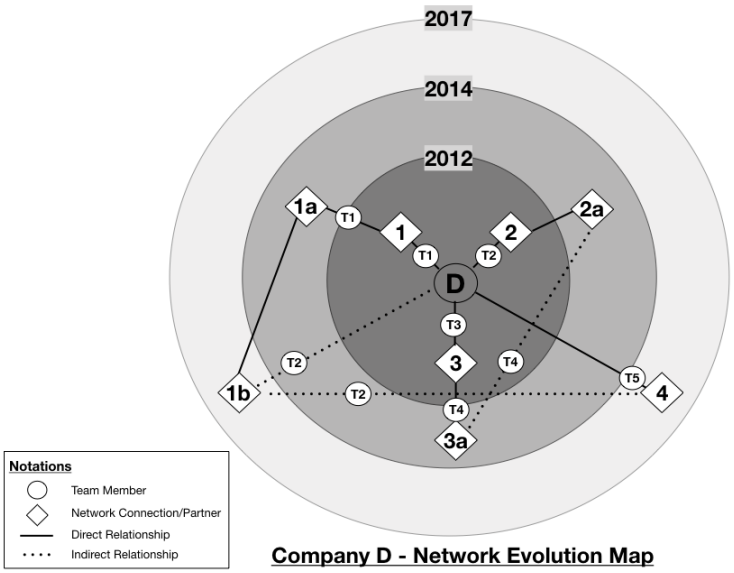
Figure 4.3: Fig. 4.3 Network Map - Company C



4.2.4. Company D

Both of the co-founders were highly talented researchers turned entrepreneurs. Their vision was to create cost-effective space solutions through nano and mirco-satellites. Within a couple of months, they realized they would be better off by tapping into their shared network connections to find both industry experts within their market community and expert researchers from their parent organization [TU Delft]. According to Eric (Co-founder 1), *".. to fill our skill gap to market our micro and nano-satellites, we brought in people with varied expertise who could create a business model that will help us market these unique products and create awareness of the value we provided"*. Initially, both of the two co-founders would switch in and out of their responsibilities in order to maintain a balance in their work. However, they soon realized that co-founder-2 had a natural knack for handling business operations and creating venture partnerships which could lead to long-term and sustainable growth. Co-founder-1 also expressed that, *"..due to Eric's (co-founder-2)ability of building great rapport with anyone - his peers, academicians, industry experts, etc, he sealed up a great relationship with the Aerospace faculty at the TU. Because of that, the initial support that we got from the TU in terms of research infrastructure and skilled personnel was immensely beneficial through our company's nascent phase. We are proud to say that 90% of our team are TU Alumni."* The main goal of Company D was to provide cost-effective space systems and turn-key missions by using nano-satellites and micro-satellites and become an industry leader in that sector. According to Eric, other than having a great product development team, sustainable growth could only be achieved through building R&D and strategic partnerships with both private and governmental aerospace organizations. With the combination capabilities of Eric and their 'Technical Sales Director' (previously Technical Sales Consultant), they created credibility of their product and of the company by creating crucial relationships and partnerships with government organizations such as ESA (European Space Agency), competing in a highly niche market with giant aerospace solutions companies such as Airbus, and other similar companies like NanoRocks. They are currently placed as one of the most sought out companies for space solutions. Moreover, it is now a rapidly growing mid-sized enterprise with close to 90 employees (indicating the year 2017) with an estimated annual revenue of $10 Million.

Figure 4.4: Fig. 4.4 Network Map - Company D



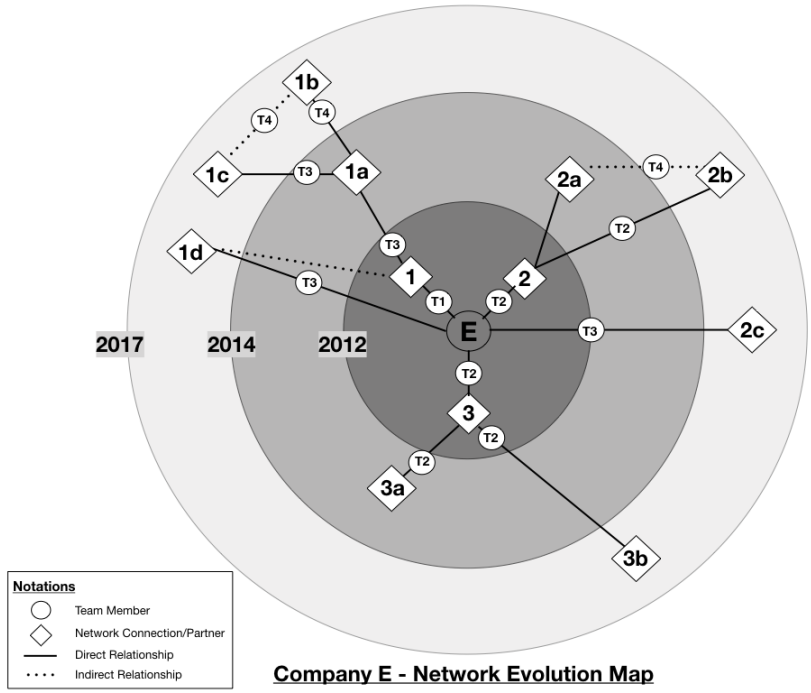
4.2.5. Company E

The business idea was a result of a thesis research work by one of the founders which translated into a business solution. Due to already existing big contenders, it was particularly difficult task to gain market share in the offshore solutions market. However, along with two more co-founders, they created an ingenious product by realizing a need within the offshore platform transfer market. Their idea was a flight simulator upside down which would be capable of compensating all six degrees of freedom of a vessel and making transferring offshore much safer.

Around 2012-13, Company E had already proved their immense value to a loyal fleet of customer base across Europe and some parts of Africa. However, due to great demand from potential users across the globe, by the end of 2012 the Director of Sales and Business Development, along with the Head of Strategic Operations decided to bring in a strong investment partner on-board. To meet the demand, Company E brought 3 Business Development Managers (BDM) on-board who were responsible for different regions across the map. However, later in 2013, one of the BDMs was removed from the team, as described by the BDM-1, it was due to lack of fit within the team. Nonetheless, before 2014 ended, the BDMs along with the Director of Sales and BD, opened up offices in Singapore and in the UK. According the interviewee, "*it was a strategic decision made by our team to have a local presence in the UK and in Singapore. Further, we also decided to partner up with local offshore solution companies within those two regions due to the presence of densely populated belt of offshore wind farms, oil and gas rigs. Demand for our product was abundant in those two places*". Company E sent one of their team members from the Netherlands to handle the operations down in Singapore. He was a Senior Design Engineer turned Business Development Manager with experience in both fields and extensive network connections in the South East Asia and Middle East regions from his prior work experience in the oil and gas industry. Exploiting his networks connections, Company E opened up sister branches in Brunei and in Doha. On the other side of the map, with the help of their team in the UK, Company E started building strategic alliances with small American offshore solution companies in Houston to better understand the market there, with the hope to deeper market penetration possibilities in the near future. The original goal of Company E was to develop an innovation so as to create better offshore transfer solutions in the North Sea. But as the demand for their solution increased, their goal was modified to meet the increased potential of their product outreach globally. With a fleet of BDMs for each market

region, fueling strategic partnerships to acquire other offshore solutions, Company E is continuing to grow in terms of market share every year. They have made close to 4 million transfers in 2017. It has grown from just 4 team members in 2007 to 70 in 2012 and a staggering 350 employees in 2017.

Figure 4.5: Fig. 4.5 Network Map - Company E



4.3. Cross-sectional Case Study Analysis

In order to gain insights about what was happening in the respective companies and what roles did the team members play in expanding their teams and building networks, we requested the interviewees to speak as freely as possible about the most important activities related to teams and networks formations, and followed up with semi-structured open questions. This led us to study the evolution of teams and networks of these high-tech ASOs in a holistic manner. *Table 4.3* will provide a representation of the changes in team-formation during the 5 years period. Although the teams in all the 5 companies had grown more than just three to five members during the data collection points, the important factor to consider here is that not all the team members added were necessarily involved in or responsible for building network connections for the companies. Our focus was mainly on the actors involved in resource assimilation through building and maintaining network connections. So in *Table 4.3*, only those teammembers are shown who were directly associated and responsible for network creation for the respective ASOs. One more important observation was that even though all the 5 spin-offs had more than one founder, not all of them were directly involved in business development.

In other words, the team members not involved in building relationships or networks connections with strategic partners to acquire critical resources for growth and sustainability aren't mentioned in this table. Sequentially, *Table 4.4* will provide a representation of the evolution of network formations of the 5 companies throughout the research period.

Table 4.3: Team-formation: Overview

**BDE*- Business Development Executive | **GBH*- Global Business Head | **ENC*- External Networking Consultant | **BTD*- Business and Technical Developer | **MO*- Marketing Officer | **GSD*- Global Sales Director | **RBC*- R&D + Business Consultant | **OD*- Operations Director | **TSD*- Technical Sales Director

	Team-Formation				
	Company A	**Company B**	**Company C**	**Company D**	**Company E**
2012	F1,2 BDE	F1,2 OD	F1,2 RBC	F1,2,3 TSC	F2, 3 BDM 1
2014	F1 BDE ENC 1	F1 OD MO RBC 1	F2 RBC	F2 TSD BDE MO	BDM 1,2 Dir MSBD 1
2017	F1 GBH BDE 2,3 ENC 1	F1 OD MO RBC 1,2	F2 RBC GSD	F1,2 BDE TSD MO	BDM 1,2,3,4,5,6 Dir MSBD 1,2

Table 4.4: Network-formation: Overview

**PSO*- Parent Support Organization | **SP*- Strategic Partner/Alliance | **JVP*- Joint Venture Partner | **RP*- Research & Development Partner | **TEO*- Tech Events & Conference Organizer | **ENC*- External Network Consultant | **BA*- Boardroom Advisor | **VC/I*- Venture Capitalist/Investor

	Network-Formation		
	2012	2014	2017
Company A	PSO 1 RP 1,2,3 JVP 1 SP 1,2	ENC RP 3, 4 JVP 1 SP 1,2,3	ENC RP 3,4 JVP 1 SP 1,2,3
Company B	BA 1,2 VC/I 1,2,3 ENC 1	BA 1,2,3 VC/I 1,2,3,4 ENC 1	BA 1,2,3 VC/I 1,2,3,4,5
Company C	PSO 1,2 - SP 1 TEOs	SP 1,2 RP 1,2 ENC TEOs	SP 1,2 RP 1,2,3 ENC TEOs
Company D	PSO 1 RP 1 JVP 1	RP 1 JVP 2 SP 1,2	RP 2 JVP 2 SP 2,3
Company E	JVP VC/I 1 VC/I 1	JVP 2 SP 1,2 ENC 1	ENC 1 SP 1,2,3 RP 1

4.3.1. Case Studies Comparison

A comparative multiple case study allowed us to analyze what is unique with each case and gave us an opportunity to observe any possible common pattern/trend (Bryman & Bell 2011) through out the different cases. Table 4.5 presents each and every case study side by side, which serves to provide a better understanding of the role of team members and the transformation of the network-formations of the respective spin-offs. It entails a comparative evaluation of all the cases together, justified by relevant quotes from the interviewees which act as evidences of the role that team members play in transforming the network connections of each of those spin-offs in order to realize company growth.

Table 4.5: Case Studies Comparison

GBH*- Global Business Head | ENC*- External Networking Consultant | BDM*- Business Development Manager | VC* - Venture Capitalist

	Evolution of team-formation	**Team effects on network-formations**	***(Impact on Company Growth)***
Company A	Company A brought in a business developer [also the 1st person who got hired after the company was founded] brought in an array of opportunities for revenue generation and gathered an entrepreneurial team of business and sales developers, networking consultants/lobbyists, suppliers and distributors through her and team's industry contacts in the target market regions using prior connections. *"..Winnie (our current GBH*) introduced us to an untapped market sector in Tanzania, Rwanda and Kenya, while building accessibility through a variety of different team players. To be honest, within three years (indicating the 2012-15 timeline) we had three production facilities, multiple branches with distributors across those 3 regions. It literally transformed our company's growth. We as a team grew from 3 people in 2011 to 49 employees in 2017."*	The entrepreneurial team led by their 'GBH' created strong relationships with some local industry and public support actors through strategic partnerships and alliances. These were used to access resources such as franchise owners who would scale up and grow the business. Consequently, as Company A's credibility grew in those regions, it became easier to develop new relationships and attract new resources from a variety of other actors. For instance, Company A along with a local business entity in Africa created a new business domain through which they provided clean sanitation along with their main business line of Bio-gas systems.	Evolution of team and network-formation led the company to have better resources to scale up and led to deeper market penetration in the Bio-Gas and Sanitation industry in Africa and later in South-east Asia. During the research period, Company A succeeded in scaling up their business in their target market locations. Eventually, at the end of the research period, Company A was operating through 4 regional branches in two different continents (Africa and Asia) with a main office in the Netherlands.

	Evolution of team-formation	**Team effects on network-formations**	***(Impact on Company Growth)***
Company B	Bringing this ENC on board, eventually, proved to be one of the most valuable relationship building asset for Company B. Since they dealt in sleep positional therapy solutions, a big percentage of their sales would come from recommendations from doctors. So it was evident that they needed to build relationships with hospitals. During the interview, Founder-2 mentioned that, *"this was actually realized during a meeting with one of our investors (VC-1). They basically recommended an External Networking Consultant who had extensive network connections within medical boards across several hospitals"*.	With the help of the 'ENC', a team of 2 Business Developer led by Founder-1 brought in 4 medical board advisors on-board who eventually laid the foundation for them to build strong relationships with several hospitals and medical organizations across the US, Switzerland, France and The Netherlands. Building a huge network of partnerships with medical organizations and professionals. As pointed out by Founder-1, *"..one of the most significant ways to create sustainable revenue stream at that time for us was through building long-term relationships with hospitals and medical board advisors who had direct influence over the hospitals, and also had prior experience of product standardization and development of clinical trials"*.	With the help of the ENC, their Global Business Development team, and the connections made with medical board advisors, Company B took the plunge of entering the US market in 2015. Their continued success sought out interested venture capitalists. By the end of 2016 Company B had acquired Series A and Series B funding of $12.5 Million in order to grow their presence in their target market areas.

	Evolution of teams members	**Team effects on network-formations**	***(Impact on Company Growth)***
Company C	Company C hired a Technical Sales Consultant in order to market their unique and intangible services such as flow analysis simulation. It was very difficult to market such products to potential customers who had hard time seeing the value in them. With the help of their facilitator, they soon realized that in order to make enough sales to generate some income, they needed experienced consultants who had both prior experience in selling such intangible products and has pre-existing network connections with potential organizations and companies that dealt with similar products and market sector. As stated by the current Managing Director (also co-founder), *"Frankly, without our R&D/Business Consultant, we may have been doomed by now. Although, initially dismissed, if it wasn't for his idea of a unique revenue model, along with his ability to convince customers to see value in our products, we would not be in business today".*	Due to the nature of their products, company C thrived on partnerships and alliances rather than just selling to B2B or B2C clientele. They provide services that are not comprehensive products that one would go buy in a store. Their products are part of wholesome products that supplement the complete product. Thus the dependency on strategic partnerships and alliances with other companies is embedded in them. The interviewee (Founder-2) candidly mentioned that, *"..the contacts and partnerships that were established around 2012-13 with the help of Yes!Delft and our consultancy team led by our 'RBC' were absolutely critical for our survival. We are still (indicating the 2017 timeline) reaping benefits from them".*	The impact on the company's grwoth due to the changes in the team and network formations was through the realization of their unique revenue generation model by exploiting external relationships to market their product, this has shaped them into becoming a global leader in building physics and flow analysis in any sector imaginable. According to Founder-2, *"currently, with the combined strength of a variety of technical experts, and resourceful, agile and creative management team, we have a steady stream of industry partners and strategic alliances and our revenue generation is at a all time high.*

	Evolution of teams members	**Team effects on network-formations**	***(Impact on Company Growth)***
Company D	Initially, both of the two co-founders would switch in and out of responsibilities in order to maintain balance in our work. However, they quickly realized that co-founder-2 had a natural knack for handling business operations and creating venture partnerships for long-term sustainability. According to Eric (Co-founder 1), *".. to fill our skill gap to market our mini and nano-satellites, we brought in people with varied expertise who could create a great business model to market these unique products and create awareness of the value we provided".*	They tapped into their shared network connections to find both industry experts and expert researchers from their parent organization [TU Delft]. Co-founder-1 pointed out that, *"..due to Eric's (co-founder-2)ability of building great rapport with his peers and academicians, we had a great relationship with the Aerospace faculty at the TU. Because of that, the initial support that we got from the TU in terms of research infrastructure and skilled personnel was immensely beneficial through our company's nascent phase."*	The impact on Company D's growth was that evolution of team and network formation curated a great product development team, and connected them with R&D and Strategic Partners in both private and governmental aerospace organizations. With the combined capabilities of Eric and their 'Technical Sales Director' (previously Technical Sales Consultant), they created credibility of their product and of the company by creating crucial relationships and partnerships with government organizations such as ESA (European Space Agency), competing with giant aerospace solutions companies such as Airbus, and other similar companies like NanoRocks, by providing similar highly quality cost-effective space solutions. They are currently placed as one of the most sought out companies for space solutions. Moreover, it is now a rapidly growing mid-sized enterprise with close to 90 employees (indicating the year 2017) with an estimated annual revenue of $10 Million.

	Eolution of teams members	**Team effects on network-formations**	***(Impact on Company Growth)***
Company E	Around 2012-13, Company E had already proved their immense value to a loyal fleet of customers across Europe and parts of Africa. However, due to great demand from potential users across the globe, by the end of 2012 the Director of Sales/Business Development, along with the Head of Strategic Operations decided to bring in a strong investment partner on-board along with 3 Business Development Managers (BDM) who were responsible market their prodcuts in 3 different target regions. Before 2014 ended, the rest of the BDMs along with the Director of Sales/Business Development, helped the company open up offices in Singapore and in the UK. Furthermore, also partnered up with local offshore solution companies within those two regions due to the presence of densely populated belts of offshore wind farms, oil and gas rigs there.	Exploiting the capabilities of their Senior Design Engineer turned Business Development Manager's pre-existing network connections in oil and gas industry in both South East Asia and the Middle East, Company E opened up sister branches in Brunei and in Doha. On the other side of the map, with the help of their team in the UK, Company E started building strategic alliances with small American offshore solution companies in Houston to better understand the market there, with the hope to deeper market penetration possibilities in the near future.	The impact on Company E's growth due to the evolution of team and network formations led Company E to rapidly scale up and acquire extensive amount of market share by meeting the increased potential of their product outreach globally. With a fleet of BDMs for each market region, fueling strategic partnerships to acquire other offshore solutions, Company E is continuing to grow in terms of market share every year. It has grown from just 4 team members in 2007 to 70 in 2012 and a staggering 350 employees in 2017.

5

Discussion and Conclusion

In Chapter 2 (Theoretical Background), theoretical perspectives pertinent to the research on teams and networks were identified. Although these perspectives do not explicitly label the process of team formations and network-formations of high-tech academic spin-offs (Forbes et. al., 2005) however insights can be extrapolated from these literature due to their relevance with teams and the networks of firms, specifically startups. This chapter will thus try to discuss the data uncovered from the interviews with actual entrepreneurial team members about their networks and how they used those networks to gain critical resources in order to fuel their company's growth. Sequentially, in the conclusion part, we have made an attempt to reflect back to the contribution of this paper both academically and for the entrepreneurs of high-tech academic spin-offs. Finally, the limitations of the research has been discussed along with suggestions for future research.

5.1. Discussion

According to (Scholten, 2006), in case of academic spin-offs the academic entrepreneurs/founders usually bring highly technical/scientific expertise and skills to the table. Although experience and skills are key factors in order to translate the scientific findings into a viable commercial product using a proper business plan however these high-tech academic spin-offs face challenges related to unique nature and smallness (Scholten, 2006). Due to the strong technical orientation of High-tech Academic Spin-offs it usually creates a lack of entrepreneurial orientation. As discussed in Chapter 1 and 2, to fulfill their commercial goals and fuel towards early company growth these firms rely on factors like network connections of the spin-off team members, support from the parent/knowledge institutions, access to resources and capabilities of the spin-off founders, etc.

In this paper we focus on the addition of team members, roles and capabilities of the spin-off founders' and team members' as to how they use their network connections to access necessary resources in order for their companies to grow. (Scholten, 2015) emphasizes on studies related to building relationships with network partners and points out the fact that these relationships can provide access to resources and other different networks with new information, which is beneficial to the spin-off founders and eventually to the company's growth. Nevertheless, (Scholten, 2015) indicates that the partners in such networks may have disparate interests, belief systems, and perceptions, which in turn may hinder the process of smooth communication and the possibility of commercialization (Obstfeld, 2005) of their scientific findings. We argue that prior experience is important when it comes to detecting, evaluating, and selecting new information and acting upon it when it is obtained through bridging ties.Studies have shown how addition of new team members with entrepreneurial capabilities and pertinent skills and experience increased firm's overall entrepreneurial and other dynamic capabilities (Forbes et.al., 2006) leading to the increment of a company's overall growth. Building on similar existing researches (Lockett et al., 2005; Wright et al., 2007; Sirmon et al., 2007; Holcomb et al., 2009; Zahra et al., 2009), it has been observed that such capabilities of team members play vital roles for ASOs to identify, build, and acquire necessary knowl-

edge and resources (Khodaei, 2015), by making use of the team's network connections and partnerships in order to fuel the company's growth. With that established this section focuses on the observations made through the lenses of empirical investigation of team-formation, network-formation and company growth.

As was revealed through the interviews, teams in entrepreneurial firms such as the ones in these five cases, it was observed that the during 2012 (i.e., during the very early stages of growth for 4 companies out of 5) had fewer established norms and processes to guide the company operations. Moreover, during 2012-13, most of those teams were relatively smaller than most other established firms. Implying to the fact that, an addition of just a single member had significant impact on the company's operations and functions. For e.g., Company D's Managing Director mentioned that they started their company primarily with two people who had pure technical backgrounds. They both didn't know how to acquire any clients and/or to retain them. There was a point in time around the end of 2012, where they were struggling with sales. During this time, they were introduced to Florieke who is still one of their current employees and handles most of their business operations. She brought in relevant industrial experience pertinent to aerospace and satellite systems. With work being delegated, both the founders could focus more on technical operations of the company while the Florieke aggressively focused on building a business team along with a strong marketing team in order to market their extremely unique nano and micro-satellites. A similar pattern of team member addition particularly as a resource seeking and skill gap bridging activity was observed in three other companies - company A, C and E. This observation resonates with the study by (Forbes et.al., 2006) which reflects back to the literature about team member addition as a resource seeking activity.

However, resource seeking behaviour in these spin-offs were not only common among the founders trying to build a company but was also observed as a common behaviour amongst the team who brought in pertinent network connections or partnerships in order to sought out necessary resources. For e.g., the interviewee at Company E mentioned that although they had a competent engineering team that shipped out such an innovative product that seemed like a product of the future back in 2012-13 but the most significant impact was made by our business team that made our company a global brand within the ocean platform transfer solutions industry was when they expanded our outreach through our different partnerships all across the globe. According to him, "..without our competent and highly resourceful team members these connections and partnerships in place Doha, Brunei, Singapore and Houston we wouldn't have been a reality today." This observation tightly resonates with the research done by (Sullivan and Ford, 2014) where they indicate how networks of entrepreneurial team members serve as a principal means of identifying and acquiring critical resources for their companies.

Moreover, throughout the interviews, addition of team members is also seen as the addition of different forms of human capital such as the team members' education (Forbes et. al, 2003), their industry experience, and research specific experience, etc (Khodaei, 2015). This addition of human capital not only sufficed the company's gap in skill set but also contributed towards forming new networks and/or towards the company's growth. But one common trend that was observed throughout all the 5 cases was that as they evolved through different developmental stages between 2012-17 the spin-off teams adapted themselves to meet any lack of skills or while venturing out to new product lines or moving to another geographic location by adding new team mebers and/or by changing their network partnerships to gather resources. In order to grow, the companies required different resources. Consequentially, the teams evolved, as did their capabilities. These evolving teams continuously led to the evolution of network connections to meet the changing resource requirements. However, for some companies there were instances where existing connections/relationships were maintained throughout the research period of 5 years despite of the evolution of team-formation during the same period. But in either instances, even though prior connections were kept intact for some companies, new ones kept forming with the changing resource needs in order to grow for almost all the cases. This observation is in line with a study by (Sullivan and Ford, 2014). For instance, Company C's primary target market was automotive, aerospace and marine vehicles design industry but as their teams' evolved they founded potential and demanding new market areas such as building physics solutions for architecture design houses. For the later market sector Company C had the pre-existing skills

to build a pertinent product for the new industry from their existing product line. So their team evolved by adding new team members who brought in specific industry and research experience and helped the company build new relationships that were critical sources of necessary market information for their new market segment. Moreover, as the demand for their product grew in the new sector Company C's network evolved over a period of 3 years (2014-17) to meet the rapidly changing trends in modern architectural designs. Moreover, the interviewee from company A indicated that during the 2014-17 period, they opened up branches in Rwanda and some other south-east Asian regions which led them to meet with increased demands. The similarity in the skill set throughout the team members in different regions thwarted their sales growth during 2014-17 period in comparison to the growth in 2012-14 period. They also mentioned that the lack of connections they had in those new territories, and the policies related to the bio-gas industry in those regions varied immensely from their existing market regions. So they decided to collaborate with two lobbyists within those regions who had great connections with the policy-makers there, ultimately directing them towards the right strategies to penetrate the market in those regions.

Moreover, it was also observed that effects of addition of some team members changed with the company stakeholders' growth expectations. This resonates with the studies from (Ensley, Pearson, Amason, 2002, Forbes et.al, 2005). So if the company's growth was in line with the expectations of the stakeholders then rather than focusing on immediate network evolution the companies focused on maintaining the existing network connections. But otherwise if the companies didn't meet the growth expectations they tended to change certain parameters such as addition or change of team members as well as network connections in order to meet the growth expectations. This observation is in line with the study by (Arenius and Laitinen, 2011) which indicates that in general, maintaining networks may be a difficult activity, and sometimes team members need to decide which network connections/relationships to maintain and which to drop. For instance, (Larson and Starr, 1993) emphasize on how team members select certain relationships and drop others, maintain some relationships and/or add new connections. This provides the notion that team members cannot spend time and effort on those relationships and networks if they do not provide access to the necessary resources.

One another note, Company B succeeded in the European market, during 2013-14, but they were struggling with marketing their product to the larger markets in the US and Canada. During their interview they mentioned that one of biggest reasons for this struggle was the lack of finances they had in order to reach out to those markets. However, one of their founders worked very closely with their existing investors, board advisors and parent institutions [TU Delft and YesDelft]. As a consequence of such relationships, they were able to bring in two new VCs (Venture Capitalists) that helped the company stay financially afloat and running. Finally in 2015, they got acquired by a huge company within the same industry ultimately leading them to be able to market their product to the larger markets while exploiting the already existing outreach of the acquiring company. As can be seen from these interview excerpts, this perspective resonates with companies overcoming critical junctures to move on to their next growth phase with the help of team members and exploiting the network connections. This is in line with Khodaei's work that founding team members consider support activities from their parent organizations/facilitators to be of paramount significance in overcoming critical junctures such as: funding, infrastructural facilities, management, business model creation, and being introduced into various other industrial networks. It also makes it easier for the founding team to access external resources.

Another interesting observation that was found was by observing the network maps found in (Chapter 4 - Results), it was observed that in three out of the five cases viz., Company A,C and E the network connections from different channels are not interlinked whereas in Company B and D most of the network connections and channels are interconnected to each other. Upon closer inspection of the network maps, one particular commonality that was found amongst Company A, C and E which could have led to their network partners to be less interlinked to network partners from another channel is because of two reasons: (1) Different network channels for Company A,C and E indicated separate geographical market regions which could lead to the fact as to why the network partners from different channels aren't linked while there is a homogeneity within the ones from a common

network channel; (2) Different network channels indicate different product/service lines.

In case of Company B and D, relatively a greater percentage of the network partners from both same or different network channels are interlinked to each other indicating to possible commonalities - similar market location, similar product/service lines leading to interlinked networks of connected suppliers, investors, consultants, etc. Moreover, our findings from the network maps show how homogeneity or heterogeneity amongst the links between network connections from both different and same network channels are key to the growth in different geographic locations and/or to build different product/service lines. In other words, it means that our findings show homogeneity and interlinked patterns between network partners from different network channels are present in companies operating within the same geographic locations and/or dealing with similar product lines, whereas, in some other cases where the companies are operating in different geographic locations and/or are dealing with different product lines have heterogeneous channels with homogeneous network partners within individual channels. This to the fact that for the former set of companies team members are more homogeneous in terms of experience and capabilities but for the latter set of companies utilized the capabilities of the different team members to focus on different market locations/geographies. This led them to have very tightly packed, independent but focused network connections. Whereas, Company B and D had intertwined network connections which could also indicate trust amongst different entities but could lead to highly competitive markets due to the availability of similar resources to many.

There is one last observation that seemed interesting enough to take notice of (despite the fact that it is an insight that is derived by observing the pre-test case study sample). Due to the fact that all our case study samples and the pre-test case have the same parent organizations, it was expected that some of the companies within our cases might have some overlapping network connections except their parent organizations. As expected company from the pre-test case study and company C have some common network connections. The only justification to this overlap is not due to the presence of same parent organizations but also due to the fact that the product from the company from the pre-test case needed the services provided by Company C in order to test their product's prototype design.

5.2. Conclusion

This paper explores how in high-tech academic spin-offs such as the ones in our case study sample, changing and adding even a single team member have a dramatic effect on both their company's network-formation and eventually its growth. Academic entrepreneurs need to create and maintain a good relationships with not only their parent organizations but also should evolve with the changing need of resources in order to grow and move from early developmental growth stages to scale up stages.

This paper contributes to scholars' understanding of how teams within high-tech academic spin-offs are able to identify, acquire and assimilate novel external knowledge and resources, and how they transform and exploit those resources to fuel the company's growth. In other words, due to the uniqueness and novelty of High-tech academic spin-offs they are relatively underexplored in terms of academic research in this field (Lazer and Katz, 2004) and studying team effects on networks and growth is a very new area. Our findings also show that next to technical and research experience, entrepreneurial team members should seek out new team members to fill in the skill gap between technical expertise and industrial/commercial experience. This may serve these spin-offs well by being able to transfer their technical and scientific knowledge to a marketable product. Therefore it seems evident to have addition of team with complimentary skills and experience to seek out necessary resources in order to succeed. Lastly, on of the most important points to ponder upon is that these spin-offs indicated different resource dependencies at different developmental growth stages, this led us to observe how teams and networks change as a reciprocal effect of the growth expectations by meeting the changing resource requirements. This led us to the interesting conclusion that this is a circular process in a loop.

Results from this study can also serve as a toolbox, where entrepreneurs can discover what benefits they can harvest from their through both their existing team members and through the addition of new team members, their existing network connections and/or by growing new connections to potentially utilize them as re-

sources channels. Based on these contexts and the findings it can be deduced that adding new team members with particular set(s) of capabilities and characteristics have helped develop the network connections in most of our case studies. This in turn has directly or indirectly aided towards signalling, building and acquiring knowledge and resources as necessary to sustain growth.

5.2.1. Limitations and implications for future research

Delimitation

The insights of this paper could be limited by the following factors:
1. The research sample consists of only High-tech academic spin-offs and not any other type of startup. Startups in a more commercial or social environment might produce different findings. That's why findings of this paper may only be reserved specifically for high-tech academic spin-offs, limiting the factor of generalizability of the findings to other types of startups. Further research on this topic with a larger data sample using both qualitative and quantitative methods is encouraged.
2. The research sample consists of firms situated only in one specific geographic location - Delft, Netherlands. Diversity in geography and cultural differences may play a vital role in a start-ups growth leading to the fact that similar research may yield different findings. This suggests that further studies in this topic in different locations or geographical context would lead to interesting insights into the fascinating world of high-tech academic spin-offs.
3. Samples for this research were selected only from TU Delft and/or Yes!Delft Incubator, which leads to the idea of homogeneity of initial resource types. Further studies with different universities/incubators could be a future research proposal.
4. Although, a critical question still remains unanswered, whether the evolution of the networks affect the team-formation or, does changes within the team-formation lead to the changes in the network-formations. According to (Mullen & Copper 1994; Lazer and Katz, 2004), there can be a bidirectional relationship between the two. However, there has been a great number of research done on the effects of network connections on team formation and growth but due to the relatively under-explored area of the vice-versa led us to explore the evolution of team-formations of High-tech ASOs and how they affect the changes in their network-formation in order to grow.

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6

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