Master Thesis

Improving Incubatee Evaluation at University Technology Incubators

The case of YES!Delft

T.H. Schijf

April 15

Improving Incubatee Evaluation at University Technology Incubators

The case of YES!Delft

Master Thesis Management of Technology

Faculty of Technology, Policy, and Management

Delft University of Technology

Thomas Schijf

4108043

April 15

Graduation Committee

Full Professor
Prof. M. (Marnina) van Geenhuizen
Professor of Innovation and Innovation Policy for the Urban Economy
Delft University of Technology
Section Economics of Technology and Innovation

First supervisor
Dr.ing V.E. (Victor) Scholten
Assistant professor in Technology-Based Entrepreneurship
Delft University of Technology
Section Economics of Technology and Innovation

Second supervisor
Dr. M. (Martijn) Groenleer
Assistant professor of Public Policy and Management
Delft University of Technology
Section Policy, Organisation, Law, and Gaming

Preface

This report is the end result of my Master Management of Technology (Faculty of Technology, Policy, and Management at the Technical University in Delft). I have to admit, writing it has been a rather difficult process. I made some major changes and choices along the way. University entrepreneurship turned out to be a complex topic, challenging to study. It took me a while to fully understand the key concepts, the highly fragmented literate related to this topic and the different incentives and motives of stakeholders.

So, before you start with the main course, I would like to speak out my gratitude to a few people, whom without this report would not even exist. Thank you, Daan Domhof, for your key inputs and reflection. Your insights helped to implement the actual results of the study. You also made me consider the values of YES!Delft more. Also, a special thanks to the three YES!Delft start-ups I have spoken with: AquaTech, CompositeTech, and WebTech. Your honest answers underpinned my conclusions strongly.

Furthermore, I thank my professor and supervisors. Marina, I appreciate your critical and well-substantiated feedback. Your expertise in the field of entrepreneurship and early growth at technology spin-offs really helped me to fully understand the complexity of high tech firm growth. Victor, thank you for the intensive support. Your insights really helped to write efficient and understandable. You made a good balance in letting me puzzle and giving specific directions in my work. The extensive research you already execute for years at YES!Delft is really valuable to my research. Martijn, I also would like to thank you for your valuable insights and feedback on the report. Like most multi-actor systems, also incubator evaluation is not a right or wrong process. Different values and believes are empowered between stakeholders. Your insights on decision-making in multi-actor systems really contributed to fully understand the concepts of the study in a wider context. Next, special thanks to my fellow study mate and sparring partner Pjotr Sillekens. Finally, many thanks to a much-loved person Lisanne Sanders. Lisanne, thanks for all substantive support and mental support.

Thomas Schijf, April 2015

Executive Summary

Support mechanisms, such as a university technology-based incubator [UTBI] have a significant role in the development of new technology-based firms [NTBFs] (Hippel, 1988; Thursby & Thursby, 2002). NTBFs have to deal with an increased number of challenges at their early stage of development (van Geenhuizen & Soetanto, 2009). UTBI can help by offering support in the most critical phase of development: the start-up phase. By providing a favourable environment for these companies it significantly reduces firm failure. In order to maximize the attainment of the incubator goal, UTBIs expect tenants to show a minimum growth within a given incubation time. It, therefore, applies strict incubatee evaluation practices. Currently, most leading technological incubators in the world evaluate their incubatees based on summative indicators, such as sales and size. Firms, who satisfy these criteria, are often further supported. On the other hand, for those who do not satisfy criteria, the support will be terminated after the incubation period. The question is, though: are summative indicators, like revenue or firm size, appropriate benchmarks for future incubation evaluation? Or should an incubator have a more balanced approach that better takes into account the heterogenic and nonlinear development of NTBFs? Aside from the heterogeneity, this might lead to the following problems:

1. *Ineffective evaluation through the selection of false positives*
2. *Inefficient evaluation sessions through homogeneous policy*
3. *Inefficient incubation trough missed support opportunities*

The objective of this study is to improve current incubatee evaluation methods that better take into account the dynamics of NTBF development. It provides an answer to the following research question: How can incubatee evaluation be improved within a university technology incubator? This research is executed for and based on the case of YES!Delft. YES!Delft is a Dutch UTBI that is focused on accelerating different types of NTBFs. YES!Delft currently applies a limited evaluation by offering a 3-year incubation period instead. However, well performing companies may apply for a growth incubation program. The criteria for these programs are based on a certain amount of revenue. YES!Delft, however, is looking to install a new evaluation program where incubatees are monitored at their early stage of development, or can proceed to the growth incubation program as they make a turnover of €200k. The fact the they ignore the nonlinear and complex development of NTBFs within YES!Delft, stresses out the importance of this study. The aim is to develop an improved incubation evaluation tool that can be used by YES!Delft. It needs to satisfy the following criteria raised by YES!Delft:

- The use of the tool should lead to better / faster achievement of the goals of YES!Delft.
- Realistic to implement
- Is not too costly to implement and maintain.

With the criteria and the problems in mind, it can be outlined what is needed to design a new tool. A better understanding is needed of NTBF development and different incubator/evaluation models. A literature study helps getting these insights (Chapter 2 and 3). Once a better understanding of NTBF development and different evaluation methods is obtained, empirical research will be used to get new insights required to develop the tool (Chapter 4 and 5). Finally, because the tool aims to solve a practical problem, a good reflection is needed regarding its implementation before it is able to draw conclusions (Chapter 6 and 7).

Chapter two describes that a UTBI offers valuable and costly resources, such as coaching, financing, and network, without asking considerable amounts of money from their tenants. A UTBI believes that NTBFs in the

long term will benefit and pay-off the investments made. In order to do so, UTBIs tightly control support to their tenants by evaluating the progress they make. Most UTBIs have selection and pre-incubation phases to evaluate the potential of start-ups beforehand. During the incubation period, it is evaluated whether the support granted had an effect on the development of the start-up. Last, after the incubation period it is evaluated whether the incubatee was able to grow and to contribute to the attainment of the incubator goal. It can be argued that at earlier stages the incubator rather evaluates incubatees by looking at what is needed, while at later stages the incubator evaluates incubatees by looking at what is achieved. Chapter three describes that the development of NTBFs can be classified into different stages. It describes how different NTBF characteristics might lead to differences in needs and, hence, can influence duration of stages. A conceptual model is constructed that will be used as input for further research. The conceptual model suggests that R&D focused firms have higher business and network needs, capital-intensive higher network and finance needs, and growth oriented higher finance needs.

Chapter four describes that the data is collected through a survey among the 72 YES!Delft incubatees and interviews held with three individual start-ups. The data of the survey is used to get a better notion of the overall firm needs during its stay in the incubator and the needs per different type of NTBF. The data from the interviews is used to substantiate the survey outcome and to see if there are other factors that are important to take into consideration when evaluating incubatees. Because the study is limited to only one incubator, results are expected to be low in generalizability, but high in reliability. The results of the quantitative research in chapter five describe that network needs of a start-up remain high until it reached its commercialization phase. Furthermore, it describes that finance needs remain relatively high over the entire incubation period. It is also shown that business needs drop gradually. Furthermore, it seems that R&D focused firms deal with a greater extent of having business and network needs during their incubation period. Together with the capital-intensive firms, they have increased finance needs for product/technology development related activities. The results of the interviews add that not all the needs, which, in theory, can be satisfied by the support from the incubator, are high at earlier stages. Firms that are still in their development phase often need much time to develop their product/technology before they need support in financing, networking or coaching. The study concludes that better incubatee evaluation can be reached when:

1) The incubator carefully takes into account the development stage and characteristics of the different technological start-ups when evaluating them.
2) Applies continuously monitoring at early incubation, the incubator should evaluate whether firms have the ambition to grow or require more time for development and testing. The latter, at these firms the need for support might not be directly visible and are spread in time. But might be apparent when they enter the commercialization phase.
3) At late incubation evaluation moments, the incubator should evaluate whether certain types of firms have led to a delay in development. It is found that R&D focused firms deal with a greater extent of having business and network needs during their incubation period. Together with the capital-intensive firms, they also have increased finance needs for product/technology development related activities. An incubator needs to balance the support and quicker respond to the needs of these companies to let them grow quicker.

Limitations can be remarked in data, measurement, and theory. Last, it is recommended to YES!Delft follow the above stated conclusions. They currently differentiate to a limited extent between different types of NTBFs. Having a more flexible attitude in evaluation towards the highly R&D focussed and capital-intensive firms maintains the strong diversity and culture of YES!Delft, but improves decision-making after evaluations.

Abstract

University technology-based incubators (UTBIs) have an important role in the development of new technology-based firms [NTBFs]. By providing a favourable environment for these companies it significantly reduces firm failure. In order to maximize the attainment of the incubator goal, UTBIs expect tenants to grow within a particular time. It, therefore, applies a strict incubatee evaluation practice that evaluates which incubatees show sufficient commercial viability to get further support and which ones do not. However because of the heterogeneity in development paths between NTBFs, considerable differences exist among incubatees. Slow growing NTBFs are not always a direct sign of lower commercial viability. Instead, these companies often show a slow commercial growth in their early stage but can grow out to large cooperation's later on. These firms often need the intensive support from the incubator before they can show such growth. The question that arises: are summative indicators, like revenue or firm size, appropriate benchmarks for future incubation evaluation? Or should an incubator have a more balanced approach that better takes into account the heterogenic and nonlinear development of NTBFs? Not taking into account that this might lead to ineffective and inefficient evaluation and thus inefficient incubation. The study calls for an improved incubatee evaluation method that better take into account the dynamics of NTBF development. It provides an answer to the following research question: How can incubatee evaluation be improved within a university technology incubator? The study concludes that better progress evaluation can be reached when the incubator carefully takes into account the nonlinear development NTBFs. Firms that deal with long periods of technology/product testing, might be not need extensive support. This implies that they might need support at a later stadium, to grow the business. Also, capital-intensive firms or firms with a strong focus on R&D have higher incubator needs for support. Evaluators should be well aware of this when evaluating their potential.

Keywords: university technology incubator, new technology based firm development, incubatee evaluation

Concepts and Definitions

Benchmark – Criteria used to benchmark growth during an incubatee evaluation. It typically entails a measure of revenue or firm size.

Business needs – The firms' needs to solve organisational problems (administrative, financial, strategy advice) that can be satisfied with business coaching.

Capital-intensive firms – Firms that deal with expensive technology development and production techniques, resources, assets, and tools.

Coaches – Often assigned by the incubator management team, coaches are experts from the industry who are (often voluntary) willing to help incubatees developing their business by making their expertise explicit.

Evaluation – events led by the incubator management team or coaches in order to assess the current status and reflect on the progress made by the start-up. The aim is to improve the development of the incubated firm.

Firm needs – The incubatees' support desires for start-up problems that can be satisfied by the incubator. In the context of an incubator, need comprises business, finance, and network needs.

Finance needs – The firms' need to obtain finance that can be satisfied with monetary support from the incubator such as providing them with a bank loan or investment.

Growth-oriented needs – Firms that have a strong focus on rapid growth. They rely on well-developed technologies and experienced entrepreneurial teams that can realize this growth.

Incubator graduation policy – the policy used by the incubator management team. The policy describes when incubatees are ready to enter the next incubation phase or need to graduate and leave.

Incubatee – Also called incubated firm or tenant. An incubatee is a start-up that rents a temporary office in an incubator and receives hands-on support accordingly.

Incubatee evaluation – Assessment that is taken by the incubator management team on behalf of the sponsor at incubatees that aims to assess the progress the firm made. Incubatee evaluation is focused on assessing if the incubatee was able to commercialize its technology and to contribute to the attainment of the incubator objective. Estimation to which point an incubator needs to grant support to the incubatee. This because incubators are expensive to operate, if at a sudden point it turns out that the incubatee, in theory, can stand on its own feet, a prolonged stay implies that the incubatee holds a valuable spot that cannot be used by someone else.

Incubator management team – Those who are responsible for (daily) incubator organisational issues such as selection, graduation, planning events, administration and budgeting.

Main incubator sponsor – Refers to the owner(s) of the incubator. The consortium often consists out of the neighbouring university or research institution, the local municipality, and/or the national government. Besides the main sponsors, there are also other sponsors connected to the incubator such as banks and legal, consultancy, and administration companies. These companies sponsor services by offering them at lower

costs. In the case of YES!Delft, the main sponsors, are the University of Technology in Delft, research institution TNO, and the municipality of Delft.

Network needs - The firms' need to get in contact with customers, investors, partners or other relevant parties that can be satisfied by making used of the incubator network.

New technology-based firms [NTBF] – Start-up companies that make use of sophisticated and science-backed technologies developed in collaboration with technology universities or research institutes.

Progress – In the context of an incubator: the firms' shift from having many needs to lower needs. In the context of an incubatee: the development the firm is making in its path towards commercial growth.

Sophisticated and science-backed technologies – Technologies that in most cases originate from scientific environments such as universities or research institutions, and are developed without necessarily having commercial applications.

R&D focused firms – Firms that have a strong focus on technological leadership and exploiting innovations and, therefore, execute intensive research and development.

Tenant – see incubatee.

University technology-based incubator [UTBI] – Also called university incubator or simply incubator. It refers to the physical building where incubatees are located to develop their business, often with the support and resources offered by the incubator. Compared to, for example, business incubators, university incubators are characterized by the fact that they have a nearby university who is in most cases also one of the sponsors

Contents

Tables and Figures

1 Introduction

1.1 Research background

New technology-based firms [NTBFs] have an important role in stimulating the development of the region in terms of employment and economy (Etzkowitz, 2002). NTBFs commercialize new technologies by pursuing strategies of internationalization, R&D rationalization, business diversification, and partnering (Donckels & Segers, 1990; Granstrand, 1998). These technologies attract well-schooled employment that, in its turn, attract other NTBFs and other companies that want to make use of knowledge spill-overs present in the area (Cooke, 2004).

Before an NTBF obtains such position its development is far from certain. The development of its new technologies take a long time to develop and bear many risks (Grübler & Messner, 1998; Harrison, Mason, & Girling, 2004; Lindstrom & Olofsson, 2001). For example, NTBFs face difficulties in the research phase when entrepreneurs often need to work with complex and not well-understood technologies (Stankiewicz, 1994). In addition, they often require large amounts of upfront investments before any proof of concept of market viability is shown (Autio & Yli-Renko, 1998). Hence, banks often discard loan proposals for these types of firms; for this reason finding funding will make the development even more uncertain (Lindstrom & Olofsson, 2001).

In addition, the new technologies that form the basis of such NTBFs often originate from university research projects. Although the intention of such projects is in many cases academically driven, there are often many commercial applications thinkable for these technologies. In such situations academic spin-offs derive. These academic spin-offs even deal with greater obstacles (van Geenhuizen & Soetanto, 2009). Their success is critically dependent on the presence of key players, such as investors and customers, but also on their capabilities to interact with them (van Geenhuizen & Soetanto, 2009). Thus, NTBFs have to deal with a larger number of start-up problems or obstacles. It is, therefore, no surprise that many NTBFs fails (Kirihata, 2007).

Support mechanisms, such as a university technology-based incubator [UTBI] or university incubator for short, play a significant role in solving these start-up problems. This way the incubator acts as a mediator or direct supplier of resources without substantial costs (Rothaermel & Thursby, 2005a; van Geenhuizen & Soetanto, 2009). Especially firms in high-tech areas, such as biotechnology or nanotechnology, seem to benefit from the university incubator. These kinds of start-ups often rely on scientific research, which in most cases can only be accumulated in such areas (Lindstrom & Olofsson, 2001; Zucker, Darby, & Armstrong, 1998; Zucker & Darby, 2006). As a result, firms, that started their business in a UTBI, have shown to perform better in terms of "adoption of advanced technologies, aptitude to participating in international R&D programs, and establishment of collaborative arrangements (especially with universities)" (Colombo & Delmastro, 2002). NTBFs positioned in an incubator show higher survival and growth rates compared to non-incubated NTBFs. According to data from the German Association of Technology Centres (Glaser, 2005) the survival rate of

NTBFs in technology incubators is around 90%. In literature, the survival rate of incubatees on science parks[1] is 93.3% (measured in a period of 7 years) versus only a 66.7% survival rate of the off-park firms (Schwartz, 2013).

A UTBI can provide support during the critical phase of development: the start-up phase. It can deliver valuable resources and services, such as a network, financial support, business coaching, and a physical residence (Hackett & Dilts, 2004a). This way, the incubator enlarges the growth potential of its tenants while keeping the costs at minimum (Lalkaka, 2000). As start-ups often do not have the resources to pay for these costly resources and services, the incubator offers these services far below market rents (Hamdani, 2006). Generally, NTBFs can make use of facilities and services often by paying a small rent only to cover the main overhead costs (Aaboen, 2009). The incubator uses the possible growth potential of its incubatees as a proxy to generate income over the long-term (Etzkowitz, 2002). As said, NTBFs have great potential to boost the economic development in the region. The attraction of well-schooled employment and settlement of innovative companies close to the incubator, as a result of NTBF development, is seen as 'income' for the UTBIs' main sponsors[2]. These sponsors have paid for the realization of these services and facilities and thus expect to see something in return.

The incubator applies strict incubation control mechanisms, such as selection and interim evaluation practices to funnel potential. These mechanisms are used to get a better grip on the realization of their return (Bergek & Norrman, 2008; Bizzotto, 2003). Selection is a strong and simple method to distinguish the most potential firms in advance (Bergek & Norrman, 2008). By looking to for example team composition, technology, and ambition the most potential firms are admitted to the incubator program. In contrast, interim evaluation as a control mechanism is more complicated. Just like investments, start-ups (and technological start-ups in particular) are in most cases not able to show a return on the first day. Indeed, these start-ups deal with a period of product and business development before they can prove commercial viability (Kazanjian & Drazin, 1989). Therefore, the incubator typically provides its incubatees with an incubation period of two to three years (Schwartz, 2009). In this period, the start-up gets time to develop its technology and business. Because most firms do not generate a turnover on day one, the incubator can only measure development in terms of milestones. It is key that these milestones stipulate a path towards commercial growth (Bizzotto, 2003). Because it is important for an incubator that firms eventually turn into high-growth ventures, the incubator offers subsequent growth programs for those who satisfy a certain growth. These programs are open for those who have reached a certain turnover or firm size level (Kakati, 2003; McGee & Dowling, 1994; Mian, 1997).

Thus, evaluation of incubatees is an important element of modern incubation. However, looking at the current UTBI landscape, no incubator really takes into account the complexities and difficulties associated with the firm development in such environments. What makes evaluating for incubatees so complex is that there is often a high diversity of academic start-ups within a university incubator, all showing a different growth path. The development path of these firms is in many cases also non-linear (Vohora, Wright, & Lockett, 2004). This implies that firms might fall back to previous development stages. It is difficult to determine a firms' potential, when some firms or industries need more time to develop and are unable to show growth potential.

[1] A science park is the area around a university where besides the university also innovative companies and research facilities are

[2] Main sponsors of UTBIs typically consist out of a consortium of the university or research institute in collaboration with a local or regional government (Viale & Etzkowitz, 2010).

1.1.1 Practical Problem

Currently, most leading technological incubators in the world evaluate their incubatees based on summative indicators, such as sales and size. Firms, who satisfy these criteria, are often further supported. On the other hand, for those who not satisfy criteria, the support will terminate after the incubation period. The question that arises: are summative indicators, like revenue or firm size, appropriate benchmarks for future incubation evaluation? Or should an incubator have a more balanced approach that better takes into account the heterogenic and nonlinear development of NTBFs? Not taking into account that this might lead to ineffective and inefficient evaluation and thus inefficient incubation.

As a result, the practical problem is that evaluation practices, currently applied at the most leading UTBIs, do not take into account the complexity and nonlinear gestalt of technological start-ups. As stressed out above, especially academic start-ups belong in this category. These firms often deal with years of development before showing sustainable returns (van Geenhuizen & Soetanto, 2009). Consequently, these companies need extensive support related to the development of their technology and finding the right parties. If the evaluation team (those who evaluate incubatee potentiality or its progress towards it on behalf of the incubator) has a limited understanding about the underlying principles of start-up growth, three major adverse effects might happen:

- *Ineffective evaluation through the selection of false positives*. For an incubator it is important to assist the most potential firms. Having a limited understanding about NTBF development, leads to a wrong identification of potential. Currently, most UTBIs look at firm size and sales as indicators for firm potentiality. However, it can be questioned whether firms, that did not show commercial growth in the first years of development, are really not potential in the long run. Often the companies, that are not or marginally able to meet sales targets in their first development period, work with new technologies that require intensive R&D. These firms have larger start-ups problems, because they also deal with newer and more innovative technologies. However, these innovative firms are also those holding a much greater potential in the long run (Buisson & Silberzahn, 2010). Conversely, it can be questioned if companies, that appear to grow rapidly, continue to grow in the future as well. Also, do these companies owe their rapid growth to the fact that they work with existing technology? In order to grow in the long term as well, it is important that the technology is disruptive. If an incubator insufficiently take into account the complexity and dynamics of NTBF growth, it might select those firms that appear to grow rapidly, but will stagnate quickly because they deal with non-disruptive technologies, and neglects those firms that deal with long periods of development and might become fast growing innovative companies on the long run.
- *Inefficient evaluation sessions through homogeneous policy*. With a limited understanding about the complexity and dynamics of NTBF growth, chances are high that all NTBFs are treated homogeneously. Implying that all firms need the same amount of time for certain actions or achieving milestones. Evaluation sessions are both costly and time consuming for incubator and incubatee. If an incubator understands the development of each incubatee, it is possible to more dynamically plan evaluation sessions per type of NTBF. Furthermore, with a better understanding of the time required for certain actions or milestones of different NTBF types, the incubator also knows what possibly may harm the firm from achieving it. For example, firms that depend heavily on field tests might be hampered from bad weather conditions. In this case, the firm is affected by force majeure. The incubator can then postpone evaluation sessions even more, to save the incubatee time.

- *Inefficient incubation through missed support opportunities*. With a better understanding of NTBF development the incubator knows what is needed to support the firm. It could be that the incubatee was able to grow quickly, if certain support at hand was granted. The aim of incubatee evaluation is not only to look at the progress, but also at ways to boost it. If an incubator knows when and what kind of support is needed for which type of firms, both incubatee and incubator benefit.

The criterion for a solution to this problem is that the incubator needs to have a more balanced and diversified approach in evaluating the firms. There are different types of industries present within an incubator. Each firm follows its own road to success. In this case, companies that grow more slowly in their first years of existence are not necessarily non-potential. On the other hand, firms that grow more quickly in their first years of existence are not necessarily potential; these firms might fall back to a previous stage where more R&D is required. A solution that does not take into account the diversity and understanding the different growth patterns may lead to inefficient and ineffective incubation.

1.1.2 Research Problem

It might be evident that yet little is known about the complexity of NTBF development. As already stressed out by Geenhuizen (2009), in the past few years a debate has emerged on how efficiency of incubation programs can be improved by taking into account the different needs of technological start-ups (Mustar et al., 2006; Wright, 2007). It is also recognized that due to the large start-up development heterogeneity (caused by different entrepreneurial background experience and R&D intensity) this is found very difficult (Druilhe & Garnsey, 2004; Heirman & Clarysse, 2004).

An increased number of studies address ways on how to make the incubator more efficient by discussing the longitudinal demands of different technological start-ups (McAdam & McAdam, 2008; Vohora et al., 2004). However, until this day there are no theoretical handholds that describe how these demands can be best evaluated in the context of an incubator. In other words, a gap in the literature can be identified where through empirical research one has given an answer to the question until which point an incubator needs to support its incubatees. On this way, the incubator can make more certain about evaluation decisions on further assistance.

1.2 Background YES!Delft

This study is entirely focused on the case of YES!Delft. YES!Delft is probably one of the most leading university technology-based incubators in Europe. YES!Delft is a UTBI located in Delft close to the Delft University of Technology. Since 2005, the YES!Delft incubator has given shelter to over 140 NTBF's of which 70 are still active in the incubator (YES!Delft, 2013). Since the start, these companies together made €60 million turnover and created nearly 800 new jobs in sectors such as the IT, energy, biomedical, industrial, and consumer discretionary sector (YES!Delft, 2014). YES!Delft is an initiative of the University of Technology in Delft, the municipality of Delft (Gemeente Delft) and research center TNO. These parties act as the main sponsor of the incubator. With its location close to the University of Technology in Delft, YES!Delft is the ideal place to transfer science-backed technologies into commercialization. With their joint aim: 'Building tomorrow's leading firms' the incubator is focused on supporting high potential NTBFs during their early and growth stage of development. The focus is not on admitting as many starters as possible, but only on admitting qualitatively excellent start-ups instead. By doing so, they aim to realize the largest firm growth for these firms in the least amount of time. On this way they eventually hope to maximize the economic growth and investment climate in the region (YES!Delft, 2014, TU Delft Agenda, 2013).

Also, at YES!Delft, firms can make use of expensive resources, such as business coaching, networking and (research) facilities[3] by only paying a small rent. Whatsmore, YES!Delft has a great funding scheme: new entrants can obtain a loan of €15.000 offered under highly favorable conditions. Namely, firms do not have to pay back the loan if the firm folds. On top of that, many investors and financiers are connected to the incubators' network making it easy for firms to get quickly in contact with these parties. In order to know what the real value is to the support of YES!Delft, I executed an initial explorative study. The results of his study suggest that the added value of YES!Delft, compared to, for example, the industry, is small[4] (*Appendix I*). Most firms obtain support from the industry rather than from the incubator management team, other starters in the incubator or coaches. As it turns out, especially younger start-ups benefit from support granted by YES!Delft. Expected is that the network and coaching available at YES!Delft provides great benefits for the younger firms. However, as start-ups mature, they become more dependent on specialized industry support, and, hence, can only be supported by industry players or specialized consultancy.

In order to make sure that the support is mobilized efficiently (e.g. provide support to those who show the largest growth potential), also YES!Delft applies several evaluation practices. At the entrance, firms are evaluated based on the level of technology newness or newness of the technological application. YES!Delft also checks whether the firms have the ambition to become a *leading firm*. Last, YES!Delft also assesses if there is a business model present around the technology. If a firm does not have a proper business model yet but has a team and technology, the firm is admitted to a special pre-incubation program. Here, firms will create and further refine their business model. Once admitted to the incubation program all firms receive an incubation period of 3 years to prove themselves. Currently, incubatees are evaluated after a period of 3 years whether they successfully utilized the resources of YES!Delft and if it was able to grow. If the firm is ready to scale the business YES!Delft postpones the stay of the incubatee. YESDelft applies a mix of variables (employment, revenue, key players, IP etc.) that indicate if a firm is ready to scale. In case the firm makes a turnover of at least a million incubatees are invited to participate in the growth program[5].

Partly because of the increased capacity of YES!Delft (due to the opening of the new facility in 2010) the incubator moderated their policy. As a result, no firm had to leave after the three-year period. Indicating that till now, every tenant is found ready to scale after a period of three years. At the moment, incubatees within YES!Delft show an average revenue of €230.000 after three years. In the near future YES!Delft is aiming to apply a stricter '*grow or go'* policy. Implying that the firm needs to show commercial growth in order to remain in the incubator. In this case, the 3-year incubation period will be maintained, but if the incubatee is unable to reach the €200.000 annual turnover it needs to leave. Firms that satisfy this 200k threshold somewhere during this period are further supported.

Prior to the research was spoken with Daan Domhof (incubation manager at YES!Delft). On the 18th of September 2014, he declared that YES!Delft had the following problems associated with the development of an improved evaluation method:

1) They have currently limited understanding of how to deal with slow growers compared to the fast growers regarding the allocation of support. In the near future they will thus give priority to firms that

[3] Often in collaboration with the Delft University of Technology (Molleman & Strijbosch, 2014)

[4] The support obtained by start-ups came in 15% (average) of the cases from the YES!Delft team, 20% from the university, 10% from other starters, and 25% from the industries (averages calculated from the figures in *Appendix I*).

[5] Growth program is designed by YES!Delft in collaboration with Port4Growth and Syntens. This program helps firms with more strategic problems by means of coaching, workshops, and training(YES!Delft, 2013).

are quickly able to make revenue of 200k, but nothing is known yet if these firms really (still) need the incubator.

2) At the basis of this problem is that they have currently insufficient understanding of the growth process of different starters. It can be asked whether fast growers are different in nature/industry compared those who grow slowly. In respect to evaluation, should priority go to enhancing the support for these groups or not?

If YES!Delft really turns towards a growth-based evaluation ('*grow-or-go*'), it is of high important that it has a more balanced way of evaluating (as stressed-out in 1.1.1) in which the differences in growth and long-term outcomes between different types of start-ups are well-considered. Furthermore, YES!Delft declares that an solution towards the problem should at least satisfy the following criteria:

- *Using the tool should lead to better / faster achievement of the goals of YES!Delft.*

  It is important for YES!Delft that companies become '*Tomorrow's leading firms*.' YES!Delfts' way of achieving this is to accelerate the development process of firms. When installing new evaluation practices firms may not adversely contribute to achieving the incubator objective; i.e. because of the new evaluation method overall firms grow less rapidly as before.

- *Realistic to implement*

  Though the evaluation team consist of experts, they do not have a complete understanding of what is precisely going on and what is best for each start-up. It is a fallacy to expect from the evaluation team they will have this understanding in the future. The solution must fall within the current ability and knowledge of the incubator.

- *Is not too costly to implement and maintain*.

  The services of YES! Delft are costly but are offered to start well below market value. Coaches help start-ups often pro-bono. YES! Delft is arranged so that under minimum cost (for starter and incubator) maximum impact can be achieved. The tool must fit into this notion. YES!Delft describes that the tool needs to be maintainable and scalable. Evaluation methods that are too costly to maintain are difficult to scale as the capacity of YES!Delft is expected to grow in the next year.

1.3 Research Objective and Questions

The study calls for a better way of evaluating incubatees. As the problem suggests, current UTBIs insufficiently take into account the diversity and complexity of NTBF development. As a result, this leads to inefficient and ineffective evaluation and thus incubation. In doing so, the study is aimed to improve current incubatee evaluation practices within technological incubators. The goal is to develop a tool that can be used as a handhold by incubation managers to improve incubatee evaluation. Because this study addresses the case of YES!Delft, the tool will be especially designed for them. They will also formulate the criteria as input for a new tool design. Overall, the present study aims to formulate an answer to the following research question:

RQ: How can incubatee evaluation be improved within a university technology incubator?

The sub-questions [SQ's] help with finding support that eventually make it possible to formulate an answer to the main RQ.

SQ1: What is an NTBF in the context of a UTBI?

SQ2: What is a UTBI in the context of an NTBF?

SQ3: What are the various incubatee evaluation practices in the world and what are the benefits and shortcomings of these?

SQ4: What types of NTBFs are present within a UTBI?

SQ5: What are the NTBF development phases and how are they measured?

SQ6: What factors play a role when evaluating incubatee development in an incubator?

1.4 Literature Review

This section addresses papers related to the subject of this study. To start, it has to be stated that there are limited studies discussing incubatee evaluation. In literature, evaluation of start-ups in an incubator is also described as assessment of the incubated companies, performance measurement or (continues) monitoring (Barbero, Casillas, Ramos, & Guitar, 2012; Wong, Cheung, & Venuvinod, 2005)(Wolfe 2000; Kumar & Kumar, 1997). Although the concept is formulated differently, they all describe the same phenomenon and take place either during or after the incubation period. Furthermore, 'screening' is a term frequently used in literature. Screening refers to the assessment of firms at entry or selection of incubatees (Lumpkin & Ireland, 1988).

One can distinguish two perspectives on incubatee evaluation. The paper by Barbero (2012) describes incubatee evaluation as a sub part of the incubation process. The author analyses several incubators and quotes several papers that discuss elements of incubatee evaluation within these incubators. Wong (et al. 2005), on the other hand, describes incubatee evaluation as an integral part of the incubation process and compares it with the process of artificial chick hatching. The author describes metaphorically that the incubation process of start-ups is comparable to those of chick embryos in an artificial environment. According to Wong the increased start-up growth within an incubator can with high certainty be imputed to the support of the incubator. Therefore, funnelling of the 'right' start-ups all comes down to deploying strict evaluation practices. Wolfe (2000, p. 6) underpins the importance of the objectives of evaluation. Kumar and Kumar (1997, p. 19), then, describe how evaluation moments should be arranged in practice (in terms of the number of persons that take the evaluation). They for example describe that the evaluation at earlier stages are done by 3 to 6 coaches or mentors, whereas evaluations at older stages typically are taken by 3 incubation managers.

To fully understand the context and application of incubatee evaluation at a university incubator, this study also addresses several university entrepreneurial studies. It can be argued that these studies are currently highly fragmented (Rothaermel, Agung, & Jiang, 2007). Until recently, researchers did not succeed in systematically analysing the effects of the university on start-ups (Hackett & Dilts, 2004a). The scientific exploration of the incubation domain has evolved gradually. While the incubator itself developed from the 1960s onwards, it took until the mid-1980's before researchers concluded with a general accepted description of the incubator and its characteristics (Rothaermel et al., 2007). Later, during the late 1980's and the beginning of the 1990's, research expanded itself to the classification of the different types of incubators, where different policies and selection procedures were discussed (Hackett & Dilts, 2004a). It also discussed several incubator components and their mutual coherence with the incubator system. During this same period also the several incubation development studies took place, focussing on new venture development and

impact of planning on development. During the late 1990's, the impact of an incubator was examined. Researchers here aimed to describe the level and unit of analysis and outcomes/measures of incubators' success. During the last decade, many studies focused on analysing the development of the incubatees themselves (for an overview of the results see *appendix II*). The Last, the fifth stream consists studies that aim to theorize the incubators. Most recent studies describe the incubation processes on a macro level using explicit and implicit formal theories (Hackett & Dilts, 2008). The authors add that the research stream of incubatee development (firm level) remained rather undeveloped. This can be explained by either the lacking presence of a common analysis unit (Rothaermel & Thursby, 2005a), and the fact that one found it hard to obtain and generalize data from early stage ventures (Hackett & Dilts, 2004a). It is indeed hard to assess which incubator practices have lead to which performance, when both incubator characteristics and the nature of start-ups differ from one another (Phan, Siegel, & Wright, 2005).

This study argues matters of and within the university incubator. The literature describes that the university incubator, in particular, is different to traditional business incubators or corporate incubators (Etzkowitz, 2002). Burnett and McMurray (2008) described an incubator model that best describes the overall functioning such university incubator. It shows how, on a system-level, the UTBI attains its objective by providing a nurturing environment for technological start-ups. To maintain this model, they apply strict evaluation measures (McMullan, Chrisman, & Vesper, 2001). Assistance programs are expensive for both incubator and incubatee. Consequently, there is a good reason to evaluate them (p.37). One of the reasons why incubatee evaluation is underexposed is presumably because measuring the effectiveness of such assistance programs is difficult due to the dynamics of growth (Sherman, 1999). In the university incubator model, it is important that an it carefully considers the needs of an individual incubatee and, from there, decides how an incubator can fulfil those needs (Colbert & Association, 2010). When an incubator performs a better need identification it is creating a benchmark framework for new and current incubatees and whether the program offers adequate adds value. It increases the incubatees' perception of the incubator and "*clarifies actions to be taken and resources to be mobilized by clients and the incubator staff*" (Colbert & Association, 2010).

This study also describes the dynamics in technological start-ups' growth. In literature, Penrose (1959) is one of the first to comprehensively describe firm growth. Penrose was interested in addressing the limits of growth. These limits gave birth to a number of organizational studies that addressed the process of the growth process based on structural changes or shifts in age and size. These structural changes were discussed in many cases using the life-cycle theory (Garnsey, 1998; Greiner, 1972). The life-cycle theory made it possible to discuss the growth of technological firms separately from regular firms. Kazanjian (1989) was one of the very few that successfully described the growth process of an NTBF based on such a life-cycle (besides Dodgson, 1991; Rothwell & Dodgson, 1991). Kazanjian (1989) described NTBF growth based on the presence of several dominant problems occurring at different stages. The presence of these problems made the development uncertain, which in its turn resulted in a higher heterogeneity in development paths (Aspelund, Berg-Utby, & Skjevdal, 2005; Rizzo, Nicolli, & Ramaciotti, 2014; Rizzo, 2012). The study by Garnsey (2002) identified six generic NTBF development patterns in order to get a better understanding of the heterogeneity (Garnsey, 2002). Most NTBFs deal with technologies that derive from an academic context. Vohora (2004) developed a model that theoretically describes the development of academic spin-offs. These spin-offs start in the research phase, but before they are able to make sustainable results they have to deal with generic obstacles such as lack of opportunity recognition, entrepreneurial commitment, credibility, and sustainability. Apart form the lifecycle theory literature discusses firm development in the lens of the resource-based view [RBV] (Barney, 1991). The RBV theory describes that a unique bundling of resources leads to the creation of a unique competitive advantage. With a strong unique competitive advantage the firm is able to generate sustainable

returns. In the context of an incubator, the incubator can help firms to build this competitive advantage but should not become the firms' competitive advantage. In case the incubator becomes the competitive advantage, other firms or countries can replicate the incubator model. The incubator thus withholds the firm from generating sustainable returns.

Concluding, there are three important aspects associated with incubatee evaluation:

- ☑ First, the perspective on incubatee evaluation is bilateral. There are incubators that consider incubatee evaluation as subpart (as discussed by Barbero 2012) or as an integral part of the incubation process (as discussed by Wong 2005). The incubators' perspective on incubatee evaluation strongly influences the urgency to revise current incubatee evaluation practices. If evaluation is an integral part of the incubation process the urgency is expected to be much higher.
- ☑ Second, Incubatee evaluation has an important role in reaching the incubator objective (Colbert & Association, 2010). It is important to understand how different perspectives of evaluation lead to the achieving which incubator objective.
- ☑ Last, the development process of technological start-ups can be described based on theoretical lifecycle models. Development models of NTBFs mainly describe the development of technological start-ups in terms of dominant problems or barriers to growth (Kazanjian, 1988; Vohora et al., 2004). In supportive environments, as in the case of an incubator, it is important to discuss how evaluation affects the development of these firms and visa versa.

1.5 Research Approach

The research objective is thus to design a tool that improves current incubatee evaluation. The following research approach is considered (*Figure 1*). To frame the problem a preliminary literature study was executed. Also an interview was held with a leading technology incubator. Based on this interview the problem was identified and criteria for a possible solution to this problem were raised. Next, because evaluation is a practical activity, the aim is to develop a tool that can be used by incubator managers and evaluators. Next, literature and empirical research form the basis of the new tool design. The last step is to assess whether the new designed tool forms a solution to the current problem and satisfies the raised criteria. Incubation managers will review the tool. Based on this it is possible to draw conclusions and give an answer on the main research question.

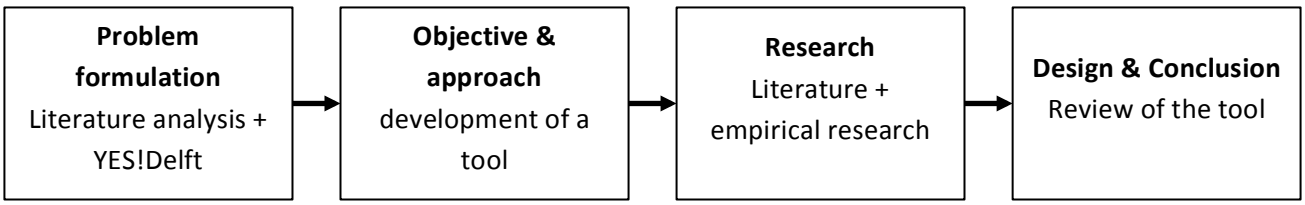


Figure 1: Research approach

Tool Development

Section 1.1 - 1.3 well addressed the problem and the objective. The next step is to provide an outline of the tool design. As stressed out above, the criteria raised by YES!Delft and observations (problems) from a preliminary literature analysis form the input of the new tool design (*Figure 2*). On one hand, it is observed in the literature that current evaluation leads to ineffective and inefficient incubation when limited attention

goes to the complexity and diversity of NTBF development. The criterion for a new tool should take into account the diversity and nonlinearity of NTBF development. On the other hand, from a practical point of view the tool needs to be realistic to implement, affordable, and maintains/improves the attainment of the current incubator objective. The design of the new tool will be in the form of a schematic framework. Incubator managers and evaluator can use the framework to better evaluate their incubatees. The tool includes a list of practical recommendations an incubator manager can respond to. Finally, a feasibility test will be executed to analyse if and how it is possible to implement the tool. Feasibility gives the outcome of the report more weight. Having clear insights in the benefits and shortcomings of the new tool makes considering the implementation of the new tool more accessible.

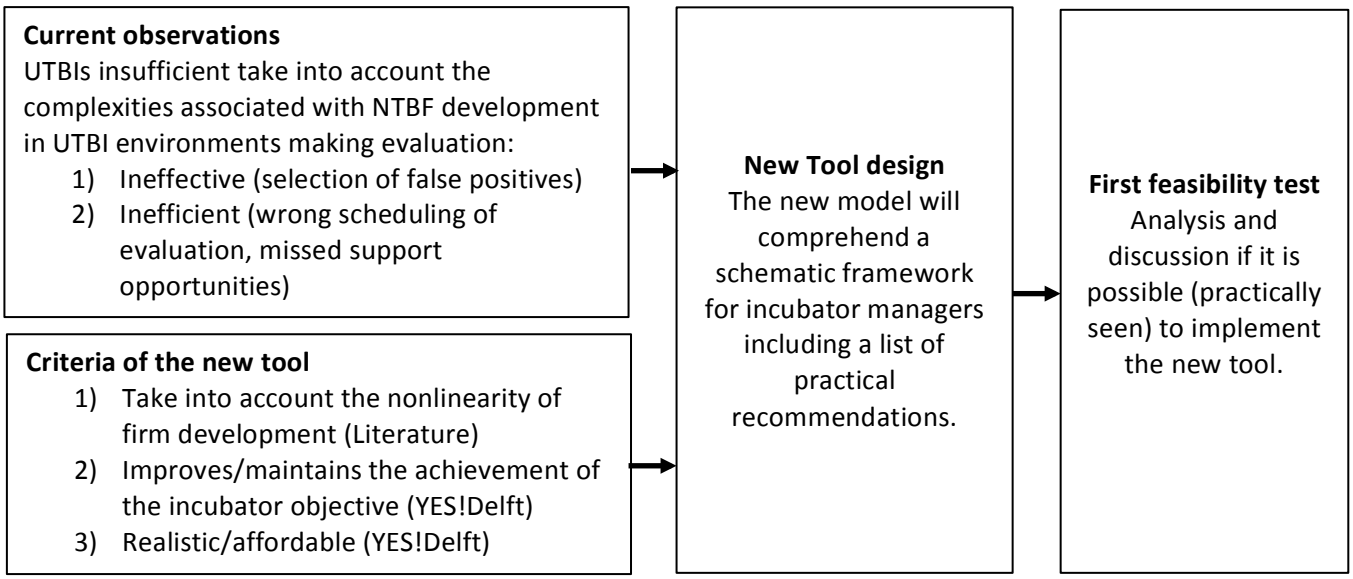


Figure 2: Design of the new evaluation tool

Research Criteria

1) The first new tool criterion states that the new tool needs to take into account the nonlinearity and complexity of NTBF development. Therefore a better understanding is needed on NTBF development. Literature is a good starting base to discuss NTBF development.
2) The next new tool criterion states that the new tool needs to improve or maintain the achievement of the incubator objective. Therefore a better understanding is needed on the incubator objective. Literature is a good starting base to discuss the different incubator objectives and the importance of reaching it.
3) The last new tool criterion states that the new tool needs to be realistic and affordable. It is therefore important to look to the current landscape of evaluation methods. What are the benefits and shortcomings of each evaluation method?
4) The new tool design calls for a schematic framework with recommendations for incubator managers. It is of high important that they can rely on these recommendations. Therefore empirical evidence on concepts and relations must find demonstrable proof.
5) Last, because of the practical orientation of this study, there is an urgency to assess the practical implementation of the tool. Therefore the findings of the study are reflected by me and are submitted to an incubator manager. His opinion and experience give valuable insights required to eventually implement the tool.

1.5.1 Phases of Research

To give it more logic, this study is divided into three distinct phases: theory, research, and analysis (*Figure 3*). The first phase, the theory phase, comprehends an in-depth analysis of the literature. Based on several articles the aim is to come to understand the importance of incubatee evaluation within university technology incubators. It therefore will look at several incubator models and structures and how evaluation takes place within each type. The theoretical part also works towards understanding the underlining principles that explain NTBF development and the effect of technology. Note that special attention will go to the technological aspect. Technology has complex and dynamic characteristics and will, therefore, have unpredictable outcomes in social, environment, and market dynamics. The first phase aims to give an answer on SQ1-5. From here on, the study flows over to the research phase. To fully address the issue a mix of quantitative and qualitative measures is used to find aspects that have an influence on incubatee evaluation. In the final phase, analysis, the outcome of the research is analysed and argued thoroughly. From here, it becomes possible to distil an answer on the main research question.

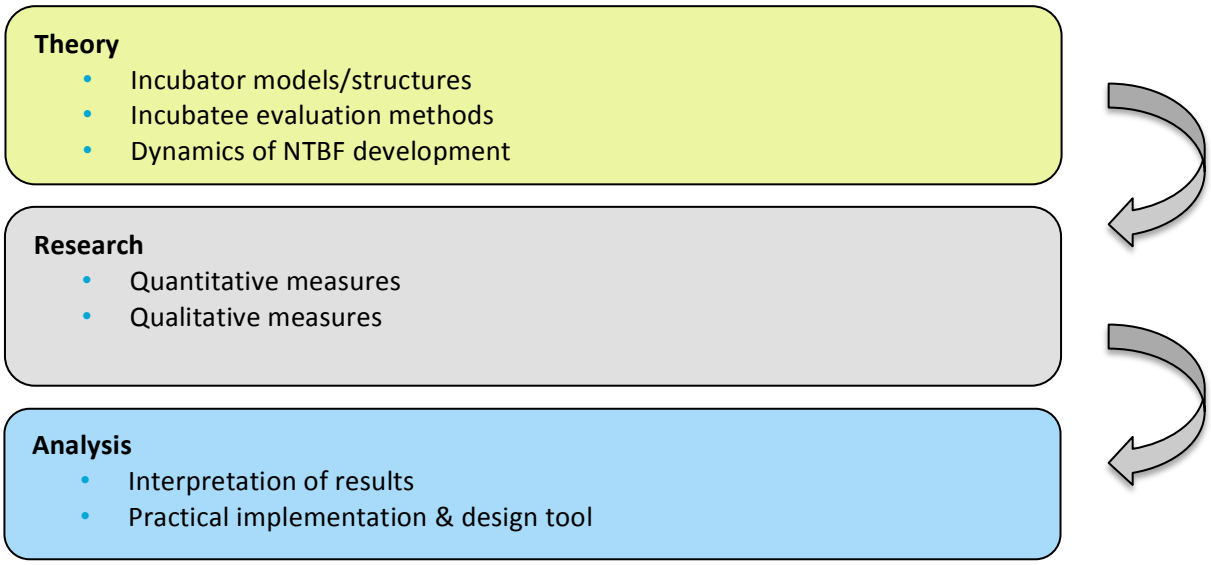


Figure 3: Research phases

1.5.2 Data Collection

A combination of three data collection methods will provide an answer to the research questions.

- In-depth literature study
- Survey
- Interview

In order to get a better understanding of the incubator objective, incubatee evaluation, and NTBF development, the first part of the study relies on an in-depth literature study. Among others, secondary data sources like business & entrepreneurial Journals, books, conference proceedings and (state) reports are considered attainable literary sources.

In February 2014 a survey was taken among 72 NTBFs situated in the Dutch UTBI: YES!Delft. The data from this survey contains valuable information on the performance, needs, and key characteristics of these firms. The data can be used to get quantitative insights.

Last, data that cannot be obtained from the survey is collected through semi-structured interviews with firms from the survey sample. These firms are discussed in-depth in order to fully understand the matter. Chapter 4 gives a more profound description of the research method and data collection.

1.6 Report Outline

The report consists of seven chapters. The first section provides the research background, objective, questions, and approach and report outline. This chapter functions as an introduction to the entire dissertation. The second section or first chapter of the theory phase includes the description of the research domain: incubatee evaluation in university incubators. The chapter's aim is to understand how UTBIs work and the importance of incubatee evaluation in these environments. The core concepts, definitions, and typologies describe the UTBI and incubatee evaluation. The third chapter outlines the theory behind NTBF development. In here, the development of NTBF is discussed based on several growth models. Furthermore, the different types of NTBFs are described, followed by an argumentation on how their development differs, or should differ, from a general NTBF-type. Based on these insights it is possible to develop a theoretical framework with the aim to use it for further research. Chapter four describes the methodology; in this study the constructs of the theoretical framework are operationalized, and the data collection methods introduced. Chapter five gives the results of the overall study. In chapter six the outcome is discussed and reflected by me. Finally, in chapter seven the main findings and conclusions are presented. It also addresses the limitations, contributions and recommendations. The table below gives an overview of the report outline (*Table 1*).

Chapter	Contents	Intent
1	- Introduction - Description of the research problem - Formulation of research objective and research questions - Research approach and report outline	
2	- Description of university technology incubators (types, structures, types of support) - Incubatee evaluation types	Answer on SQ 1, 2, 3, and 4
3	- Firm growth models - NTBF growth models and stage gate problems - NTBF profiles - Development of a theoretical framework	Answers on SQ 5
4	- Methods - Research methods, data collection, and the construct operationalization	
5	- Outcome of the research	Answers on SQ 6
6	- Discussion of the results and development of tool - Practical implementation	
7	- Conclusions - Limitations - Contributions - Recommendations	Answer on main RQ

Table 1: Schematic overview of report outline

1.7 Relevance

1.7.1 Academic Relevance

This study provides critical insights to researchers and scholars who are studying university technology incubators. Until today, discourse on technology incubators mainly relies on best practices (Bergek & Norrman, 2008; Hackett & Dilts, 2004a). When one comes to understanding the why and how of the application of specific best practices, it becomes possible to improve current incubation models further. Especially in the field of technology start-ups this need can be enlightened since their development is still uncertain and unpredictable (Murray & Marriott, 1998). The formation and development of new firms are difficult and complex matters. Shedding light on the most critical aspects of firm development, its critical needs and early signs of progress, will hopefully make incubatee development more understandable as well as more measurable.

1.7.2 Managerial Relevance

The results of this study will enable management teams of UTBI's to run the incubation business more effectively and efficiently. Effectively in terms of better allocating resources to those who need it, and efficiently in terms of generating higher yields with the same resources. With the results of this study, incubators can detect more accurately underperforming but high potential firms and respond quicker to their needs. Ideally, incubation managers need to be able to mobilize support without having to doubt whether that would be the right decision.

2 University Incubation and Incubatee Evaluation

The aim of this chapter is to come to understand incubation evaluation practices within university technology incubators. The chapter starts with outlining why universities form the perfect place to start a business (2.1). Universities and their ecosystems play a crucial role in the development of new technology-based firms. To facilitate development universities developed specially designated incubators. These incubators provide support to these start-ups in the critical phase of development: the start-up phase. In the following section, it will become clear what the different types of support are (2.2). For an incubator, there are several strategies to grant support efficiently to its tenants (2.3). Next, an incubator must make sure that the right support will go to the right firms. Different incubation programs make sure that the right support goes to specific groups of start-ups (2.4). Several evaluation practices are used to keep track of the start-ups' development within these programs. In the following section, it will become apparent what the importance is of a rightly executed incubatee evaluation in UTBI environments and what the differences are between different incubation practices (2.5).

2.1 University Entrepreneurship and the University Incubator

Universities are seen as the perfect place to foster innovation. They enable entrepreneurs to commercialize technologies at lower costs, meaning that they are less dependent on public funding regarding the development of these technologies (Hippel, 1988; Thursby & Thursby, 2002). Especially start-ups in high-tech areas, such as biotechnology or nanotechnology, seem to benefit from the university. They often rely on scientific research that can only be accumulated in such areas (Zucker & Darby, 2006).

Start-ups can benefit extensively from the technology transfer that takes place in such areas. For them, the proactive involvement of universities enables them to develop pioneering technologies – often referred to as technology push – without directly relying on public funding (D. S. Siegel, Thursby, Thursby, & Ziedonis, 2001). For this reason, an increased number of researchers, students, and post-graduates realize now that a university can offer opportunities that could increase their chances of success. Furthermore, factors like the rise in venture capital, the passage of the Bayh-Dole Act[6], increased scientist mobility, growing demand for technological innovation by organisations, and the introduction of several high-tech innovations – such as the microprocessor, genetic engineering and nanotechnology – have all led to the increased entrepreneurial activity of universities (Rothaermel et al., 2007).

The growing popularity of university entrepreneurship has led to the introduction of specially designated facilities that separate pure research from the valorisation of technologies and research. These so-called university incubators make it possible for researchers, scholars, and postgraduates to leverage the

[6] The Bayh-Dole Act provided in the US incentives for universities to patent technological breakthroughs with financial support from the government.

development and commercialization of inventions, technologies, or tacit knowledge by receiving hands-on support (Mian, 1996a, 1997; Rothaermel & Thursby, 2005a). Incubators are important links in the entrepreneurial value chain because they add value during the critical stage of firm development: the start-up phase (Phan et al., 2005). Especially in high-tech sectors there is a must for incubation. High tech start-ups face many risks and complexities when it comes to transferring technology into market viable applications (McAdam, Galbraith, McAdam, & Humphreys, 2006). In addition, technologies developed within a university often have a research motive instead of a market motive. Entrepreneurs get their ideas from technology innovation rather than from market needs (Ndonzuau, Pirnay, & Surlemont, 2002). Entrepreneurs enter the business environment with a set of skills not relevant for running a business (Bower, 2003). For this reason, University spinouts or start-ups require intensive and specified business support when it comes to translating the technology into market conditions; one that purely technological universities cannot provide (Smilor, 1987). Aside from specified business support, a University incubator can play a role in the attainment of resources required to further develop technologies (Garnsey, Stam, & Heffernan, 2006).

After the introduction of the classical business incubator during the early 1960's, the university incubator was introduced. A university incubator, also referred to as university science park Incubator [USI], university technology business incubator [UTBI], distinguishes itself from the traditional business incubator in the sense that its contractual or formal ownership maintains with the university (Phillips, 2002; Tamasy, 2007). Often in collaboration with (local) government, nearby industries or research institutes, they form the main sponsors of the incubator (Etzkowitz, 2002). The main sponsors pay the initial facility development costs, but often also pay for the expensive resources such as coaches, events, and the incubation management team. The university incubator focuses on the promotion of R&D or the transfer of technology to a university-industry partnership and, in that way, transforms knowledge and technology into commercial viable innovations (Tamasy, 2007). UTBIs are in most cases part of a larger ecosystem consisting of a university, research institutions, and industries (Etzkowitz, 2008).

2.1.1 Incubator Ecosystem

A University incubator is located in a Science Park [SP]. An SP is an: "Area [that] allows agglomeration of technological activities [and] [leads] to positive externality benefits to individual firms located in the park" (Westhead, Batstone, & Martin, 2000). This development implies that the area around a university is an attractive spot for knowledge-based large firms because they can benefit from the available knowledge on site. Not only are the incubator and the university located in an SP, but also companies and research institutes who collaboratively develop technologies for commercial purpose.

To facilitate the transfer of technology at SPs, a Technology Transfer Office [TTO] is often present. A TTO has a significant role in the flow of technologies that are brought to commercialization (D. Siegel, Waldman, & Link, 1999). Technologies that are developed as a part of a university research project, and it becomes valuable, it will be offered to the TTO. The TTO assesses and decides what the best strategy is to commercialize the technology (Link, Siegel, & Bozeman, 2007). In most cases, a patent is obtained for a well-developed technology. Now it is possible to licensing out the technology to an entrepreneur that has a business idea in mind around the technology. In doing so, they need to pay a license fee to the university. Another option is to buy technologies 'of-the-shelf' (D. S. Siegel et al., 2001). Here the entire technology 'as-is' is sold to the company (D. S. Siegel, Waldman, & Link, 2003). Thus, no start-ups are or will be hosted by the TTO office. It only holds the formal ownership of technologies originating from universities.

2.1.2 Incubator Definition and Function

The definition of an incubator is "*a shared office space facility that offers tenants a strategic, value-adding intervention system of monitoring and business assistance*" (Hackett & Dilts, 2004a). The intervention system links resources to their tenants, in order to minimize their chance of failure. This means that an incubator is both a place and a process (Voisey, Gornall, Jones, & Thomas, 2006).

The function of an incubator is to provide support at the early stages of firm development. The incubator thus focuses on solving the critical problems or barriers at these stages, such as finding a launching customer, investor or key partner, and giving advice on initial strategic and organizational firm setup. Because an incubator cannot keep track of the actual and real problems of every individual incubatee, the incubator needs to carefully listen to the firms' needs for (generic) early stage problems. Over time, the firms' need regarding early stage problems will decline (Kirwan, van der Sijde, & Groen, 2006). As the firm matures, it will have to deal with other and more specialized problems. At this point, the incubator can marginally contribute to further assist the company since it lacks in having these highly specialized resources (Mian, 1996a). As a result, the firm is either released or asked to leave. Indeed, remaining longer in the incubator as necessary will make the incubatee too dependent on the services of an incubator and hence leads to a lack of building internal capabilities (Schwartz, 2009).

2.1.3 Perspectives on the Incubation Concept

The incubator and its position in a system are probably best described by Burnett and McMurray (2008). They discuss the incubator based on an outside and an inside environment (*Figure 4*). The basic notion they discuss is that an incubator constitutes an environment especially designed to hatch start-ups. In doing so, they offer a range of services and resources – think of mentoring and providing networks, spaces, and equipment. By having the basic resources in place, a firm is assumed to concentrate more on the business planning and, thus, increases its chances of success (Aerts, Matthyssens, & Vandenbempt, 2007). Firms that successfully graduate from the incubator bring new technologies, products, services, networks, partnerships, and joint ventures to the external environment (Viale & Etzkowitz, 2010). As a result, this boosts the local business community, civil society, and global environment (Cooke, 2004). The increased image of the incubator for the civil society and business community leads to a new influx of spin-ins and new firm creations within the incubator. On this way, the inside and outside incubator environment interact which each other.

Another view on incubation is the concept of 'macro-managing' (Hackett & Dilts, 2004b). This perspective on incubation suggests that Incubators, who help their incubatees fail quickly and economically, are the most successful ones. The sooner the incubator knows which projects have potential, the higher the overall payoff will be in respect to the attainment of the overall incubator goal. In addition, quick and cheap failures provide opportunities for entrepreneurial learning, firm recovery and repositioning, and an optimal injection of organizational population churn into the local economy. The perspective of Hackett and Dilts (2004b) describes that success is no longer defined as the moment when incubatees survive but rather as the moment incubatees grow towards profitability or already are lucrative. In addition, the researchers argue that incubation success is also at hand if a start-up fails while still in the incubator with minimal losses.

When looking at the different perspectives on business incubation concepts found in the literature, the incubator concept consists of two parts: The first part reflects the supply side of the incubator and the second part the demand side (Bruneel, Ratinho, Clarysse, & Groen, 2012). From a supply side perspective, an incubator seeks to employ different support services and resources for its tenants. The support and resources are often heavily subsidized and can used almost free by incubatees. This eases the start-up phase by reducing

fixed costs (Tamasy, 2007). From a demand side perspective, incubatees obtain resources and services in order to 'accelerate development' (Grimaldi & Grandi, 2005; Mian, 1996a), 'exploit innovations made at the incubator or university' (Aaboen, 2009; Löfsten & Lindelöf, 2002), 'ensure entrepreneurial stability' (Schwartz & Hornych, 2010), and help business grow fast (Ogenio, 2013).

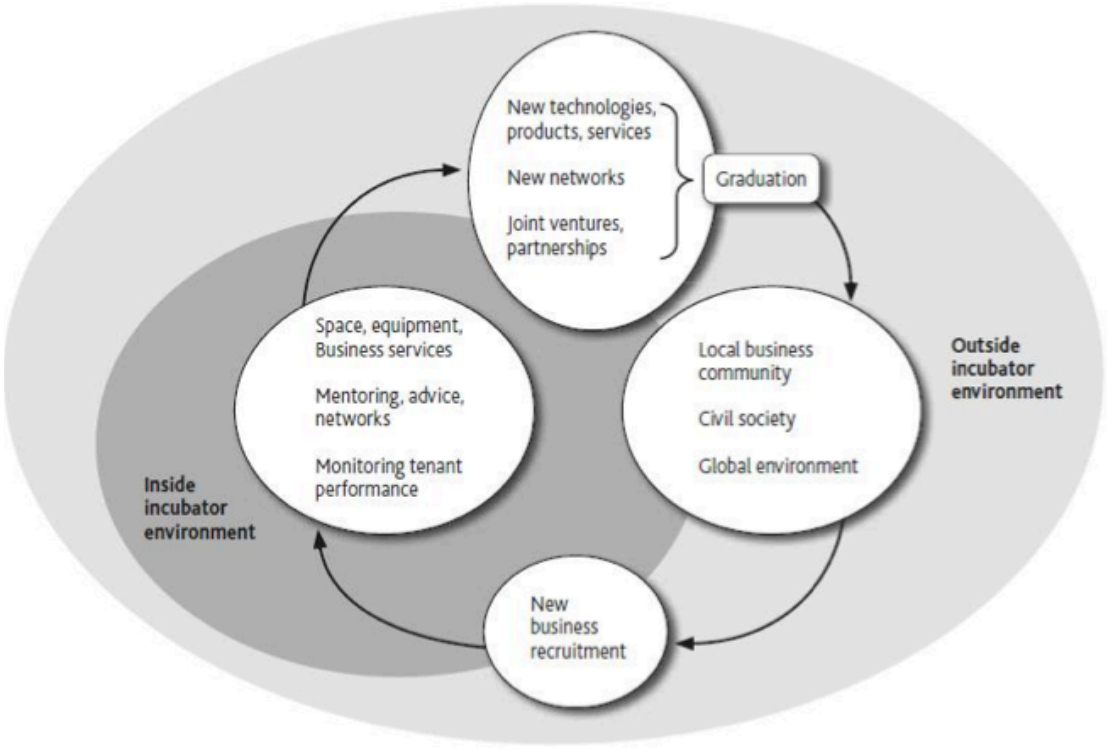


Figure 4: Business Incubation Concept (Burnett & McMurray, 2008, p. 61)

2.1.4 Incubator Objective of an University Technology Incubator

UTIBs primarily rely on the success of NTBF in order to attain their objective. NTBFs have a high potential for national economies (Donckels & Segers, 1990; Granstrand, 1998). These NTBFs base their business on the commercialization, development, and manufacturing of technology. Their link with existing larger companies and research institutions provides them with relevant specialist inputs and capabilities to larger networks (Delapierre, Madeuf, & Savoy, 1998). Some of these firms turned as real success stories by bringing break-through innovations to the market. This, in turn, boosts the local economic development (Etzkowitz, 2002). For this reason, UTIB strives to lower the chances of failure of these firms by providing value-added support to NTBFs. In doing so they aim to maximise the economic growth by the exploitation of innovative technologies (Viale & Etzkowitz, 2010). On top of that, the focus on exploitation of these technologies also brings international allure in the benefit of the main sponsors. UTBIs are in sponsored by an university (Viale & Etzkowitz, 2010). A better international reputation also attracts new students and industries to the university and surrounding institutes. Today, once incubated in a UTBI, NTBF failure is unlikely. Surprisingly, many incubators do not focus on the survival of start-ups, but on the acceleration of it instead (Bizzotto, 2003; Smilor, 1987).

2.2 Incubator Support

Incubators helps tenants by providing them in building their capabilities and handing them resources (Hackett & Dilts, 2004a; Somsuk, 2010). The support granted varies from access to networks, coaching or access to a shared pool of resources (Bergek & Norrman, 2008). As shown in *figure 5*, the support provided by the

incubator was not always the same. Over time, the incubator evolved from a merely real estate incubator to a value added services incubator (Akçomak, 2009). As a result, the diversity of support expanded from only offering shared space to the offering of intensive trainings and coaching. During the last decade, most incubators grew out to networked incubators. These incubator provide support through offering a strong network with essential parties relevant for business development. Colbert et all. (2010) classifies support into three main dimensions: infrastructure, business assistance network and clusters (Colbert & Association, 2010; NBIA, 2008). Note that the demand for support varies among firms (Ferguson & Olofsson, 2004; Kirwan et al., 2006; Luggen & Tschirky, 2003; Spencer & Kirchhoff, 2006). This is why not all the available support is obtained by each NTBF. Naturally, the physical space is, but variations in obtainment of support typically differ among firms. The three dimensions are further discussed below.

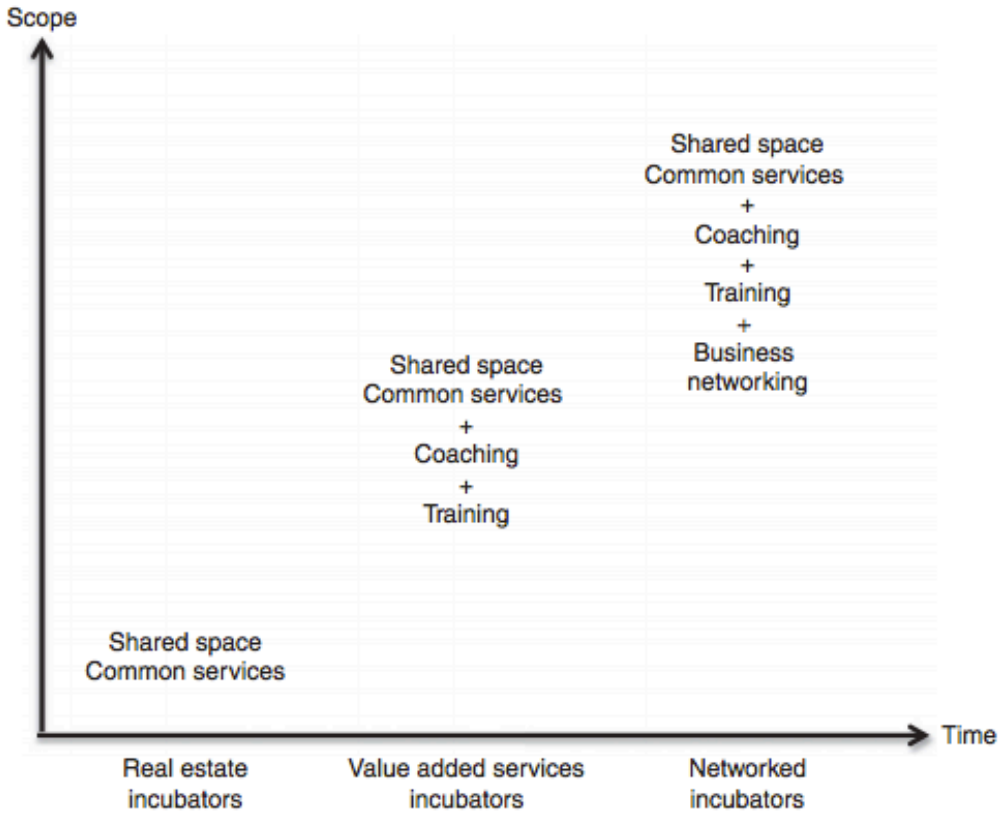


Figure 5: Scope of incubator support over time (Akçomak, 2009)

- *Infrastructure*

One of the base components of an incubator is the facility itself along with its infrastructure (Mian, 1996b). Having access to services like administration, office facilities, shared reception are key for the survival of early stage NTBFs (Todorovic, 2010). It enables the entrepreneur to focus entirely on adding value to the product rather than do day-to-day business tasks. Also, especially in the starting phase of the start-up the credibility gained by having an official office was seen as an advantage by entrepreneurs. Also sharing a pool of resources, such as a car park, tax administration service, or jurist office gives many benefits to the firms since costs can be spread (Mian, 1996b). During the early stage of development, the NTBF incurs vital costs mainly

meant for developing the technology. Leveraging expensive resources by sharing it with other tenants needing the same services, gives access to valuable resources at lower costs.

The incubators' infrastructure has a great influence on lowering the high initial finance needs of the NTBFs. Because of the high costs, involved in business and technology development, NTBFs face difficulties in obtaining money from, for example, banks (Mason & Harrison, 2004). The reduction of the required funding makes it more attractive for moneylenders to lend or invest money (Politis, Gabrielsson, & Shveykina, 2012). In some cases, the technological incubator provides a bank-loan to all entrants including a very favorable conditions; low interest, no pay-back after failure (YES!Delft, 2013). The capital enables the entrepreneurial team to keep its focus on technology development. This way, the incubator supports the development of innovations.

- *Business Assistance*

Many entrepreneurs have their background in the academic field and do not have sufficient business skills (McAdam & McAdam, 2008). Although these people are experts in the field but often lack managerial expertise (Heirman & Clarysse, 2004). Nearly no NTBF develops technologies that are directly market ready, as a consequence they are dependent on external support in order to adapt and tailor the technologies on customer requirements (Stevenson & Jarillo, 1990). Coaching is an excellent remedy to solve firms' these problems. The incubator offers a broad pool of legal, financing and administration experts. Typically coaches help by consulting on organizational issues such as people, administration, legal, sales and marketing, and strategic positioning. Sometimes these coaches also give advice on technology related matters such as the request for a certification or patent application. Coaching provides a comprehensive way of obtaining creative and tailored solutions. Coaches are deliberately thinking along (often pro bono) with the founding team and advise them on areas they lack in knowledge (Bergek & Norrman, 2008). Especially frequent occurring problems are easier to tackle with coaching (Zucker et al., 1998).

Firms that receive coaching perform better and are more likely to survive, than those who do not (Aaboen, 2009). As firms grow, they become more aware of their challenges and are more likely to correspond their needs (Bruneel et al., 2012). Over time, this will make coaching a more valuable support mechanism. There are three types of coaching: reactive episodic, proactive episodic, proactive continual (Bergek & Norrman, 2008). Reactive episodic describes an entrepreneur-initiated way of coaching, the entrepreneur asks for help when needed. In the case of proactive episodic an incubator manager is initiating informal ad-hoc coaching sessions. The proactive continual way of coaching describes as periodical (formal) meeting where coaching is merely focused on long-term problems. In order to successfully grow the business, the entrepreneurial team needs to have commercial expertise regarding sales, marketing, but also business strategy and legal matters (Michelacci, 2003; Stevenson & Jarillo, 1990). Whatsmore, especially at early stages, entrepreneurs often deal with the development of technology and business at the same time. Often with the pressure of tight deadlines the NTBF has no time to make mistakes and need to execute proper entrepreneurship (Peters, Rice, & Sundararajan, 2004).

- *Network & Clusters*

Having a well-developed network reduces entry barriers and leads to economies of scale and scope (Porter, 1998). Throughout all development stages of an NTBF, networking can enhance its development. In the first stage of development, the NTBF is seeking for external resources to test and manufacture the first prototype such as industry and market knowledge, funding or technological expertise (Karlsson & Olsson, 1998). Hence,

the NTBF needs to get in touch with possible partners, investors, researchers or advisors (Elfring & Hulsink, 2003). The incubator management team, coaches or other incubatees within the incubator network, are all in the position to provide this introduction. In the next stage, a technology needs to have a market fit. Since the majority of the market does not yet understand the technology, an NTBF is dependent on a strong network to find the right 'launching' customer that is willing to adopt the technology (Politis et al., 2012). The same holds for finding investors in the commercialization phase. Because banks too often regard NTBFs as risky projects, NTBFs rely on finding key investors who understand the business and technology (Brockhoff, 2003). The latter, also to this extent networking is essential. Entrepreneurship literature has documented that start-ups fail most often because they lack access to capital. Having a strong network that offers incubatees often direct access to capital is, for this reason, found on of the three services (Aram, 1989).

Network needs are an important criterion for NTBFs (Elfring & Hulsink, 2003). In the start-up phase NTBFs are not able to generate resources internally, they, as a result, need to interact with the environment (Autio & Yli-Renko, 1998; Elfring & Hulsink, 2003). A healthy and strong network is an effective way to attract these external resources (Elfring & Hulsink, 2003). The network needs change as the type and size of the network changes during the development of firms (Mário Franco & Haase, 2011; Lechner, Dowling, & Welpe, 2006). In the early stage of development, the start-up often relies on social or cooperative ties. These ties are required to develop first prototypes collaboratively, or find investors, key partners via friends and family. As the firm matures the number of reputational network links – a.k.a. The number of ties a firm holds with the industry – increase considering that the social and collaborative networks become less important. To expand business further, one needs such reputational connections and needs to connect with the key players in the particular market.

2.3 Incubator Strategies

In order to operate efficiently incubators should run like a real business (Zedtwitz, 2003). This implies that the incubator needs to execute strategies to ensure that its strategic position is reserved (Vanderstraeten & Matthyssens, 2010). Incubators strategies might differ (Clarysse, Wright, Lockett, Van de Velde, & Vohora, 2005), but they are always dependent on the nature of resources within a network, their position in the value chain, and learning abilities (Markman, Phan, Balkin, & Gianiodis, 2005).There are three generic incubator strategies identified: low selective, supportive, and incubator type (Clarysse et al., 2005). The low selective strategy describes a strategy that aims to stimulate entrepreneurship, in general. On this way, everyone with the ambition to become an entrepreneur can enter this incubator type. The supportive type, on the other hand, is merely focused on commercializing technology. These types of incubators aim to realize growth in the economic region rather than gaining from short-term revenues. This also implies that these types of incubators do have strict selection procedures to make sure that only the most viable projects are chosen. Finally, the incubator type describes a model that seeks direct gains from technology transfer. They have a high degree of control and keep interest in the start-ups. Technologies are licenced in or cross-licenced before a company is started. Also, the firm remains in the incubator until all resources are in place.

Furthermore, Clarysse (2005) stresses out that there needs to be a balance between the number or diversity of resources offered and the number of activities. With resources is mend all types of support (i.e. network, financing, coaching). With activities is mend all types of control and regulation practices by the incubator (selection, scouting, regulate funding process, and progress evaluations). Clarysse (2005) argues that incubators need to execute more controlling activities, if they have access to a larger pool of resources. When the incubator is not capable to arrange these controlling activities, incubators might become *competence deficient*. This means that the incubator lacks knowledge and capabilities to employ resources productively

and efficiently. Contrary, if the incubator applies many activities without being able to offer a large number or resources to its tenants, the incubator is found *resource deficient*. Resource deficiency is often the result of an incubator that is too ambitious in terms of objectives (e.g. they want to realize as many fast growing firms as possible without having adequate resources to do so). Resource deficient firms cannot make the right decisions because they either do not have access to "*financial resources to make decisions autonomously from the university"*, have the *"right mix of competencies or people in terms of experience and networking to deploy these activities*", or *"are not supported by a university board with an entrepreneurial orientation and/or they cannot rely on a strong regional infrastructure and network that supports innovation and enterprise"* (Clarysse et al., 2005). *Figure 6* shows that the incubator strategy applied thus needs to be in balance; the higher the number or diversity of resources, the more activities the incubator needs to perform.

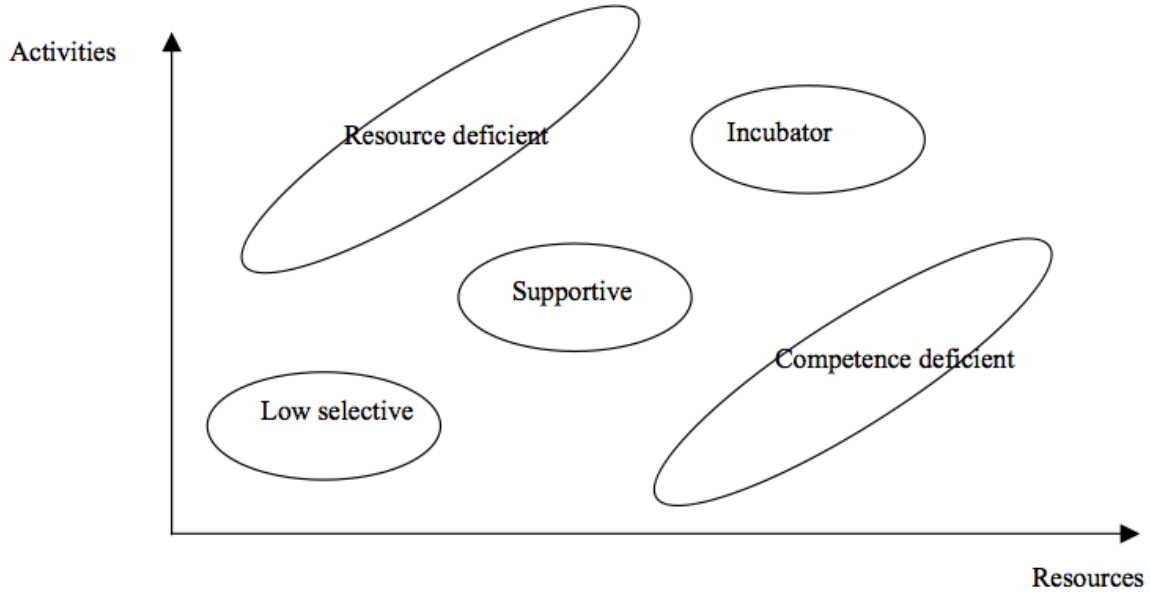


Figure 6: Incubator type in relation with resources and activities (Clarysse et al., 2005)

The incubator strategy chosen by UTBIs is the supportive type, or in some cases, the incubator type (Akçomak, 2009). UTBIs seek to support technological start-ups that, by definition, need more resources and support for their development. The incubator strategy is more prevalent at corporate or specialized incubators that host office space to firms concerned with already well-developed technologies. Within UTBIs, there are spinouts that derive from the university. These spinouts deal with technologies that are often not entirely developed (Rothaermel & Thursby, 2005b).

2.4 Incubation Process

The incubator process is characterized by a number of events and stages, in which funnelling of start-up potential takes place (Peters, Rice, & Sundararajan, 2004). On this way, the incubator aims funnel support to the best performing companies. Hence, best-performing incubators behave like an "ideal-type" venture capitalist (Vanderstraeten & Matthyssens, 2010). Funnel the most potential firms saves valuable time and resources (Peters, Rice, & Sundararajan, 2004). To give more structure to this process the incubator designed a two to tree years incubation program. An incubation time of three years is argued at the most optimal time in respect to the benefits versus the likelihood of post-survival (NBIA, 2008; Rothaermel & Thursby, 2005b). Incubatees that extended their stay for over three years seem to benefit less from the incubator compared to firms that stayed longer (Hytti & Maki, 2007). Alternatively, firms that remain in the incubator longer than

necessary are more likely to fail after graduation, for they lack in building internal capabilities (Schwartz, 2008). It can be concluded that incubation programs are seen as one of the most important tools of the university incubator management team (Aerts et al., 2007). They help the incubator realize its objective (Aerts et al., 2007; Bruneel et al., 2012; S. S. Lee & Osteryoung, 2004; Lumpkin & Ireland, 1988; Ratinho, Harms, & Groen, 2009). The incubation process is arranged in line with the incubator objective (Bergek & Norrman, 2008). Bergek et al. (2008) describes the incubation process based on three phases: selection, mediation, and graduation. Each of them is discussed below:

- *Selection/Pre-incubation*

Selecting start-ups is an important first step that enables UTBIs to select only the most promising start-up that is likely to contribute to the incubator objective. UTBIs are particular interested in NTBFs that deal with high-end technologies that are already in a premature state and show some commercial viability (McGowan et al., 2011). Important is that the novice start-up addresses a particular market problem and tries to solve it with a technological application or service. These start-ups deal with a greater extent with early start-up problems but hold a high potential to become a leading technological firm (Feeser & Willard, 1990). Besides this strategic fit, the incubator also looks at the operational fit. There must be a good fit between the needs of the incubatee and the support an incubator can offer (Hackett & Dilts, 2004a; Hannon, 2005). Only with a good understanding of these needs an incubator can deliver the most value to its tenants (Hannon, 2005).

Some incubators have a pre-incubation program (Bizzotto, 2003). With short program, in general, a period of three to six months before the final selection, the incubator aims to support firms that do have a technology and a team but lack a business model. The pre-incubation program allows the firms to test the technology in several markets with different customers. This way, a suitable business model can be developed. The importance of developing a business model based on a tight interaction with different possible customers and market segment is stressed in the literature (S. Blank & Dorf, 2012; Ries, 2011). The pre-incubation phase is often used to see if the entrepreneurial team is capable and has survival spirit. Thus, this program can be seen as an ennobled selection strategy, allowing the incubator evaluate which incubatees have potential. In the end, presentations are held to convince coaches and investors, to 'sell' their business idea.

- *Mediation*

Once the start-up is admitted to the incubation program. A UTBI can mediate by offering hands-on support such as coaching programs, but also by frequently evaluate progress of their incubatees. Especially in the beginning when much generic start-up problems can be bypassed by offering this mediation. The way in which mediation is executed differs per incubator. Some incubators mediate by offering strong hands-on support and monitoring progress frequently, considering that others maintain the freedom of the entrepreneur (Bizzotto, 2003).

- *Graduation*

Graduation takes place when the incubatee does not longer benefit from foreseeable advantages offered by the incubator (DoBell, 2009; Schwartz, 2009). This might be the case when either the incubatee has grown to a stage in which it can provide itself with all resources and capabilities required to continue business, or when the firm is unable to set-up a viable business after a given time. Regarding the latter, this time is specified in an incubation contract that incubatees sign during admission. As said, the length of the incubation program is two to three years. After this point, the incubator evaluates the progress made and decides whether the incubatee

can stay or needs to leave. At some UTBIs extended stay of an incubatee is not possible, in this case the incubatee graduates after its incubation period.

2.5 Incubatee Evaluation

In order to streamline the incubation process, efficiently achieve the incubator objective and, thus, funnel potentiality, the incubator applies several evaluation strategies. This evaluations are important because without knowing this, the start-up might receive support when appears to have no potential after all, or the support available does not fit the needs of the start-up. After an evaluation a decision takes place. The team decides whether incubatees are suited for the incubation program (i.e. at selection/after pre-incubation). Decisions of evaluation during the incubation programs relate to whether more coaching is required or whether further incubation is a go or a no. Because NTBFs are responsible for the eventual success of the incubator, decisions concerning their stay or support have a great impact on both incubator and incubatee.

The formal definition of incubatee evaluation is: "*events led by the incubator management team or coaches focused on evaluating the current status and progress made of the start-up*". Evaluation is also often referred as the "*systematic determination of a subject's merit, worth and significance, using criteria governed by a set of standards*". Evaluation in business helps to assess any aim, realizable concept / proposal, or any alternative, to help in decision-making. The aim is to assess whether the resources and services of the incubator add value to the survival or growth of the start-up (Bizzotto, 2003). If this is not the case, the incubator will take action. An NTBF needs to grow during its incubation stay to positively contribute the incubator objective. In modern businesses, evaluations can be both formative and assumptive. The formative evaluations constantly monitor the development of a concept, proposal, or project. It is intended to improve the value or effectiveness of what is being evaluated. Assumptive evaluation is drawing conclusions from a completed action or project. In many cases summative numbers are used to benchmark the status of what is being evaluated. These benchmarks describe what is satisfactory and what is not.

In literature, incubatee evaluation is described as a sub-part or supporting element (Bizzotto, 2003) or as an integral element of the incubation program (Wong, 2005). The argument describing incubatee evaluation as a sub part argues that start-ups deal with complex issues and challenges they need to overcome with or without support. It is the responsibility of the start-up to assemble the right resources to build a viable business. Evaluation by the incubator is just another service like the network or business coaching is. Evaluation gives the incubator understanding of the current status of the incubatee and a kind of x-ray to be keen on opportunities that might be interesting (Bizzotto, 2003). What describes incubatee evaluation as an integral part is the fact that the incubation process is comparable with the process of artificial chick hatching. According to Wong (2005) the increased start-up growth within an incubator can with high certainty be attributed to the support of the incubator. The incubator forms just like artificial chick hatching an artificial environment. When in a natural environment, it can be discussed whether environmental factors influence the number of embryo's and, therefore, making it difficult to evaluate the development process of embryo's. In an artificial environment, embryos are isolated from environmental factors of which effects might relate to certain interactions. Therefore, selecting the right embryos or funneling of the 'right' start-ups all comes down to deploying strict evaluation practices.

From here, one can distinguish two ways of evaluating: evaluation of incubatee progress and evaluation of incubatee qualities. In general, evaluation of incubatee qualities only takes place during the pre-incubation

and selection phase (2.5.1). Evaluation of incubatee progress, however, takes place during and after the incubation period (2.5.2). In some incubators, an evaluation of progress also takes place after graduation.

2.5.1 Incubatee Quality Evaluation

Because it is hard to evaluate incubatee progress during selection and pre-incubation incubators evaluate qualities of an incubatee (Aerts et al., 2007; Wulung, Takahashi, & Morikawa, 2014). In literature, incubatee quality evaluation is also described as screening or selection (Aerts et al., 2007; Lumpkin & Ireland, 1988). Within a UTBI, the incubation managers or an admission committee assesses whether the firm's core consists of a decent entrepreneurial team with the skills to understand or further develop the technology. Also, it decides whether a business idea and business plan are present, and last, whether the technology is found distinctive enough (Lumpkin & Ireland, 1988; Thierstein & Willhelm, 2001).

Clarysse, Wright et al. (2005) describes three types of selection. As already stressed out in section 2.3, the low selective policy is associated with a low entrance barrier. In this case, there is limited to no selection, and the focus is on admitting as many start-ups as possible. This way, the incubator maximizes the number of investments options. The downside, however, is that with a low selection barrier, no potentiality is assessed in the beginning, and thus, the failure rate is higher compared to incubators that already selects the most potential firms (Bergek & Norrman, 2008). On the other hand there is the 'picking-the-winners' selection strategy, aimed to only select the most promising business ideas, hence, successful incubation starts by selecting the most viable projects (Cammarata, Erlewine, & Association, 2003). Ruling out the low potential ideas saves the incubator a lot of effort but on the other side leads to false positives since the incubator cannot be a hundred percent sure if this start-up turns into a successful business or not.

2.5.2 Incubatee Progress Evaluation

2.5.2.1 Moments of Progress Evaluation

There are four moments at which the incubator can evaluate incubatee progress: after the pre-incubation program, during incubation, after the incubation program, and after graduation (Bizzotto, 2003):

- *After Pre-Incubation*

The evaluation of incubatee progress after the pre-incubation period is most difficult. The pre-incubation period is a short period of typically two to three months, aimed to validate main business model assumptions (Bizzotto, 2003). The focus of this evaluation moment is to see whether the start-up was able to find a product for a market niche. The evaluation typically takes place in the form of an investor pitch. The incubator management team, coaches and sometimes investors are present in this pitch. In general, the incubator does not make a hard decision after this evaluation moment. Rather, it advises whether the start-up should join the incubation program (Wolfe et al., 2000).

- *During Incubation*

Incubatee evaluation during incubation focuses on assessing whether incubator support has helped the start-up to grow further. When this is not the case, a new approach will be found to tackle the issues. Mentors and coaches typically take the evaluation at this moment (TEIXEIRA, 2001). Special focus will be on critical problems, like lacking initial contacts with launching customers, investors or partners. Attention will also go to needs related to technological development and organizations, when these are not satisfied (e.g.

administration, legal etc.). In most cases, this type of evaluation only takes place in the first months or years of incubation. During this period, the firm experiences the most start-up problems. The incubator can boost the development of firms by frequently having evaluations and look if support increased the pace of development. In this case, a strong interaction and a planned evaluation session lead to *continuous monitoring.* Continuous monitoring, thus, leads to a better guidance and quicker problem solving. The downside is that continuous monitoring is often found an expensive evaluation method for incubators. Therefore, it is in many cases only applied in the critical periods of development where the impact is highest (the first years of development). Continuous monitoring also restrains the start-ups ability to learn to deal with issues on their own (C. Lee, Lee, & Pennings, 2001). Because an incubator cannot decide to outplace incubators during the 3-year incubation period, decisions are taken by the incubator are merely focused on sharpening support.

- *After Incubation*

During the evaluation at the end of the (first) incubation period addresses the question whether the incubatee was able to grow and contribute to the attainment of the incubator objective (Zedtwitz, 2003). Incubatees that were able to grow often benefit from additional programs specially designed to further support these incubatees in their next phase. Because an incubator wants to be certain that only the most viable firms are supported, this evaluation is based on tacit evidence (Wolfe et al., 2000, p. 77). At the moment, the most prevalent way to benchmark viability is by looking at firm sales and size – in terms of employment – as a function of time (Kakati, 2003; D. A. Lewis, Harper-Anderson, & Molnar, 2011; McGee & Dowling, 1994; Mian, 1997). The criteria and moment of incubation are stressed out in the incubator graduation policy and need to be communicated during admission to the tenants (Schwartz, 2009). The incubator management team takes evaluation after incubation and takes the decision if incubation terminates for the incubatee after three year or it receive further support.

- *After Graduation*

In some cases, the incubator also evaluates the growth of alumni (Bizzotto, 2003). The evaluation of these graduates is often applied to assess if the graduated firms had an effect on the economic development in the region. A commission of inquiry also investigates whether the current incubation model needs to be improved. In fact, this type of evaluation is not focused on the funneling tenants, but on improving the incubator itself and its services as a whole (European commission, 2002b). This evaluation can take place years after the start-up has graduated. Table 2 provides an overview of all evaluation moments and their evaluation type, scope, and governance.

	Selection	**After pre-incubation**	**During incubation**	**After incubation**	**After graduation**
Evaluation type	Quality	Quality/Progress	Progress	Progress	Progress
Scope	Incubator fit, team, Technology distinctiveness	Validated business model	Effect of support	Incubatee targets reached	Impact on economic development of region to steer incubator
Governance	Admission	Investors pitch	Coaches or	Graduation policy	Commission of

	committee		mentors		Inquiry
Decisions	Admit incubatee to the incubation program	(no hard decision)	Provide more coaching to incubatee	Further incubation of incubatee	Improve incubator

Table 2: Overview of evaluation practices during the three incubation phases

2.5.2.2 Application of Evaluation Moments

Regarding the ways incubatees can be evaluated; one can conclude that there is no general pattern visible on how this is arranged. Every incubator evaluates its tenants on their own way (*Table 3*). Some incubators evaluate progress only at one stage, where others evaluate in nearly all stages. Note that selection is not expressed in the figure, because all discussed incubators apply selection evaluations. How evaluation eventually is set up, strongly depends on the objectives, characteristics, and the environment of the incubator (Clarysse et al., 2005). For example, if the start-ups' development trajectory is characterized by a long period of problems, the incubator will apply many evaluation moments to funnel potentiality the best way possible. The incubator also offers multiple incubation programs aiming to assist the entire development trajectory. If the development trajectory is characterized by only a short and intense moment in which main problems occur (e.g. as often in the case at software start-ups), the evaluation of only the early start-up phase will satisfy. These incubators often merely offer one program to terminate incubation for every tenant when the time is passed.

As stressed out in the table, most technological incubators perform evaluation sessions during the incubation phase. As stressed out in the literature, most incubators perform evaluations at these moments as an additional service to be of better assistance to their tenants. The incubator actively investigates if there are ways to solve the firm's current problems. This way of evaluating is in-line with the perspective of Bizzotto (Bizzotto, 2003). There are also incubators that perform these evaluations to 'observe' the development of firms, without giving directed support. These incubators use these insights to substantiate the judgment after incubation. Because many incubators offer a continued program for some of their tenants, a better insight into the overall development helps them to make a better decision. Because most incubators do not exist for a very long time, the wide evaluation of alumnus after their graduation is not an option. Therefore, only a limited number of incubators are currently applying this type of evaluation. Similarly, the importance of a pre-incubation, in which the business model of an incubatee is tested using *lean start-up principles*, is stressed out not long ago (S. Blank & Dorf, 2012; Ries, 2011).

Technology Incubator	**After Pre-incubation**	**During incubation**	**After incubation**	**After graduation**	**Source**
Centre for Advanced Technology - CAT (Denmark)		X			(European Commission, 2002)
Bordeaux Productic (France)		X		X	
Dublin Business Innovation Centre and Guinness Enterprise Centre (Ireland)				X	
Technologie Centrum Chemnitz - Chemnitz - (Germany)			X		

BIC Liguria (Italy)		X			
Software Business Cluster - San Jose (California - USA)		X			(Wolfe et al., 2000)
Boulder Technology Incubator (BTI) - Boulder and Longmont (Colorado - USA)	X	X	X		
University of San Diego CONNECT - San Diego (California - USA)	X				
Arizona Technology Incubator - Scottsdale (Arizona - USA)	X	X	X		
Incubator for Technological Entrepreneurship at Kiryat Weizmann (ITEK) - Ness Ziona (Israel)		X			
UNITEC of the University of the Vale do Rio dos Sinos (UNISINOS) - Sao Leopoldo (Rio Grande do Sul, Brazil)		X	X		(Silva et al., 2003)
Gene-Blumenau Institute, Blumenau (Santa Catarina, Brazil)	X				(Bizzotto, 2003)
YES!Delft - Delft (The Netherlands)	X		X		(YES!Delft, 2013)
Technology Innovation Centre - (Jamaica)					(TECHNOLOGY INOVATION CENTRE, 2015)
IndiaCo Incubator – (India)			X		(Patwardan, 2003, p. 3)

Table 3: Overview of evaluation practices during the three incubation phases

2.5.2.3 Evaluation Moments in Comparison

First, as stressed out in the previous section, there is no general way of evaluating progress. There is no good or bad evaluation method. These evaluation methods match with the structure and objectives of the incubators. It is difficult to compare the different evaluation moments between incubators because it is also difficult to get a clear understanding of the context of each incubator. Therefore, this study compares the moments that take place at the beginning of the incubation process to those that take place in the end. Based on the incubator descriptions, as discussed in Wolfe, 2000 and Bizzotto (2001) the following comparison could be made.

Figure 7 shows the main differences between several evaluation methods. An incubation team will merely look at what is needed because an incubatee is unable to show progress at selection. At this moment evaluation of required support is for both incubatee and incubator controllable. An incubatee can clearly stress out its needs, and an incubator can confirm whether they have the resources to satisfy those needs. Though, after the pre-incubation phase still little is known about the progress. At this point, however, the incubator knows more regarding what is needed. During the incubation period a transition will take place. Whereas in the beginning the focus is still on what is needed, the focus will merely shift to what is achieved, based on what is given. At this moment, decisions of support become more negotiable. The expectations of both incubatee and incubator are highest at this point; is the incubatee able to grow quickly after support and is the incubator able to satisfy the needs of the incubatee? It needs to be negotiated whether the incubatee can develop on its own or still needs hands-on support from the incubator. After incubation, the focus will be on what is achieved in terms of growth. Here, a limited focus will be on 'what is needed'. In some cases, an exception is made as further to support the incubatee where critical needs were not satisfied. Decisions at these stages become more equitable. At this moment, typically decisions depend on the same criteria for every incubatee. Last, the

incubatee evaluation after graduation is purely focused on what is achieved in the benefit of improving the incubator, not the graduated firm.

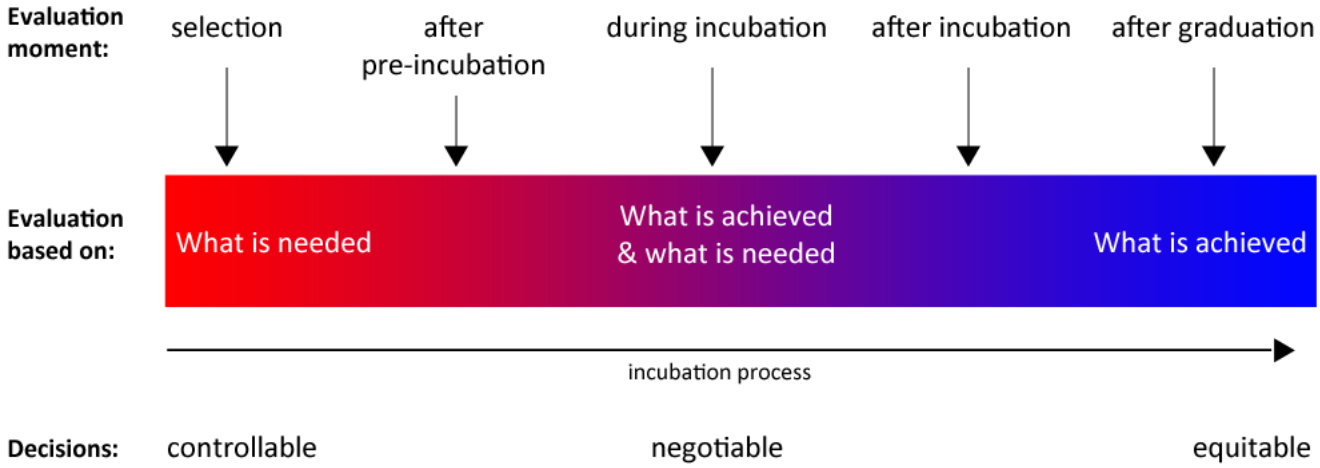


Figure 7: Transition of evaluation examination during the incubation process

To conclude, also within an incubator a formative and assumptive evaluation practices are applied. Because technical start-ups deal with critical barriers or problems in their early stage of development they need to overcome before they can grow (Vohora et al., 2004), evaluators are unable to apply assumptive evaluate practices at this extent. Instead, the incubator uses formative evaluation practices and looks how the development process can be improved by looking to what is needed. Assumptive evaluation, on the other hand, aims to evaluate if the start-up was able to grow. Each of the reciprocal perspectives is discussed below

- *Formative evaluation (early evaluation moments)*

The evaluations are characterized by their strong interaction with the incubator. From a social capital perspective, having more frequently interactions with the incubatee will result in stronger ties helping them to better monitor progress, understand their needs, and better serve them by building venture capabilities (Scillitoe & Chakrabarti, 2010). Hence, if an incubator does not track client progress on a frequent basis, both incubator and incubatee might unable to recognize the problem until it is too late (Knopp, 2006). However, Warren et al. (Warren, Patton, & Bream, 2009) warns that having a too tight interaction system would inhibit the entrepreneurial flair. Based on logic, the benefits and constraints for the incubator and incubatee can be discussed. The benefit for the incubatee of this evaluation moment is that it can explain the context and convince the incubator to support it further, if necessary. Also, the most problematic cases get an opportunity to address their issues and receive support by the incubator. The downside for the incubatee is that this type of evaluation possibly distracts it from its current way of building a business. The evaluations consume precious time, especially when the incubatee is performing well and, in fact, might not need evaluation. Furthermore, although coaches and mentors taking the evaluation are experts, they might lack in solving industry-specific issues. Thus, small chance they understand the problem and, therefore, can be of great value afterward. The benefit for the incubator is that they get a good impression of the overall development of the firm and can take these insights into consideration during the after-incubation evaluation moment. Aside from high costs, the downside for the incubator, however, is that a tight interaction can lead a determinative and unilateral way of business building, where the entrepreneurs' creativity and own insights are required for building internal capabilities.

- *Assumptive evaluation (late evaluation moments)*

During these moments, the incubator needs to look at hard figures such as sales growth or firm size, to evaluate the contribution of the firm to the incubator. For the incubator, this is the only tacit way to evaluate growth. Ideally, the incubator addresses the context of different firms. For example, some firms need a longer the lead-time to develop technologies; for them it takes longer to realize growth (NBIA, 2008). These companies should ideally be given more time and thus better criteria to reflect the start-ups progress. On average IT companies graduate within 18 months or less, because biomedical companies need 72 months or more (NBIA, 2008). Some incubators do make a distinction between industries based on historic data (European commission, 2002b). Cammarata (2003) lists some better criteria by taking the technological sophistication in consideration. According to him incubators should also assess if the company has a partnership, received funding, or was able to establishing an independent board of directors. At the moment, most incubators hold on to traditional performance indicators, such as revenue and employment size (Kakati, 2003; McGee & Dowling, 1994; Mian, 1997). The benefit for incubatees is that these criteria pressure the start-up to make sure that revenue is made within the given time. The danger for incubatees is that the high pressure increases the chances for entrepreneurs to take the wrong business decisions; on this way the high pressure shadows the ability for entrepreneurs to show proper entrepreneurship. The benefit for the incubator is that these indicators require minimal effort to maintain and are simple to communicate; there is no disagreement possible because the criteria are fixed. More importantly, they give the incubator concrete evidence that the firm can grow. The downside of it all is that, among the low performing early stage start-ups, a few pearls might be hidden. These start-up might deal with greater barriers related to new technologies, but could hold a far greater potential than those who were able to grow quickly.

The table below shows an overview of the advantages and disadvantages for both incubator and incubatee *(Table 4*).

		Evaluation on what is needed	**Evaluation on what is achieved**
For incubators	**+**	Insight in development to substantiate next evaluations	Easy to communicate with tenants, no disagreements, and cost-efficient, tacit evidence
	-	Costly; determinative and unilateral	Biases, low performing not necessarily low potential in first stages
For incubatees	**+**	Context can be expressed; Problem also get the opportunity	Gives pressure to reach targets
	-	Consumes time; coaches might not have full understanding on how to solve industry specific issues	Pressure increases the chances of taking the wrong decisions

Table 4: Overview of benefits and implications of the 2 generic evaluation moments for both incubator and incubatee

Key insights of Chapter 2

- UTBIs provide essential support to technological start-ups in their critical start-up phase.
- A UTBI is a complex support mechanism that needs proper control mechanisms to operate efficiently.
- One of the most important control mechanisms is incubatee evaluation, which takes place at various moments in the incubation process.
- Incubatee evaluations lead to decisions on the stay or mobilization of support to incubatees and are taken by incubator
- There are two reciprocal perspectives on how evaluation takes place: evaluation moments when the incubatee states what it needs (formative evaluation) and evaluation moments when is assessed what is achieved by the incubatee (assumptive evaluation).
- There is no good or bad evaluation moment, overall evaluation moments at which are stated what is needed are usually at the beginning of the incubation process, whereas the other takes place in the end.

3 NTBF Development Theory

This chapter zooms in on the development process of NTBFs. In the search for an answer on how to improve evaluation practices of technological start-ups, first better understanding on NTBF development is needed. The chapter starts with outlining classical perspectives on firm development (3.1). Compared to a regular firm, an NTBF faces additional challenges and problems per stage of development (3.2). When the firm finds solutions or receives support to these problems, the NTBF business develops as a whole. Aside from NTBF business development, this section also outlines two other important development directions: finance and network development. It appears that the new technologies, where NTBFs deal with, have effects on the obtainment of financing and on finding the right persons. For example, compared to regular firms, NTBFs deal with higher risks associated with the new technologies, often making them unable to obtain money from banks. These firms need to find other ways of financing. Next, different type of NTBFs can be identified. Each type has key characteristics related to technology (3.3). It is discussed if the different types have different incubator needs. At the end of this section, a conceptual model is constructed that is used for further research.

3.1 Classical Perspectives on Firm Development

When describing firm development, many authors rely on stage gate models or growth models (Chandler, 1962; Greiner, 1972; V. L. Lewis & Churchill, 1983; Scott & Bruce, 1987). They describe how certain groups and activities clustered together produce different stages. In most cases, the groups flow over from one to another. Describing firm development based on such models gives a good indication of the current status of the company and makes it able to determine its next move. Stage gate models are arbitrary meaning that the stages are based on the perspective chosen by the researcher. Greiner (1972), for example, describes a five-stage evolutionary model that distinguishes phases based on the main events that take place at each stage. With this, he reacts on Chandler (1962), who distinguishes phases by the nature of growth opportunities.

This study will mainly focus on growth models that describe stages based on distinct problems, activities and resources that characterize each phase. These models start with prototype development, market discovery and first customer approach - also known as the start-up phase. Then follows a moment of demonstrability and commercialization or the commercialization phase. After that take-off, up-scaling, and expansion takes place - referred to as the growth phase. Finally, a moment of maturity, stabilization, and efficiency steps in - also known as the stabilization phase (Scott & Bruce, 1987). Each phase will be further outlined below.

- *Start-up*

In this stage, the firm needs to deal with issues related to finding a market or problem fit for its solution/product. The entrepreneur is seeking for a present market problem that needs to be solved. In most cases, technology plays a crucial role in the solution (Penrose, 1959; Rhenman & Adler, 1973). In this stage, business survival is highly unlikely. It all depends on the clarity of the problem and to what extent the proposed solution results in a first set of customers that are willing to pay for it (Kline & Rosenberg, 1986).

Failure in this stage can be either related to flattered development of technology or finding a solution to a non-identified problem (S. G. Blank & Dorf, 2012; Ries, 2011).

- *Commercialization*

Once a first proof of concept reached, the firm needs to commercialize the products further. In the start-up phase, only a basic or minimal viable product is offered to customers. Once the companies know who their first customers are, they can improve the product or service capabilities and functionalities and create a first version of their product. The biggest challenge in this phase is to drive up sales i.e. finding partners that supply resources or sell the products as well as market the product and find new customer segments. A company failure may arise when the entrepreneur or entrepreneurial team is unable to connect to such partner or lacks in setting up a solid marketing channel (S. G. Blank & Dorf, 2012). At this stage also the interaction with the market is of high importance. The firm needs to listen carefully to the needs of the market (in respect to functionalities, channel, and pricing) in order to shape the product for further adoption. Hence, firm failure to this extent is also determined by a lack in obtaining sufficient customer feedback (V. L. Lewis & Churchill, 1983).

- *Growth*

The growth stage is characterized by its rapid increase in sales. Firms will thrive up production in order to satisfy the demand. As firms grow, they tend to exhibit, on average, greater formalization, greater complexity, and less centralization (Veryzer, 1998). In other words, the company needs to scale business operations further implying that the firm needs to focus on its organizational structure. Among other things, the supply channels need to be optimized, and the management be structured (Olson & Terpstra, 1992). Firm failure at this stage can be linked back to firms lack in finding the right partners that can satisfy the demand for resources (Van de Ven, Hudson, & Schroeder, 1984). Maybe more crucial at this stage is the development of internal capabilities. If a firm is unable to develop internal capabilities, it is likely to fail at this stage (Scott & Bruce, 1987).

- *Stagnation*

The company reached this phase its majority stage. The number of sales has levelled off, and the business is seeking to new markets. In doing so current business operations are optimized, and costs are reduced. The firm needs to invest in developing new strategies and innovations to grow further in existing and current markets. Although the firm has likely a stable position in the market, company failure may arise when it is unable to design proper long-term strategies or to bring new innovative products to the market (Christensen, 2013). Competitors at this point may steal away market with superior product (S. S. Lee & Osteryoung, 2004)

3.2 NTBF Development

The development of NTBFs is comparable with normal firm development. Just like non-technology start-ups is the development of an NTBF characterized by a start-up, commercialization, growth, and stability phase (Kazanjian, 1988). The difference is that NTBFs have to deal with both business and technology development at the same time. For this reason, these companies face larger obstacles and problems regarding the exploitation of these technologies, which directly affect the pace of development (Kazanjian & Drazin, 1989). Overall, they deal with greater difficulties in the entire development process (Aspelund et al., 2005). For example, they face difficulties regarding financing, finding the right market niche, and turning an early product concept into market viable applications. The mature NTBFs firms, however, face difficulties with manoeuvring

new technologies in new (undeveloped) emerging markets (Lindstrom & Olofsson, 2001). Describing firm development of technology-based firms based on the problems that occur might provide a good understanding of the overall firm development. Especially when looking at the early stages of development. A firms' ability to solve or circumvent these challenges at this stage will result in significant strides of development and reduce its chances of failure vastly (Baron & Hannan, 2002; van Geenhuizen & Soetanto, 2009).

Kazanjian (1989) made a step in describing problem-based NTBF development. He proposes a model with four phases of which each phase is characterized by the presence of dominant problems. The problems per phase relate to 1) resource acquisition and technology development in the conception and development stage, 2) production during the commercialization stage, 3) sales/market share growth and organizational issues during the growth phase, and 4) organization and strategy during the stability phase (*Figure 8*).

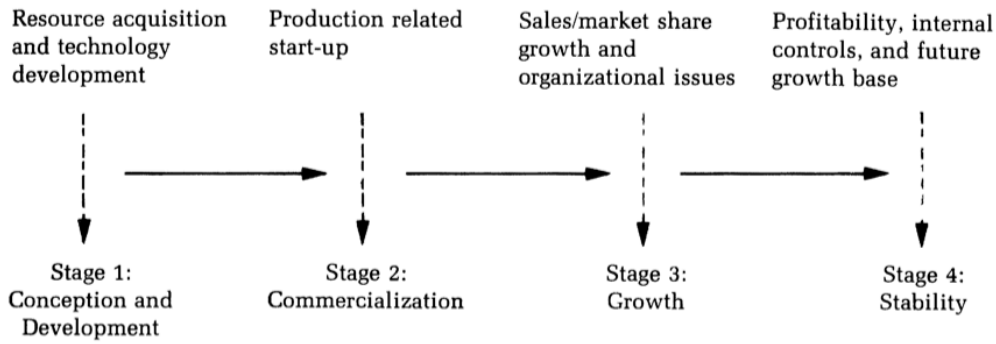


Figure 8: Relation of dominant problems to stages of growth at NTBFs (Kazanjian & Drazin, 1989)

Kazanjian's findings suggest that indeed for the first three phases such dominant problems are present (Kazanjian & Drazin, 1989). More specifically, the researchers show that problems related to people, strategic positioning, and sales and marketing are found the most occurring dominant problems over the entire development (*Figure 9*). The development of new technologies requires skilled, and often academic schooled, labour that is hard to find (Kirihata, 2007), which might explain the concurrent problems related to people. In addition, NTBFs struggle with finding the right market niche at an early stage, and with manoeuvring new technologies in new (undeveloped) emerging markets later on (Lindstrom & Olofsson, 2001). This might explain the problems related to a firm's strategic positioning. Last, new technologies and their functions are often not directly understood by its market (R. G. Cooper, 1979); this might explain its problems related to sales and marketing.

Problems often describe only a temporary obstruction in the development process. It becomes critical when problems become barriers. Vohora (2004) argued a growth model based on four generic barriers or junctures (Vohora et al., 2004). Compared to the paper by Kazanjian (1989), Vohora explicitly focuses on NTBFs as academic spinouts. As said, most NTBFs use technologies that originate from scientific environments. Four major barriers to growth retain these science-backed NTBFs: opportunity recognition, entrepreneurial commitment, credibility, and sustainable returns. Having a technological break-through, receiving funding or strengthening of the entrepreneurial team can evade these barriers. The development model, as described by Vohora, is non-linear, implying that start-ups may need to revisit some of the earlier decisions and activities by going back to previous stages (Vohora et al., 2004).

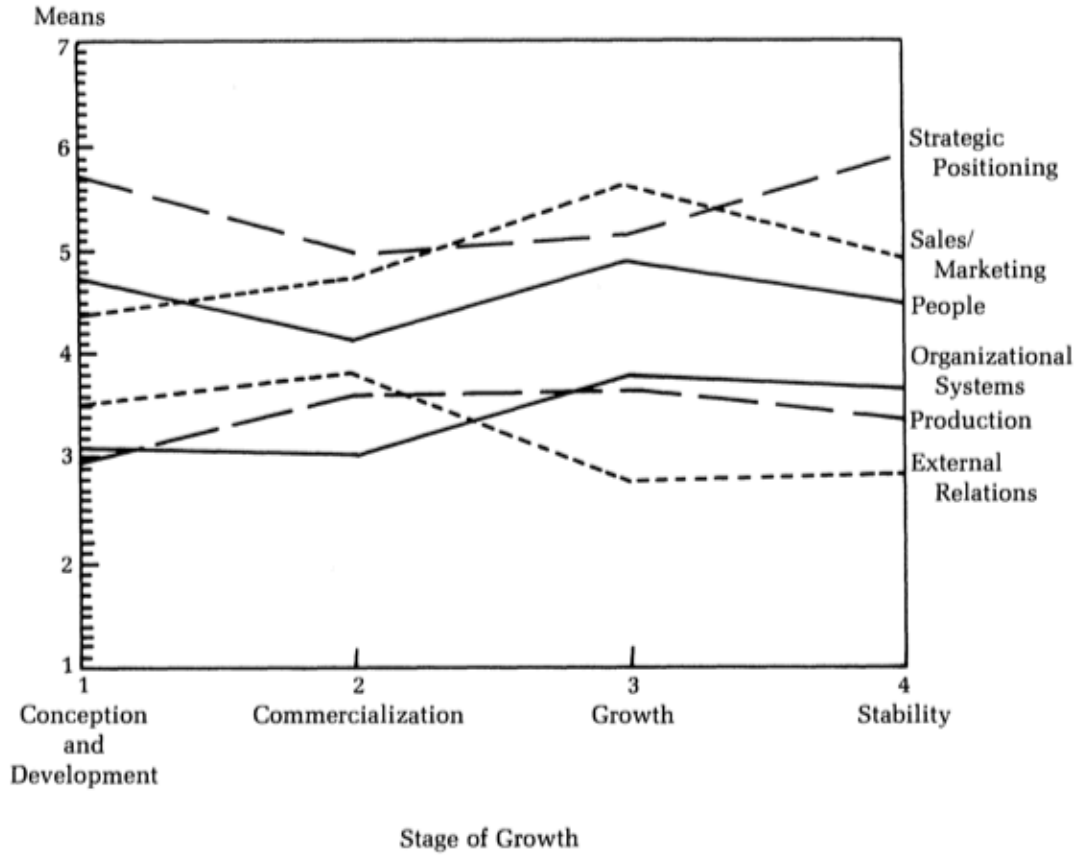


Figure 9: average dominant problems to stages of growth at NTBFs (Kazanjian & Drazin, 1989) (Adapted)

The model by Vohora and Kazanjian already gives a clear impression of the development NTBFs. Their development, however, can be split out into a three-fold: organizational, network, and finance-wise. As stressed out in chapter two, developments in one of these three directions are important for the development of the NTBF as a whole. Hence, an incubator can help providing support in these directions as well. Each of the directions and the way the NTBF makes developments in these directions is discussed below (3.2.1 – 3.2.3).

3.2.1 Organizational Development

As companies grow, they learn and get more experienced (Cohen & Levinthal, 1990), and know how to deal with new problems. As a result, the amount of business related problems drops as the firm enters the commercialization and growth phase. It can be questioned until what point the technological start-up needs business support from, for example, the incubator before it can solve its issues. Although this point differs among NTBFs, it can be stressed out that there are some key elements important for every NTBF, as an initial step to developing business-wise:

- A proper business idea with product and/or market fit
- A highly motivated entrepreneurial team with the skills to develop a first prototype
- A launching customer
- Funding to operate in the first moments of existence

Geenhuizen (2009) describes that highly innovative academic spin-offs can quickly overcome the first obstacles[7] of business development within one year. On the other hand, they much longer, up to six year even, deal with the obstacle withholding the start-up from making sustainable returns.

3.2.2 Network Development

During the NTBFs development, the firm depends on several key persons and parties. Technologies are often developed within universities without paying attention to practical feasibility of technologies in business and markets. Therefore, technological firms depend on a partnership with innovative companies or research institutes, who are willing to develop the technology in collaboration further. A link with such partners has become essential. Next, when the first commercial applications based on the technology are found, the start-up needs to find its first customer or launching customer. NTBFs, in particular, have larger difficulties in finding such a launching customer, because the market often does not understand the new technology. Then, if commercial viability is proven by a number of customers, the NTBFs face obstacles in obtaining financing. The uncertainty of technology makes it hard for banks to agree to provide a loan. Thus, a link with an investor has become essential.

Yli-Renko and Autio (1998) describes network development of an NTBF based on a systemic evolution model in which its firms needs change as the firm becomes more embedded in the network. At the foundation of the NTBF, the start-up has no ties with the external network. Most NTBFs are dependent on critical partners in the industry that help them further develop the technology. The NTBF gets over time more and more synergized within an industry cluster (*see Appendix III*). At this point, it has become easier for NTBFs to find the right people within the network via the industry's network. Hence, firms can make a greater return once having industry connections at the maturity state (Lechner et al., 2006). This way of network leverage is strongly applicable at technological start-ups since they remain dependent on industry specific knowledge required for further development of their technology (Autio, 1997; Franco & Haase, 2011).

3.2.3 Finance Development

A firm develops financial-wise once it gets easier to obtain money, to make revenue (Davila, Foster, & Gupta, 2003). Naturally, most firms experience difficulties in obtaining money at early stages. In these stages, the viability of technology is still uncertain. These uncertainties make it much harder for entrepreneurs to obtain funding, end hence more efforts need to be made in finding it; efforts that cannot be made in the development of the technology. The wrong focus may cause a delay the development of the firm with months.

The nature of the finance options changes, once the firm progresses in its development (Berger & Udell, 1998; Bonnet, Cieply, & Dejardin, 2005; Gregory, Rutherford, Oswald, & Gardiner, 2005). According to Berger and Udell (1998) that, during the first stage of development, the need for *angel* investment or other forms of seed financing (like crowd-funding, friends, and family) becomes the most popular form of financing. Once the firm matures, finance forms like venture capital and private equity funds become more popular. It can be said that each finance option belongs to a particular phase of development (*Figure 10*) (Gompers, 1995). The level of risk capital lenders must take decreases when the start-up matures, making it overall easier to get funding for matured and growing firms than for small firms that are still in their start-up phase(Berger & Udell, 1998). In addition, large capital moneylenders like VCs and private equity [PE] holders are not conventional finance options for early stage firms. For them maintaining a broad portfolio with many small investments is too costly to maintain and control (Birch, Gundersen, Haggerty, & Parsons, 1999).

[7] Obstacles include: opportunity recognition (or business idea identification), entrepreneurial commitment (or motivation team), and credibility (finding an investor or launching customer).

Banks are a most often approached by NTBFs for funding (Anderson, 1999; Shepherd, Douglas, & Shanley, 2000). However, banks are also the most reluctant to lend money because of the large risks involved (Minola & Giorgino, 2011). Contrary to banks, are Venture capitalist more willing to invest in technology-based firms. However, VCs often start to invest if the company has proven market potential. By doing so, they focus on NTBFs where the information asymmetries are highest (Gompers, 1995). Having a radical and new technology thus enhances the likelihood of a VC, who is willing to participate (Van Osnabrugge & Robinson, 2000).

To still cover the costs of fairly risky research, early stage start-ups often depend on government grants (Erlewine, 2004). They afford entrepreneurs not only time to develop the technology further, but also find a commercial application for their technology (Blair & Hitchens, 1998; Mustar, 1997; Shane, 2004). Having a grant, on the other hand, reinforces the likelihood of public funding since VCs perceive grants as a sign of commercial viability of the technology (Shane, 2004). Business Angles and VC's are found the most favourable group among growth-oriented firms (Lindstrom & Olofsson, 2001). Berger & Udell (1998) argue that firm age, size, and information availability are decent variables to analyse the development of finance type needs. However, Gregory et al. (2005) claim that only size (in terms of employment) can be seen as suitable for analysis. The authors argue that younger firms experience on average the largest growth rates and are, for this reason, able to secure the most attractive forms of finance.

An NTBF needs to find a balance between the right investment option in comparison with its stage and thus the level of risk assumed by the investor. Besides government grants investment by founders, friends and family are common most applicable, in this case. These people buy in on the idea, vision, or expertise. They trust that these entrepreneurs, their friend or family member, will turn the business into a success. Figure 9 shows that once the firm matures the risk assumed by the investor decreases, and other types of finance options become available.

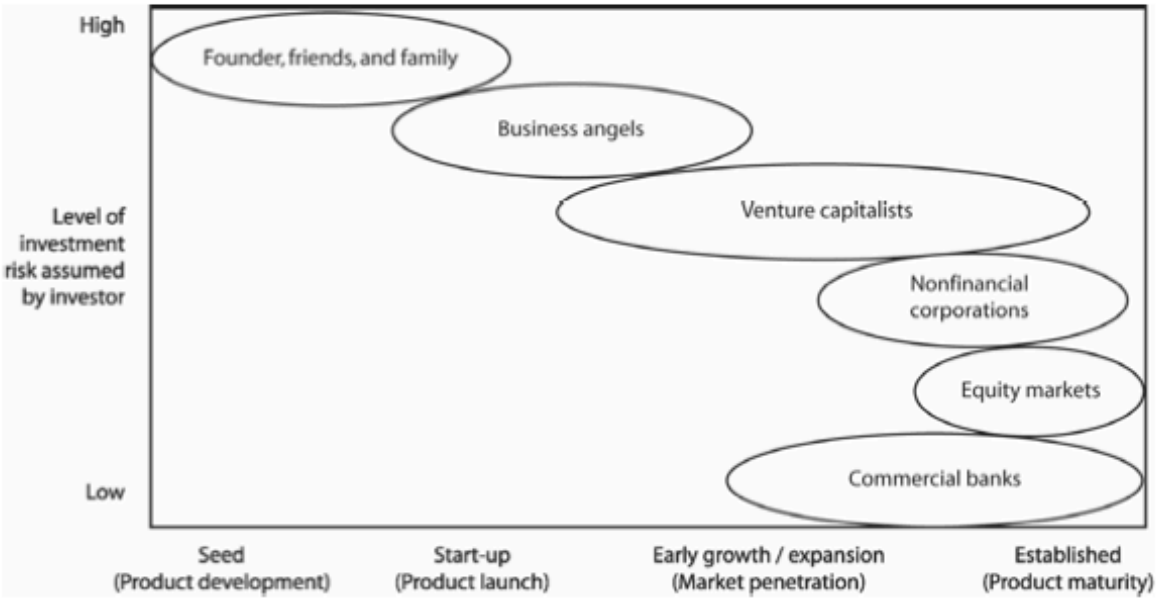


Figure 10: Different types of investors at different stages of NTBF development (Gompers & Lerner, 1999; Gompers, 1995; Lerner & Tetlock, 1999; Shane, 2004)

3.3 NTBF Profiles

The following section contains an outline of different NTBF profiles. NTBFs are characterized by the fact that they exploit new technologies as a core capability of their business (Lindelöf & Löfsten, 2003; Löfsten & Lindelöf, 2005). The presence of such technologies fosters innovation and increases sustainable returns, sub-normal profits, and market leadership (Spencer & Kirchhoff, 2006). These types of firms are typically characterized by the fact that they use expensive technologies, have a strong focus on R&D, and can grow quickly based on the technology. Also, they hold the potentiality to disrupt markets (Yli-Renko, Autio, & Sapienza, 2001), increase the *entry barriers* for competition (Barney, 1991; Tushman & Anderson, 1986), and pursue *technology leadership strategies* (Amit, MacCrimmon, Zietsma, & Oesch, 2001; Clark, 1989). These firms are discussed in more detail because these types in particular hold great potential to contribute extensively to the attainment of the incubator objective (e.g. foster innovation, growth, and employment in the region). To make the study more understandable, three profiles based on the characteristics of the NTBF are identified: the growth-oriented firms (3.3.1), the capital-intensive firms (3.3.2), and the R&D focused firms (3.3.3).

3.3.1 Growth-Oriented Firms

At first glance, these types of NTBFs do not seem to need incubator support for growth, however, although they have a high orientation it does not imply they already have achieved this growth. They still deal with high-end, and often risky, technologies (Feeser & Willard, 1990). NTBFs are by nature growth oriented (Tötterman, 2004). Founders leading of an NTBF are willing to take risks to pursue growth. They believe in the success of technology. It can be concluded that orientation of NTBFs is heavily subjected to the standpoint of the entrepreneur or entrepreneurial team (Saemundsson, 2003). This is well described by the dominant coalition model (Cyert & March, 1963). The model argues that owners in such areas have power positions they can use to achieve growth (Hickson, Hinings, Lee, Schneck, & Pennings, 1971). These power positions are achieved by several factors related to its technology. As the technologies mature, they will less likely break down and, for this reason; the entrepreneurial team can with more certainty take a growth position. Radical en new technologies also have a lower substitutability (Christensen, 2013; Garud & Kumaraswamy, 1995; Sood & Tellis, 2005), which also enables the entrepreneurial team to take a stronger power position. NTBFs often consist of small and centralized teams. A team that is small can be easier controlled and so the power position increases.

Firms with a high growth orientation are likely to have already a high developed and patented technology (Amit et al., 2001; Tötterman, 2004). These entrepreneurs are aware that the technology can grow quickly and have an enormous market potential (Tötterman, 2004). Thus, it is required that these types of people have strong business skills. Hence, the faster the entrepreneur is able to make decisions on critical problems, the faster a solution is found to each problem and the firm can further develop. The downside of a fast growth orientation is that the entrepreneurial team might have higher risks because they have limited time to assess all solutions and pick the best. This might indicate that because of the limited time the wrong solution is chosen and a higher risk is taken. In addition, firms can take such growth-oriented positions once they know that all suppliers and distributors are in place. Growth oriented firms generally are more embedded in a network (Autio, 1997).

Apart from needs related to the development of technologies, the needs are delineated to resources such as people or assets to grow (A. C. Cooper, 1986). For high-growth firms, it is important that they attract VC funding at short notice (Amit et al., 2001). Delayed execution may have substantial negative consequences

with respect to the firms' success (Sharpe, Alexander, & Bailey, 1999). With an increased trend for fast growth and the extreme ability to scale quickly, it can be said the higher the company expects to grow the higher the need for financing will be. Therefore:

Proposition 1: The firms' growth orientation is positively associated with having finance needs

Literary sources show minor signs that indicate that firms with higher growth orientation have higher business or network needs. As discussed earlier, in order to have a high growth orientation, firms already need an experienced entrepreneurial team that can realize growth (Tötterman, 2004). These entrepreneurs already gained network contacts and substantive business skills in their previous career (Autio, 1997).

3.3.2 Capital-Intensive Firms

Some NTBF's require more capital in order to develop and test their technologies more than others. Capital-intensive firms are firms that deal with expensive new technologies in terms of research, development, and production (Brandkamp, 1997). The author describes that capital intensity is close related to the industry of the firm. Industries creating software technologies are much less capital intensive than, for example, biomedical technologies. Especially in the case of the latter, there is a need for labs, specialized materials, skills, and time to test, making the business development costly (Brandkamp, 1997). These companies need to secure funding at an early stage, test and re-test to lower the risks of the invested money, and search for a potential partner to spread development costs.

Funding can speed-up the development of capital intensive firms i.e. more (expensive) researchers or facilities can be hired to develop the technology (Brandkamp, 1997). The isoquality line describes how time can be substituted for capital (*Figure 11*). Note that after a sudden point (point A) the switch from capital to time no longer justifies a lower capital requirement. Contrary, the development of technology requires a certain level of expertise to assure the same quality. With limited capital available to pay an R&D team, specific knowledge is acquired by means of consultancy, which, as a result, will cost more. Overall the narrowness of the gap between the scientists' technological knowledge and experience of the business activity determines the resources required and thus the speed of progress to market (Wheelwright, 1992). The point at which the highest quality can be reached with limited capital (referred as point A) also differs per industry (Druilhe & Garnsey, 2004). In general, industries with a lower technological sophistication (i.e. software) this point lies at a lower capital and time requirement level (*Figure 12*).

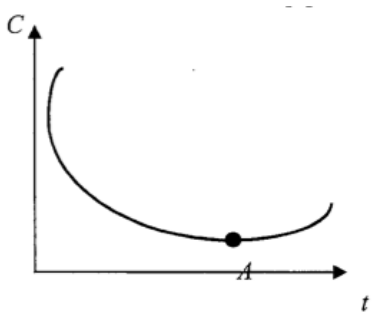


Figure 11. Capital and time requirements along isoquality line (Brandkamp, 1997).

A capital-intensive firm thus needs substantial money to develop its technology. Start-ups are often unable to generate the substantial costs internally. They, therefore, become dependent on secondary sources. In this case, the firm will have to rely on grants, investments, and loans. Therefore:

Proposition 2: The firms' capital intensity is positively associated with having finance needs

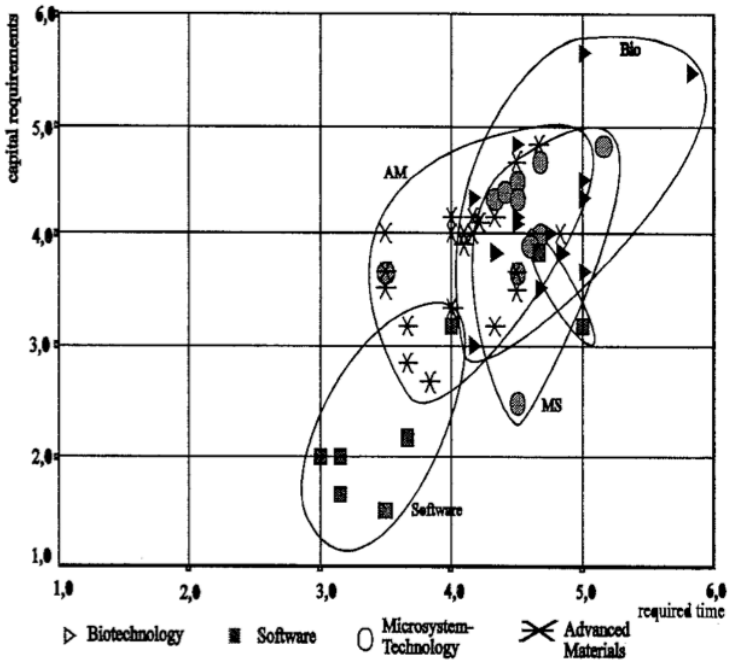


Figure 12. Capital intensity of different industries (Brandkamp, 1997)

For a capital-intensive start-up it is often difficult to obtain funding. These firms require investments before any return is realized (Atkinson & Stiglitz, 1969; Wu, Kleindorfer, & Zhang, 2002). Banks often discard these start-ups as too risky and withhold lending or investing capital (Lindstrom & Olofsson, 2001). On this way, it is suggested that capital-intensive firms are in higher need to get in contact with investors or partners to share the development costs. Therefore:

Proposition 3: The firms' capital intensity is positively associated with having networking needs

No particular argument can be found that indicates that higher capital-intensive firms higher business needs. It is expected that funding, or access to a network to get funding, enables firms to hire the required expertise for business assistance as discussed by Brandkamp (Brandkamp 1997).

3.3.3 R&D Focused Firms

As described earlier, most NTBFs originate from research projects that derive from the university. The technologies of these firms are invented from an academic point of view and rather than from a market point of view. This implies that new technologies often need years of further research and development before one can find a good product/market fit for them. This also implies that the entrepreneurial team exists of people that understand the technology in order to develop it further. As a result, these types of firms are often led by researchers and scientists (Heirman & Clarysse, 2004). The main focus of these firms is to listen carefully to the customer by testing the technology/product and adapt it accordingly. R&D focused firms are firms that, to a larger degree, deal with technologies that require intensive research and development (V. L. Lewis & Churchill, 1983).

However, from the other side, in order to commercialize a technology, the entrepreneurial team needs to understand market dynamics. Experts and scientist are experts in the field but often lack managerial expertise required to turn technology into a product that is understandable for the market and addresses a solution to a

problem of a particular market niche (Lindstrom & Olofsson, 2001). They therefore need business support regarding business models, marketing and sales.

Furthermore, firms exploiting R&D intensive technologies in new markets deal with different customer segments, needs, and context (Tyebjee & Bruno, 1980). Technologies that are very new to the market require small and iterative adaptions before the majority of the market will adopt it. In this case, the NTBF has to deal with a learning curve based growth that describes how a new technology is adopted by the market with small iterations on the product (Malerba, 1992). Intensive businesses skills are needed that make sure the right business models are applied to the technology. It can be stated: a higher R&D focus is positively associated with having more business development problems and thus requires more support form the incubator. Hence:

Proposition 4: The firms' R&D focus is positively associated with having business needs

Firms that execute intensive R&D require a broad network of many different parties relevant for business growth (i.e. investors, suppliers, distributors)(Nicolaou & Birley, 2003). Firms coping with higher degrees of innovative technologies require skilled people (Vohora et al., 2004). These people are not easy to find. On top of that, R&D focused firms also experience greater difficulties in obtaining funding due to great uncertainties in technology (Westhead & Storey, 1997). Banks often discard loan proposals for these types of firms; these companies are appointed to their network to find the required financing (Lindstrom & Olofsson, 2001). Overall, it can be discussed the higher the technological distinctiveness, the higher the chances of misunderstanding by the market, difficulties to obtain money, and dependence on required expertise for technology development; hence the higher its needs to find the right people. Therefore:

Proposition 5: The firms' R&D focus is positively associated with having networking needs

In literature, no real arguments become apparent indicating that R&D focused firms also has high finance needs. The expectation is that firms with a strong focus on R&D typically deal with longer periods subjected to testing and coordination (Brockhoff, 2003). During these periods the finance needs are low; hence firms are not yet commercializing or scaling the business, which requires much more financing. Often present finance needs in these periods are satisfied by research grants or subsidies (Gregory et al., 2005).

Overview of the proposed propositions

Figure 13 shows a schematic overview of the proposed relations between the NTBF characteristics and their needs. Proposition 1 describes a positive relation with the firms growth orientation and with having early finance needs. These firms want to grow rapidly and need financial support in order to facilitate this growth. Capital-intensive firms, on the other hand, need financing to pay the expenses for their expensive resources and tools and are therefore expected to have higher finance needs (Proposition 2). If these firms cannot obtain the required funding from investors or banks (who often discard capital-intensive start-ups as too risky) these firms have higher network needs to get in contact with for example partners to share costs (Proposition 3). Next, firms with a stronger R&D focus need a more time to develop new technologies. The presence of engineers or researchers as entrepreneurs, who are experts in their field often lack managerial skills. As a result these it is suggested that these firms have higher business needs (Proposition 4). Last, R&D focused firms, have more difficulties in finding a market niche for their innovative technologies. The new technology is often not well and fastly understood, and not fully developed; only a few parties believe in the product. The need to get in contact with a launching customer is therefore very high (Proposition 5).

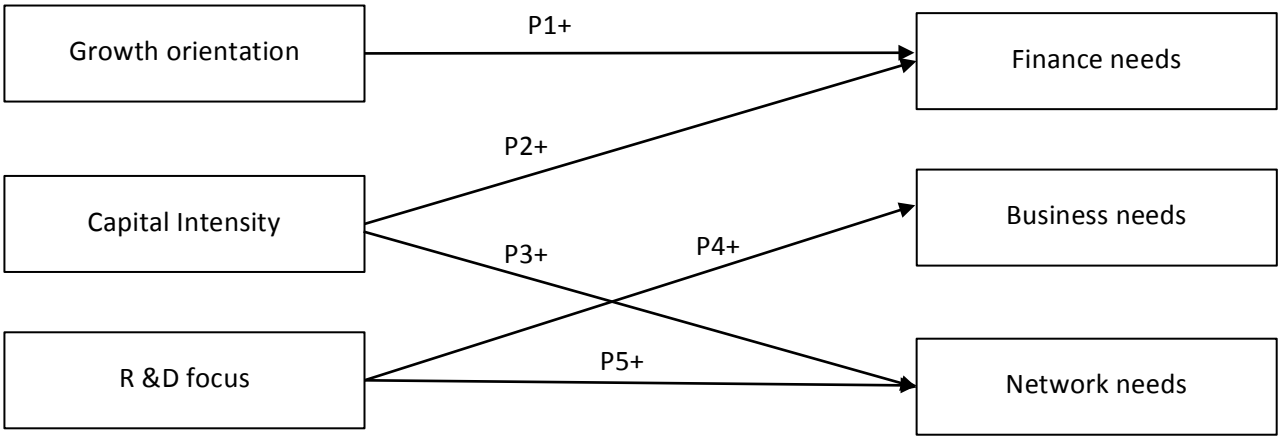


Figure 13: Preliminary conceptual framework

Key insights of Chapter 3

- Development of NTBFs can be described based on life-cycle models in which the firm encompasses several stages of development.
- The life-cycle model of the development of acadamic underpined NTBFs is non-linear. Implying that these firms may fall back to previous stages in some situations.
- NTBFs within UTBIs can be distinguished by three profiles: the R&D focussed, capital-intensive, and growth oriented firms.
- A conceptual model that describes the relation between the NTBF profiles and higher needs will help to understand the differences in the development process of the three identified incubatee profiles.

-

4 Methodology

This chapter addresses the methodology of this study. The chapter starts with describing the research design of this study; it outlines in what way the study aims to provide an answer to the research question (4.1). The explorative context of the study calls for a broad understanding of the situation at hand. Therefore, a mixed model is used, consisting of both qualitative and quantitative measures. In the following section, it becomes clear how the data is obtained for these two measures (4.2). Chapter 3 ended with the description of a conceptual model. In this model, several constructs are identified. Next, it becomes clear how these constructs are operationalized (4.3). Also, the operationalization of the interview analysis is described. Lastly, is discussed how data is analysed for both research measures, taking into account the validity, reliability and generalizability of the results (4.4).

4.1 Research Design

First to mention, when looking to the study as a whole, it can be concluded that there is limited understanding of incubatee evaluation, and hence, an explorative study can provide a way to get a better notion of this. An explorative study offers the possibility to explore and analyse the underlying ideologies of the concepts, of which yet little is known in the first place, in a time-efficient fashion (Yin, 2011). The pure functional orientation distinguishes itself from disciplinary orientations, that studies culture or experiences like in ethnographical or phenomenological approaches (Merriam, 2014). Compared to grounded theory, an explorative study is open to theories or conceptual categories to guide the research and analysis of data (Meyer, 2004). In addition, an explorative study gives a rich description of the phenomena in a real-life setting (Yin, 2011). In fact, a grounded theory will result merely in a theory that is 'grounded' in data. To this extent, an explorative is found the most suitable format.

The explorative nature of this study implies that the research must be open for getting a broader understanding of concepts and constructs. The yet broadly undiscovered area of research provides many opportunities for researchers and scholars addressing the incubator concept. The short time frame calls for an efficient way of doing research. Therefore, this study will limit itself in only a single shot cross-sectional way of obtaining data. Additionally, the limited time scope and the in literature unaddressed, relationships between constructs make it difficult to execute a pure causal study. Instead, the focus lies on finding correlations between constructs.

As described in chapter 1, ineffective and inefficient incubation/evaluation takes place as a result of having (as an evaluator) a poor understanding of NTBF development during incubatee evaluation. The aim of this study is to develop a new evaluation tool. Empirical research will help to deliver inputs and insights for the new tool. Therefore it is important to research the following three aspects:

1) An incubator helps to find support for early stage start-up problems. In fact, an incubator can in theory add value as long as these problems remain. However, as described there need to be limits and criteria

to reach efficient incubation. The incubator evaluates progress after a first incubation term. It is interesting to study till what point, overall incubatees have needs for early stage needs. Perhaps this evaluation can take place sooner.

2) Next, as found in literature, some NTBF profiles are expected to have higher support needs as other types. In order to balance the provision of support, differences in needs among these firm profiles need to be well addressed.
3) Most incubators perform evaluation in the first year of firm development. In this period the number of start-ups problems that can be satisfied by incubator support is highest (Scillitoe & Chakrabarti, 2010). It is important to study what factors might bias the evaluation at these moments.

4.2 Data Collection

Two ways of data collections are used for this research: a survey and interviews. The survey is used to come to understand the overall change of needs during the incubation period and at the different NTBF profile characteristics (Bullet 1 and 2 of the previous section). The interviews are used to get a grip on other, yet unknown factors that might influence the progress of incubatees (bullet 3).

4.2.1 The Survey

A researcher from the Dutch University of Technology in Delft (Faculty Technology, Management, and Policy, section: Economics of Technology and Innovation) cultivates data annually from NTBFs within YES!Delft. This data obtained from a survey. The data is used for a large number of studies studying university entrepreneurship. Because fields of study change over time, minor changes and revisions are applied to the survey annually. The researcher sending out the questions started by asking for permission from the incubator manager. With the authorization of the interviewee, the surveys were digitally distributed to all founders of companies currently present in the YES!Delft incubator. To prevent potential method biases (i.e. biases that occur due to problems in questionnaire design), a cover letter motivation stated clearly the purpose and intention of the survey. The questions were also grouped and structured in a logical order. The first set of questions covered the firms' base characteristics and performance. The second part covered more in-depth questions on attitudes and experiences of the company. Examples of the first set include questions regarding its performance, size, funding, and markets active. Examples of the second part include questions on the firms' opinion and experience of being incubated in the incubator as well as questions regarding the firms' strategy and capacity. The data gives insight into the Intellectual property, financial status, number of employees, collaboration with universities, and capacity needs of firms within the incubator.

The survey used for this study (YES!Delft Technostarteronderzoek 2013) contains 72 firms of the in February 2014 active companies. 59 firms (or 82%) gave a valid response; the other 12 (17%) did not give a response or hand-in an invalid survey. Potential non-response biases were circumvented by asking the YES!Delft incubator management team for a list with base data from the companies currently present in the incubator. No differences in growth, size, age, and industry were found between those who gave a response and those who did not.

4.2.2 The Interview

Three semi-structured interviews were held with three NTBFs from the survey sample. The interviewees were chosen from the survey based on convenience sampling by myself. Furthermore, at YES!Delft, the Incubation program is the base program that aims to support NTBFs during their first three year of development. In this period, problems and incubatee expectations of firms are highest, and, for this reason, this would most likely give the best insights and expressions required to substantiate the outcome. For this reason, the interviews

held with three companies are not older than three years. Special attention went to selecting firms that diverge in terms of industry and development. This concluded in a selection of three firms: one material engineering firm that grows moderate ad still develops its technology in collaboration with the industry (CompositeTech), one mechanical engineering firm that is heavily in its development phase without showing a direct growth in size and sales (AquaTech), and one software firm that was able to grow rapidly because they were able to develop their technology (WebTech) quickly.

CompositeTech works with advanced composite materials and has a unique way of applying this as a core capability at various industries. The technology itself is not new, but the way it is developed and applied is. The company exists for over 2,5 years at the moment the interview was taken (Dec. 2014). CompositeTech made a turnover of €150.000 and realized 4 FTE's in 2013. During the interview is spoken with one of the co-owners of CompositeTech. The second company, AquaTech, is a young cleantech company that develops an emission and maintenance free water-pump. Although the company won many prices because of its high sustainability, it still made no turnover. The 1,5-year-old company is still in its development phase and has a rather long development trajectory. It still needs to test the first versions of the product, as well as to set up a distribution channel. The interview was held with one of the co-founders of AquaTech. The third company, WebTech, is a young IT company. The one-year-old company generated within a year already €40.000 euro. WebTech used pre-programmed technologies and tools. By applying *lean start-up principles*, they were able to develop quickly and commercialize their technology. The founders of the team already had gained experience before they started this company.

An email with a request and motivation was sent to the chosen companies. They were all able to participate on a short notice. The questions asked require managerial and strategic expertise that can only be obtained by someone who fully understands the current strategy of the firm and contingent shifts in its course. Thus, I explicitly asked for an interview with one of the co-founders or co-owners of the NTBF, as they are most likely the ones who thoroughly understand their company.

Interview Protocol

As its start, I communicated that the interview would only take 15 minutes of their time. Entrepreneurs are busy people; in order to prevent biases related to nonparticipation a tight schedule was used to cover all questions. Next, I asked permission to record the interview. I clearly explained the recordings would only have a purpose for the analysis, and it would be deleted after graduation. At the end of the interview, I expressed appreciation and asked if the interviewee had any remarks. Last, I worked out the answers on the interview deliberately after the interview and documented the outcomes into interpretable interview transcriptions (see *appendix IV*).

During the interview, I made sure that trust levels with the respondent where optimal. I was keen on signals indicating the interviewee might not feel comfortable. As a researcher, showing a "*genuine interest in the responses and allying any anxieties, fears, suspicions, and tensions sensed in the situation will help responders*" (Uma Sekaran & Bougie, 2010). A transparent and empathize style of interviewing has its preference. I clarified and elaborated on why they were chosen and how the answers contribute to the research. Lastly, a bias may occur when people do not feel comfortable. I made sure, in case of confidential questions that no open space was chosen. Also, I asked the interviewee to choose a meeting point where he would feel most comfortable to talk. Biases related to content or the style of questions where circumvented by not asking steered questions. Last, regarding the documentation of the interviews in the report real names are in accordance with the spoken companies altered to alternative names to keep the confidentially.

4.3 Operationalization

The operationalization of the survey analysis is described in 4.3.1. The operationalization of the interview analysis is discussed in 4.3.2.

4.3.1 Survey Question Operationalization

This section describes the operationalization for the statistical part of the study. Literature is used to find validated measures for the constructs whenever possible. See *Appendix V* for an overview of the questions used for the survey analysis. The analysis on overall firm development includes an operationalization of the firm needs and firm development (see bullet 1 of section 4.1). This is discussed in sub-section 4.3.1.1 and 4.3.1.2. The analysis on the differences in needs between NTBF profiles includes an operationalization of the firm needs and firm profiles (see bullet 2 of section 4.1). This is discussed in sub-section 4.3.1.3

4.3.1.1 Firm Needs

All questions reflect on early stage needs or needs that can be satisfied by incubator support (business coaching, funding, or networking). Each type of firm need consists off multiple sub answers. Each sub answer reflects a specified item the incubatee needs within this dimension. All (sub) answers were measured by means of questions with a 7-point Likert scale. Respondents could indicate whether they agreed or disagreed if they need finance for one of the activities.

- *Finance Needs*

In order to understand the finance needs of a firm, I did not look to the type of financing they are possibly interested in, but rather where do they need it for i.e. market expansion, product development etc. The question that was asked was: "To what extent do you need additional financing for research, prototype building, product launch, attract personal, running business processes, geographical market expansion, or other." These activities take place at various stages of development. In addition, by adding the word 'additional' also those who recently received financing can answer this question. Asking about the type of financing or amount of financing required would have provided unreliable results, since it carries the assumption that the respondent by definition needs financing. The answers to all sub-questions are bundled into one variable labelled as 'FIN_NEED'.

- *Network Needs*

Network needs cover a firm's urge to get in contact with investors, clients, suppliers and distributors. The respondents were asked, to indicate, using the same Likert scale, whether they need support in finding a partner, a (launching) customer or other relevant parties by means of lobbying. The answers on all sub-questions are bundled into one variable labelled as 'NET_NEED'.

- *Business Needs*

The business needs reflect all needs directly related to its business operations, for example, all legal, financial or practical matters. Again based on a 7-point Likert scale, respondents were asked to indicate whether they needed support in writing a grant application, selecting and recruiting employees, doing financial or personal administration, requesting certifications, or making prototypes. Although there are probably more business needs to distinguish, the current set gives an overall impression of needs that could exist within an incubator. The answers on all sub questions are bundled into one variable labelled as '*BUS_NEED*'.

4.3.1.2 Firm Development Constructs

In literature, firm development is measured with development stages (Gaibraith, 1982; Greiner, 1972; Kazanjian & Drazin, 1989; V. L. Lewis & Churchill, 1983), but also based on age (Evans, 1987; Lundvall & Battese, 2000; van Geenhuizen & Soetanto, 2009).

- Age

Age is operationalized as the log of the firm's foundation year. The variable is labelled in the analysis as '*AGE*'.

- *Stage*

Next to age also a firm's growth stage influences the needs of a company. As it grows, the firm becomes more independent and is likely to depend to a lower extent on the support from the external environment. As a result, developed firms will be less explicit about their needs. In order to test the relations, stage should be included as a control variable. Stage is determined by looking at the number of employees, actual sales, sales growth (Kazanjian & Drazin, 1989), but also to and nature of activities (Birley & Westhead, 1990; Greiner, 1972; V. L. Lewis & Churchill, 1983). The variable is labelled in the analysis as '*STAGE*'.

4.3.1.3 Conceptual Model Constructs

As shown in the conceptual model the dependent variables are different types of needs, the operationalization of these constructs is already discussed above. The independent variables are three NTBF characteristics that are expected to affect the needs of an NTBF. These are firms' growth orientation, capital intensity, and R&D focus. Because differences might occur between different ages, stages or recent support, these three variables are selected as controls. Below the different constructs and the way they are operationalized is further discussed.

Independent Variables

- *Growth Orientation*

Growth orientation was measured by the firms' promptness of investments and decision-making. Other papers that measured growth orientation on this way are found (Covin, Green, & Slevin, 2006; Liao, Welsch, & Stoica, 2003). Having a concise time horizon for investments and decision-making indicates that a company is aiming for fast growth (Davila et al., 2003; Tötterman, 2004). Growth orientation is measured on a 7-point Likert scale based on (dis)agree measurement for three levels of growth orientation: time horizon and decision-making of less than 1 year, between 2 and 3 years, or higher than 3 years. This triple level measurement is chosen in order to control for divergent growth orientation between investment rounds or projects. A question asking the number of years for investments and decision-making would provide one (average) insight whereas this triple level measurement provides a broader insight into a firm's overall growth orientation. In order to calculate a correlation between the constructs the three measures are merged. The variable is labelled in the analysis as '*GROWTH_ORIENT*'.

- *Capital Intensity*

Operationalizing a firms' capital intensity can be realized by giving industries, dealing with higher degrees of technological sophistication, a higher nominal value. These firms deal with higher costs in development and production (Brandkamp, 1997). Software, consumer products, and services industries received a value of 1. Advanced materials, industrial machinery and tools got a value of 2. Microsystem technologies and specialized

equipment got a value of 3 and biotechnology, aerospace, and Nanotechnologies got a value of 4. The variable is labelled in the analysis as '*CAPITAL_INTENSE*'.

- *R&D Focus*

The R&D is measured based on a 7-point Likert scale, the respondent was asked to agree with either "*In general we have a strong emphasis on exploiting existing products and services"* or "*In general we have a strong emphasis on R&D, technological leadership and innovations*". The variable is labelled in the analysis as '*RD_FOCUS*'.

Dependent Variables
The firm needs (as discussed in 4.3.1.1.) are in the conceptual model considered as dependent variable.

Control Variables
For the analysis of the conceptual model it can be argued that time and firm development influences the results. Therefore the variables 'age' and 'stage' are used as control variables. Their operationalization is discussed above.

4.3.2 Interview Question Operationalization

The main focus of the interviews is to get a better insight in the firm development process associated needs of the three selected cases. A better insight in this development trajectory makes it possible to find unknown aspects that might be relevant to improving incubation evaluation. On this way, it is possible to find other factors that might play a role when evaluating incubatees (especially at early evaluation moments). As described in Chapter 3, NTBF development can be distinguished into three development directions (financial, network, and business). I asked questions related to each development direction.

- The first question was used to get a basic understanding of how the firm developed in each direction. For example, *"can you give an indication how your {network/business/funding} developed"*. This question tells more about the possible past appearance and sequence of needs.
- The next step was to get clear how important each dimension is for the entire firm development. For example: *"can you indicate how important your {network/business/funding} is for your entire development".* This question tells more about the importance of certain needs.
- Last, to get an idea about the current needs I asked for the current needs. For example: *"What kind of your {network/business/funding} needs do you currently have? Why is it important?"*

4.4 Data Analysis

To analyse the survey data two statistical approaches are used: comparing means and a correlational analysis. The comparing means analysis gives a general impression of the situation at hand. The correlational analysis is used to empirical test the relations. Because the focus in this study is prior on finding these relations – without knowing the entire context – based on existing theories the usage of more complex correlation measures, such as a regression analysis, is found unattainable for this research. Spearman's rank correlation coefficient is used to calculate the correlation coefficient and significance of the constructs. Because the data is ordered on an ordinal scale, the Spearman rank correlation coefficient is the most appropriate coefficient for this analysis.

I qualitatively interpreted the answers given by the interviewees. Although the research was semi-structured, special attention went to comments and additions to the proposed questions. Special attention also went to the verbal interpretation of the answers. At the analysis, theories are used to substantiate the results.

4.4.1 Validity

Content validity is gained by looking at the research methods and concepts used by authors of previous studies (i.e. Kazanjian, 1989, Covin, 2006, Brandkamp, 1997). In addition, a senior researcher has already designed and executed the questionnaire used for this study. His expertise is already included in the content of measures. By means of a factor analysis constructs validity is achieved. The analysis assessed whether grouped questions from the survey measure the same construct (Appendix VI). The use of criterion validity in survey studies is rather uncommon, this because there might be a lack of empirical criteria against which the criteria can be assessed.

The questions asked reflect past development steps. In the quantitative analysis, for example, the descriptive analysis in chapter 5, the averages showed sometimes-mixed result. In order to correct for this descriptive stats were corrected by deleting groups that had too few items.

4.4.2 Reliability

Performing a reliability analysis ensures the reliability of the survey study. In the previous section, the independent variables are operationalized through a set of survey questions, measuring the same construct. The Cronbach's Alpha of the construct, which is measuring financing, network, and business needs are all above 0.5 (.686, .740, .813 respectively)(Appendix VII). This means that one can describe as a high reliable that all sub-questions, measuring the firm needs construct, are strongly connected. However, after performing a factor analysis, it turns out that the finance needs can be divided into components. A new reliability analysis on each component shows that the first component, hereafter defined as finance needs for product/technology development (FIN_NEED_DEV), has a Cronbach's Alpha of 0.721 (sub-questions CAP_GOAL_A, CAP_GOAL_B, and CAP_GOAL_C[8]). The other identified component, from now on defined as finance needs for organization development (FIN_NEED_ORG), has a Cronbach's Alpha of 0.591 (CAP_GOAL_D, CAP_GOAL_E, and CAP_GOAL_F). If the results show peculiar outcomes, the finance needs will be split in two. Because the finance needs already have a high Cronbach's Alpha in the initial statistical analysis, it will be discussed as one.

4.4.3 Generalizability

Representativeness of the sample is an important determinant of generalizability. In order to get a representative sample, the sample must be discussed broadly. In this study both the UTBI and NBTF are in-depth analysed. The sample from this study describes the interaction of NTBFs in case of YES!Delft. Implying that it only describes the situation of one UTBI. Taken into account the fact that each UTBI represents a different context, the results of this study have a rather low generalizability. A special remark must be made for future studies that rely on the outcome of this study. Thus, a detailed description of the context of the phenomenon is necessary, in all cases. Also a reflection of the results of comparable studies is.

[8] Funding required for product/technology development related activities, such as further research, prototype building, or product launch.

5 Results

In this chapter, the outcome of the empirical part of the study, the research, is presented. First, a brief outline is given of the outcome of the descriptive analysis (5.1). The outcome of the descriptive analysis helps understanding the context of results. The chapter continues with showing the results of the survey analysis (5.2). This section provides the outcome and qualitative interpretation of the quantitative analysis (survey). The chapter ends with providing the results of the interview analysis (5.3). This section will first discuss the development of each company, followed by an interpretation of the results.

5.1 Descriptives

YES!Delft supports a high variety of firms within various types of industries. People come from both the academic and the industrial environments, contributing to a diverse culture. This section elaborates on the composition of the sample used for this research. The descriptive analysis is based 61 firms (N=61).

- *Age*

On average, firms within YES!Delft has an age of 3,4 years. When looking at Table 5, one can state that most of the firms can be classified to the group with tenants that are not older than one year (23%). Furthermore, one can state that there are significantly more firms in the group between 3-4 years. In 2010 (3 years before the observation) YES!Delft moved to a new facility extensively expanding the capacity of the incubator. Possibly at that moment, YES!Delft decided to allow more start-ups to the incubator in order to fill its capacity. In the entire overview, it is clearly visible that there are younger firms than older ones. This can be explained by the fact that there are firms who leave the incubator at an earlier stage, both failures and examples or early maturity. Another reason is the fact that over time YES!Delft grew in popularity and admitted more start-ups annually.

Age [2013]	**N**	**%**
0-1 yr.	14	23
1-2 yr.	8	13
2-3 yr.	6	10
3-4 yr.	11	18
4-5 yr.	8	13
5-6 yr.	3	5
6-7 yr.	5	8
7-8 yr.	4	7
7-8 yr.	2	3
Total	61	100

Table 5: Descriptive overview frim age in 2013

- *Revenue*

When looking at the start-ups' sales distribution *(Table 6*), it can be remarked that most firms can be placed in the group that is making a turnover of less than €100.000 (39%). On average, the incubatees at YES!Delft made an annual turnover of € 281.000 in 2013. Seven companies (12%) made an annual turnover of above €500.000, of which two firms managed to make an annual turnover of above a million Euro's[9].

Revenue – X 1.000 € [2013]	**N**	**%**
< 100	24	39
100 – 199	9	15
200 – 299	7	12
300 – 399	10	16
400 – 499	4	7
500+	7	12
Total	61	100

Table 6: Descriptive overview firm annual turnover in 2013

- *Sector*

As said, YES!Delft hosts incubatees from different sectors. Based on the general identification classification system [GICS], five different sectors can be identified (*Table 7*). Most companies are in the IT (35%) and Industrials (33%) sector. When zooming in on the firms at sector level, one can see that the IT sector has 0,4 patents on average and 5,1 employees, which is below average: 1,0 for patents and 6,3 for number of employees (*Appendix VIII*). The rather high representation of IT firms within YES!Delft is possibly related to the low start-up costs of IT firms for they do not rely on patents and much human capital.

Sector	**N**	**%**
Consumer Discretionary	9	15
Energy	5	8
Health Care	5	8
Industrials	20	33
IT	21	35
Other	2	1
Total	61	100

Table 7: Descriptive overview firm sectors in 2013

- *Need for Support*

The needs for incubator support can be classified into three groups (Clarysse, Wright, Lockett, Mustar, & Knockaert, 2007): finance, business (coaching), and networking. In the survey, needs are measured on a 7-point Likert scale, where a value of '1' represents 'low in need' and '7' represents 'high in need'. When looking at the need for business support, most companies require advice/coaching on recruiting and selection employees (3,9) (figures of this section are included in *Appendix IX*). All other business needs are indicated just above or below 3,0. When looking at the firms' need for financing, most financing is needed to pay for organisational related activities (market expansion (5,5), attract personnel (5,3), and running business processes (4,5). Less financing is needed to pay for product and technology related activities (product launch

[9] €2,5 and €3,0 million

(5,2), building prototype (4,2) and doing research (4,0)). Last, regarding network needs, most firms need more support in lobbying or networking for their technological solution (4,6). Less support is needed for finding a partner (3,7) and finding a customer (3,5).

5.2 Survey Results

The first step is to see whether and the overall firm needs drop as it gets older or further develops. As long as the needs of a company are substantial, the incubator can be of great value to accelerate growth. This first sub-section analyses if the incubator management team can better look at the firm age or stage of development, when assessing progress in order to know what the needs are development (5.2.1). The next step is to focus on firm needs in relation to different firm profiles present within an incubator (5.2.2). Because the comparing means analysis, in some graphs, shows a peculiar result for finance needs, the following section will discuss the outcome of the comparing means analysis from 5.2.1 and 5.2.2 when splitting finance needs (5.2.3). Next to the comparing means analysis a correlation analysis is performed to assess whether the constructs from the conceptual model do hold a relation (5.2.4).

5.2.1 Firm Needs and Firm Development

As shown in the graph, all three types of needs decline as the company ages[10] (*Figure 14*). Over time, a firm learns and gets more experienced (Cohen & Levinthal, 1990). Experienced firms require less business support to develop since they can solve most critical issues on their own (Boschma & Weterings, 2005). Also, the firms' network needs decrease over time. When a firm enters an ecosystem, its network becomes more embedded. Thus, it is likely to find the required people with more easily (Autio & Yli-Renko, 1998). Over time, entrepreneurs within an incubator get to know each other and know where they need to be for particular questions or finding people. The initial decline of need for financing might be explained by the fact that firms that show persistence – i.e. by showing they can hold on the idea the first years of existence – are more preferred by capital lenders compared to the new entrants (Vanacker, Manigart, & Meuleman, 2009). This way, they can obtain the required investment faster. The slight increase in finance needs of firms between four and six years might be the explained by older non-performing firms claiming that a lack of financing is the only reason they do not show growth. Another reason might be that most technology firms, at this point, successfully developed, tested, and commercialized their technology, and, therefore, now aim to grow exponentially. In order to do so, they need financing.

[10] Firms' age is grouped into four classes. An annual interval would give unreliable results, because at some ages only a few observations could be denoted at some ages.

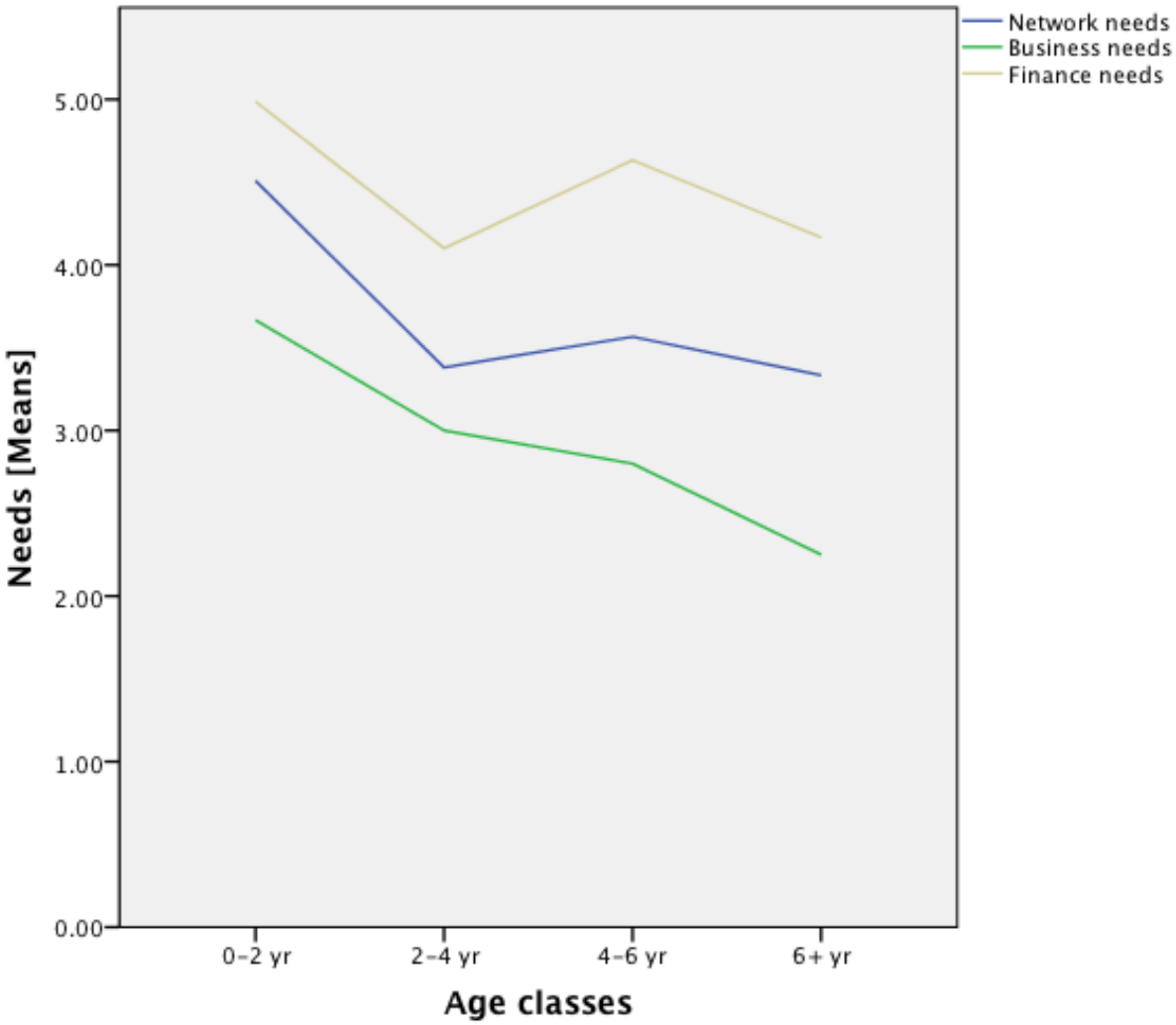


Figure 14: Average firm needs per need type, expressed at different firm years (Number of observation at minimum N= 50; see appendix X for detailed information)

When further looking to the graph, a steep drop in all types can be particularity found after the first year of incubation. This extensive decline implies that the incubator does satisfy all basic needs of the NTBFs as quickly as it should. Whereas network needs remain constant after the firms first years (this is well shown in a more detailed age class figure that can be found in *Appendix XI*), business needs drop further and finance needs remain predominantly high.

When comparing, for example, the shape of the network needs line with the line of network needs per stage[11] of development, it can be remarked that network needs do not remain constant after the first year (as denoted by *Figure 14*) but drop further as the firm develops (*Figure 15*). An explanation for this is that some older firms are expected to be still in an early development stage, which results in a line that is kept relatively high. Furthermore, also the business and network needs show different results. Where the needs of older firms further decrease, the business needs level-off at the stabilization phase. The latter, very (old) firms are

[11] Growth stage is determined by looking to revenue, sales growth, company size, and type of stage dependent activities. In short: firms in the development & conceptualization have no revenue, no growth, and a small team; firms in the commercialization phase have little revenue, early growth, but still a small team; firms in the growth stage have substantial growth, increased team size, large growth expectations; last, firms in the stabilization phase have substantial revenue, levelled-off growth, and a large team (R. G. Cooper, 1990).

expected to lose the possibility to obtain value from the incubator since they received all possible support (Hytti & Maki, 2007; Schwartz, 2008). Therefore, counter-intuitively indicated they do not have business needs anymore. The other side of the discussion is that firms in the stabilization phase need to find a solution for their stagnated sales. They are expected to be in higher need for support on product/market re-positioning. When looking specifically at financing and network needs, as represented in *figure 15,* it is shown that network needs remain high up to the commercialization phase whereas finance needs remain high up to the growth phase. It is expected that if a firm starts to enters its growth stage it has all the required parties in place – i.e. customer, partner, distributor, supplier, etc. – but only needs funding to further scale the business.

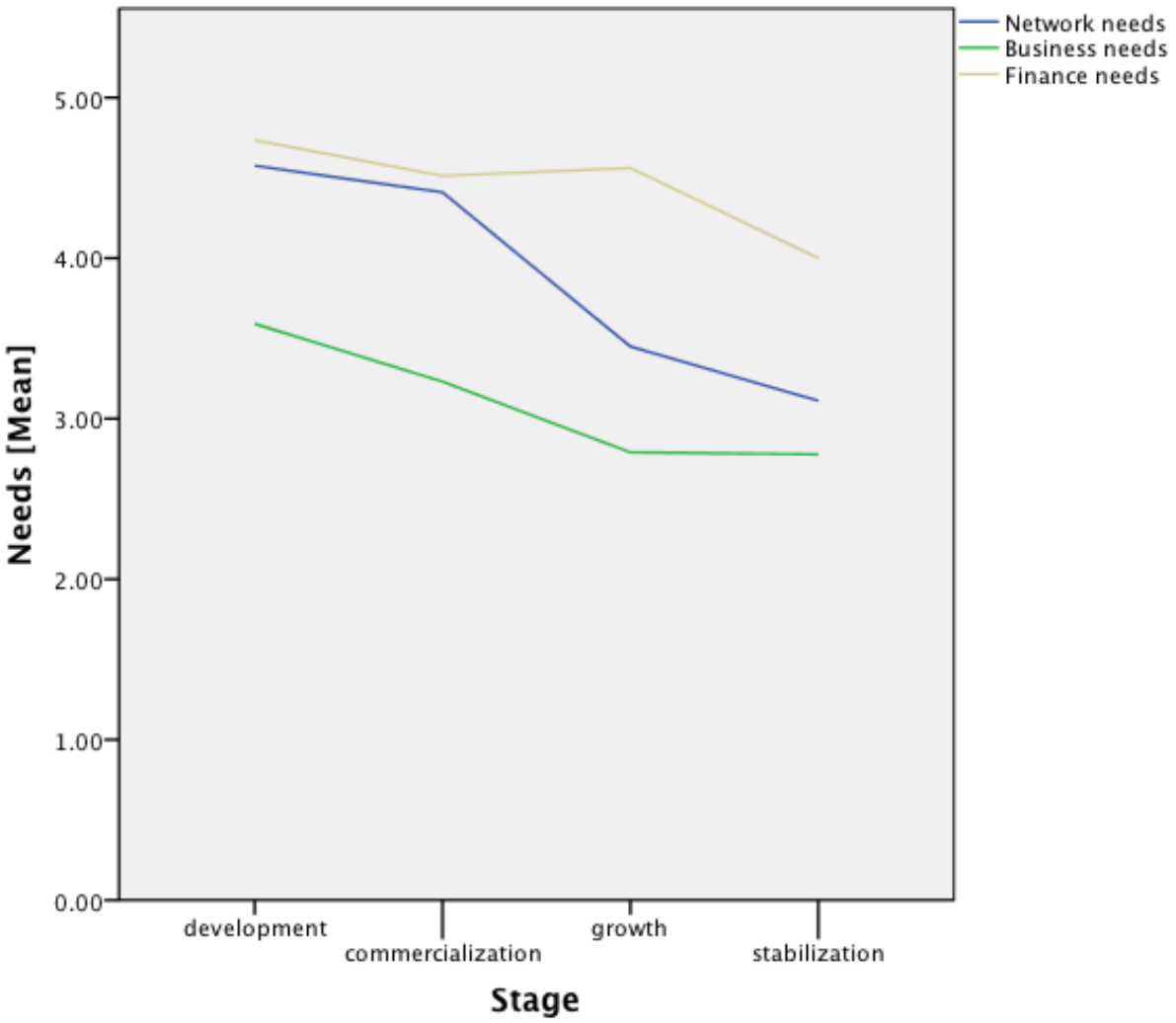


Figure 15: Average firm needs per need type, expressed at different development stages (Number of observation at minimum N= 51; see appendix XII for detailed information)

5.2.2 Firm Needs and Firm Profiles

This report discusses three important firm profiles that characterize different types of NTBFs. In chapter 3 a conceptual framework was developed showing that higher characteristics of these firm profiles lead to higher needs for support. The comparing means analysis of the three profiles is discussed below.

5.2.2.1 Growth Orientation

From the figure, it becomes clear that both the highly growth-oriented firms and the absolute non-growth oriented firms have higher business and networking needs compared to moderate growth-oriented firms

(*Figure 16*). It is expected that low growth oriented firms are also those who deal with innovative technologies and hence have, as proposed, higher networking and business needs.

When we look back to the needs in addition to the profile characteristics, no clear trend can be distinguished. After an elaborated comparing means analysis (Appendix) it appears that low growing companies (value =1 and 2) show a low N. This means that, when only discussing the lines at values between 3-7, it can be remarked the lines in the figure represent a U-shaped figure. A possible explanation is these are the firms with a low growth orientation that are possibly in their early development phase and, thus, have higher needs. Firms that are in higher growth orientation have the needs because they want to grow faster.

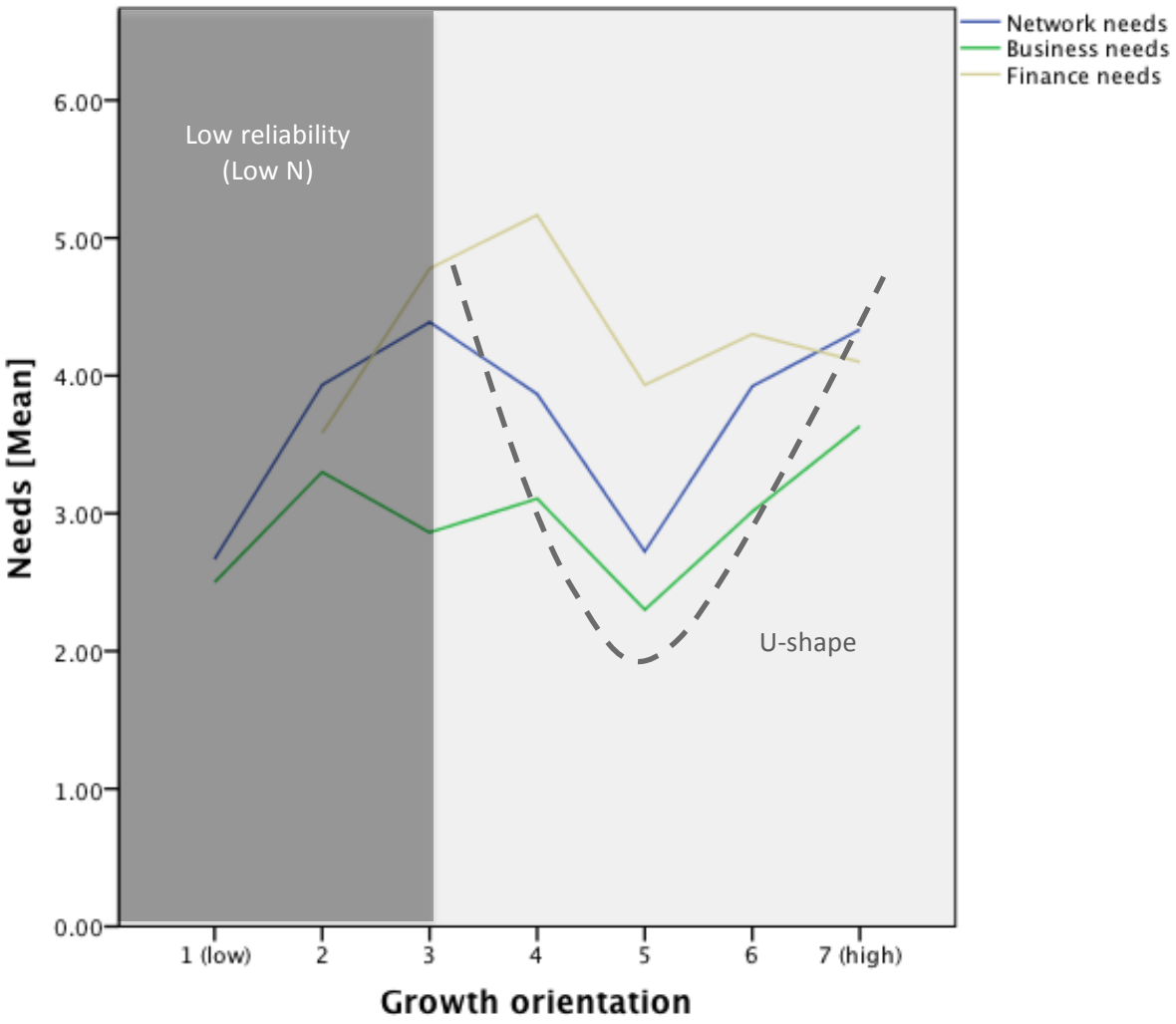


Figure 16: Average firm needs per need type, expressed at different levels of growth orientation (Number of observation at minimum N= 51; see appendix XIII for detailed information)

5.2.2.2 Capital Intensity

YES!Delft offers shelter to a wide range of industries (i.e. biomedical, IT, industrial applications, advanced materials). As discussed in chapter 3, some industries are more capital intensive than others. These NTBFs require to a larger extent capital for specific tools such as labs or clean rooms. As shown in *figure 17* this also seems to be the case at YES!Delft (a mean finance needs of 4.3 at lower capital industries compared to a mean

of 5.0 at higher segments, see appendix XIII for the exact numbers). Business and network needs seem to remain constant at various levels of capital intensity, with an exception at firms that are classified as a capital intensity of 3. When looking at a firms' capital intensity, it can be remarked that the finance increase at higher levels of capital intensity. When discussing network needs, it can be questioned whether the bend at microsystem firms can be explained by the fact that less capital intensive firms, such as software and advanced materials, want and are able to grow faster and, therefore, have higher needs, as discusses in the previous figure. The minor increase in network needs at the extreme high capital-intensive firms can be explained by the fact that possibly these firms have very high development costs. Because these firms face many difficulties in obtaining money, they have an increased need to get in contact investors or key partners, who are willing to share the development costs. On the other hand, the decline in business needs can be explained by the fact that firms in these sectors (biotechnology and aerospace) often already have the expertise because often the progress they make relies *conditio-sine-qua-non* on advances in development of technology.

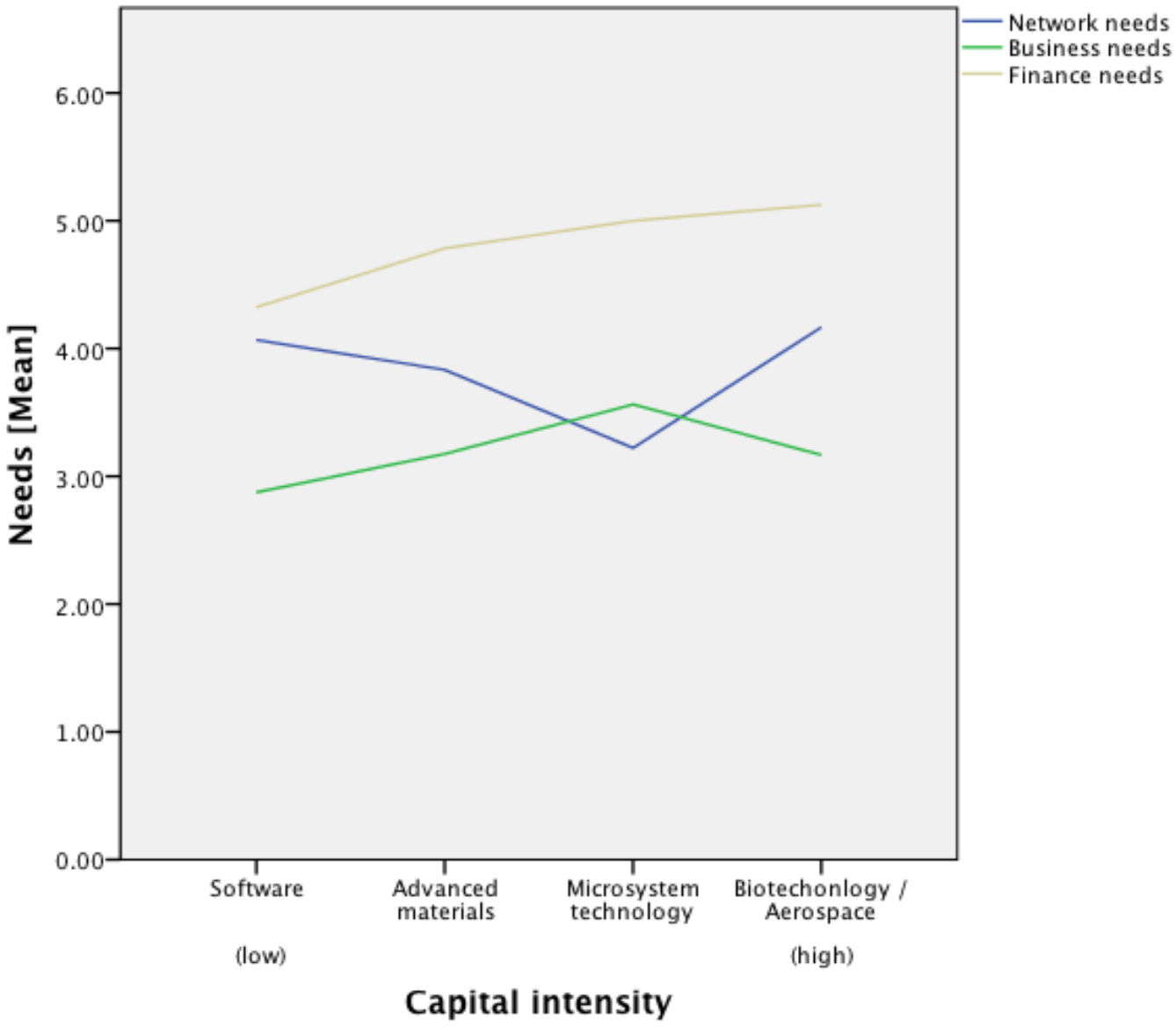


Figure 17: Average firm needs per need type, expressed at different levels of capital intensity (Number of observation at minimum N= 51; see appendix XIV for detailed information)

5.2.2.3 R&D Focus

When looking to the needs of firms with technological distinctive technologies, it can be remarked that high technological distinctive are on average in high need of networking, business, and finance needs (*Figure 18*). The graph shows a steep line for particularly in networking and business needs. This indicates that firms performing intensive R&D indeed deal with more problems related to business and technology development. As suggested, engineers or researchers lead most NTBFs. They have a crucial role in the first development stages of the firm. In this phase, the technology needs to be further developed requiring specific technology skills. Though these engineers and researchers are experts in their own field, they often lack business skills. Also, it is expected that more R&D focused technologies are also more innovative technologies. These types of technologies are often not direct understood by the market. Hence, the firm needs business coaching on how to tackle these issues. Furthermore, because the market does not directly understand innovative technologies, the R&D focused firm is unlikely to find its first customer nearby (Elfring & Hulsink, 2003). The firm needs a wide network to find its first customer. This partly explains the high network needs of R&D focused firms. An example in the case of YES!Delft is the company SunTech. This highly R&D focused firm develops solar simulators to test solar panels. Firm expected to have its first customers nearby (i.e. in Germany where energy from many solar panels is booming). However, after some R&D they found out the equipment was also suitable for other industries, such as the automotive, aerospace, and pharmaceutical industry. After a while, they found their first customers in Turkey and South-Korea (says W. de Bruijne, *Incubation manager* at YES!Delft). R&D focused firms do not only need a broad network for finding their first customers. They are also likely to have difficulties in finding the right investor willing to invest in the still high-risk technology. Overall, from the figure it can be concluded that no company from the sample has a low R&D focus (N at 1=1 and 2=0).

5.2.3 Splitting Finance Needs

Although finance needs could be split into two components, the Cronbachs' Alpha indicated that the finance needs would still not lose its reliability once discussed as one component. Therefore, figures above discuss finance needs as one. Because finance needs do not always show a convincing good representation of the actual situation, it is analysed whether splitting the finance needs has an effect on the outcome of the comparing means analysis. *Appendix XVI to appendix XIX* gives the figures of the comparing means analysis when splitting finance needs into its two components.

The figures that describe the development of a firm based on age and stage are highly comparable. The figures show a fast drop in FIN_NEED_DEV that increases at older ages or stages again. The FIN_NEED_ORG remains rather high but drops at the after the age of 4-6 years or once the firm has entered the stabilization phase. A split in finance needs at growth-oriented firms does not give contrary results; still, the graph shows that FIN_NEED_ORG are more preferred for this group. The reason could be that, as described, firms with a higher growth orientation already deal with well-developed technologies. The increased FIN_NEED_DEV is clearly visible in more capital-intensive industries. The graph shows a nearly straight curve for these needs, whereas the finance needs for organisational issues remain constant over time. This implies that more capital-intensive firms especially need funding for their development phase. The same can be said for R&D focused firms. The more R&D focused firms have higher finance needs for product/technology related activities, whereas the finance needs for organisational issues remain constant or even decrease at a higher R&D focus. Also, it can be concluded that R&D focused firms especially need funding for product/technology development.

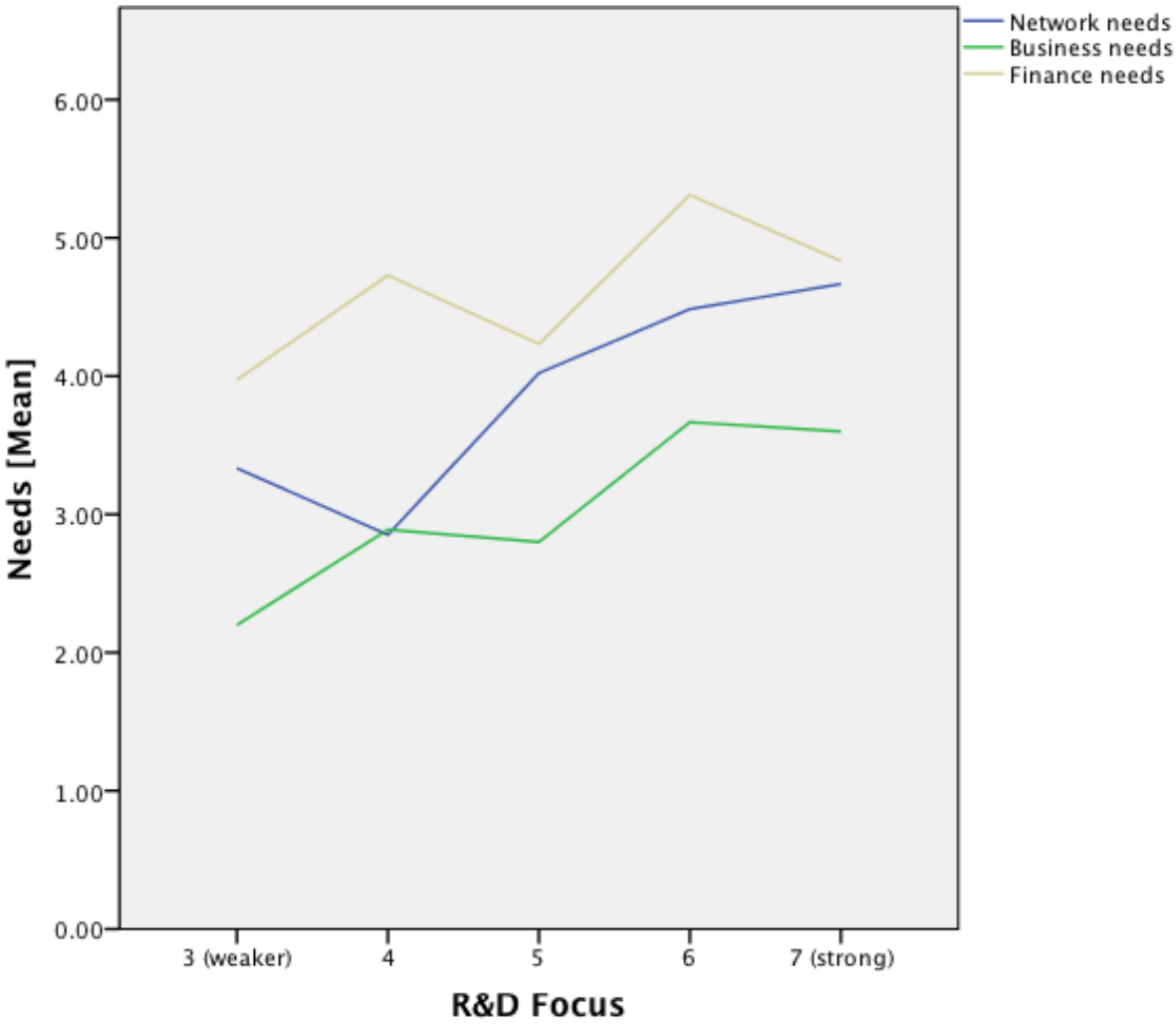


Figure 18: Average firm needs per need type, expressed at different R&D intensities (Number of observation at minimum N= 51; see appendix XV for detailed information)

5.2.4 Correlational Analysis

To get a clear picture of the relation between the proposed constructs, a correlational analysis is executed. The correlational analysis shows a significant relation between R&D focus and network needs and R&D focus and business needs (*Table 8*). Based on this, support can be found for proposition 4 and 5. No direct support could be found for the three other propositions. Though, the research resulted in several interesting outcomes, once the finance needs were split. The base correlational analysis (without splitting finance needs) did not give a direct significance for higher degrees of capital intensity and finance needs. However, including the two different finance types gave significant results between some constructs (*Appendix XX*). It stresses out that the capital-intensive firms especially need finance for product/technology development related activities. This way, proposition 2 gave mixed results. Not proposed by the conceptual model, but nevertheless interesting to see, is that high R&D focused firms also have a high finance need for product/technology development activities. *Table 9* gives an overview of the outcome of the propositions. Furthermore, the table shows significant relations between stage and network needs, and age and business needs. As the firm grows, it becomes more embedded in its network lowering its needs for network. Hence, the firm is able to find the right persons without support. As the firm gets older it gets more experienced and knows how to tackle business issues itself. Therefore, its business needs drop as the firm gets older. Business needs also seem to

correlate with finance and network needs. As firms receive coaching for their business problems, they might as well discover indirectly how to solve network and finance needs, or at least they can ask coaches to help them with finance and network needs as well. On this way, finance and network needs drop as business needs drop.

		1	2	3	4	5	6	7	8
Spearman's rho	1. FIN_NEED	(53)							
	2. NET_NEED	.253 (53)	(56)						
	3. BUS_NEED	.398** (52)	.476** (54)	(54)					
	4. CAP_INTENSE	.152 (51)	-.120 (54)	.128 (52)	(63)				
	5. GROWTH_ORIENT	-.109 (48)	.008 (51)	.013 (49)	.043 (52)	(54)			
	6. RD_FOCUS	.154 (45)	.302* (47)	.384** (46)	.270 (45)	-.064 (47)	(47)		
	7. AGE	-.225 (52)	-.230 (55)	-.411** (53)	.012 (63)	-.233 (53)	-.306* (46)	(64)	
	8. STAGE	-.037 (51)	-.276* (54)	-.263 (52)	.262* (61)	-.048 (52)	-.169 (45)	.535** (61)	(61)

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 8: Results of the correlational analysis between different profiles

P1: A firms' growth orientation is positively associated with having early finance needs	Not supported
P2: A firms' capital intensity is positively associated with having early finance needs	Mixed results
P3: A firms' capital intensity is positively associated with having early networking needs	Not supported
P4: A firms' R&D focus is positively associated with having early business needs	Supported
P5: A firms' R&D focus is positively associated with having early network needs	Supported

Table 9: Outcome propositions

At this point, it can already been stressed out that high R&D focussed firms, but also high capital-intensive firms, possible need more support from the incubator. When evaluating these firms special attention must go to the fact that these firms possibly need more support at early stage problems. Chances are high that the highly R&D focused and capital-intensive firms need either more support or more time to realize a similar growth figure as other start-ups do within an incubator. Because the incubator has a significant role in especially providing support for early stage problems, let say, problems that occur in the first year, it is important to understand how certain development directions bias evaluation outcomes. For example, as discussed in chapter 2, early evaluation methods especially look at what is requested by the incubatee. However, it can be argued to what extent these incubatees really do not require support, if they do not request it. To find out, an interview analysis is applied to better understand the early development trajectory of three different start-ups. The development trajectory and the needs they have during this period are discussed in the next section.

5.3 Qualitative Results

Below a summary of the most relevant observations per interviewed company is given (5.3.1 – 5.3.3). Based on these summaries, it becomes possible to deduct how the needs are at each company (5.3.4).

5.3.1 Growth at CompositeTech

CompositeTech has compared to most other incubated companies no single technological solution for one particular problem. Instead, they shape their technology, or rather, 'the understanding of the process of applying the technology' by having tight interactions with their client. Based on this they develop products specifically for the client. In collaboration with the client, they only refine the process rather than the technology itself. Once they entirely optimized the process, they can scale the business.

> **CT**: *"Since the beginning of CompositeTech we are dependent on the industry. We gain when collaboratively develop products with our client. We do not have a particular product; our solutions are tailored made. We have found an effective way to develop our products at a limited number of key players. The aim is to stay within these environments with key players to eventually have a great position and scale our business quickly."*

As a result, CompositeTech heavily relies on a strong network with the industry since they need to realize customer returns. Indeed, their technology is applicable to a wide range of industries for a wide range of applications. Products they already developed range from bridges to oil pipeline links. Composite Tech works internally with their clients on developing products for the client. If a project is finished, the client keeps the product and CompositeTech the knowledge. From now on, CompositeTech relies on the network of the client to find its next client. Although the incubator supported CompositeTech by connecting them to their first client in the construction and manufacturing industry, they now rely merely on industry specific connections that can only be obtained by actually collaborating with them and build a reputation hereafter. CompositeTech believes

that if they succeed in building a strong reputation they will much easier in finding the right persons to grow further.

> **CT**: *"Key for us is to improve our understanding of how to optimize the technology development process. If we succeed in doing so, we become valuable for a wide audience and current customers are willing to connect us with new clients."*

Although networking is an important element for CompositeTech, their need for support in the network decreased as the company grew. CompositeTech relies on a strong interaction with their customers. Before they were able to make growth, they needed an entrance in key industry area. The incubator supported them by connecting them with one of these major players. Now CompositeTech has an entrance in the industry it realizes that contacts for new clients are more easily to obtain once they have optimized their service and product.

Pointedly, CompositeTech was able to grow sales without having strong finance needs. As it turns out, many high-tech companies first try to sell licenses, consults or parts of their technology in order to build a first cash flow. Also CompositeTech works in this way, it will ask for finance when they have ultimate fit between market and technology.

5.3.2 Growth at AquaTech

The clean-tech company AquaTech uses a patented maintenance and fuel free solution to pumping water to onshore grounds. They developed and tested a first working prototype collaboratively with researchers at the University of Technology in Delft. Their technology can in principle be applied everywhere in the world provided that the environmental conditions are met. Before they can sell their product globally, they need to improve their current product towards a robust product that will show consistently more or less the same yields at different (environmental) conditions and settings.

The interviewee remarked that currently the development of technology is the most important part of the entire process. He also mentioned that time is the most important barrier to growth; time that cannot be enforced by adding more researchers or funding to the project. AquaTech says that they already have the capabilities and expertise in-house to refine the product. They rely on measurements and test to further develop their technology, but due to environmental circumstances they sometimes have to wait. The machines are mainly operating at places where rain seasons make it unable to execute these tests.

> **AT**: *"The only thing we are hindered by is time, we have the right support and financing but it takes time to develop our technology further."*

It can be said that AquaTech develops its business by purely focussing on the technology. In their market, the success of the technology relies on consistency and reputation of the product. Many tests and alterations are made in the technology. During this process, they do not yet focus on commercialization of technologies. With all the expertise in-house, they can execute and optimize their product. It is only a matter of time that is required before they can scale the business. In order to do so, they rely on a strong network of (local) customers, governments, and distributors. For them having a strong network is their enabler to build a worldwide distribution channel. Their technology is applicable at nearly everywhere on earth where agriculture is taken place near wetlands. A strong network in the agriculture industry enables them to get sellers to a local level. This is exactly where their customer is. The company is not able to grow fast because

their customers are scattered all over the world and are hard to approach, even with a good reputation. Their network needs are therefore very high. AquaTech recalls:

> **AT**: *"We have a specific product in a very big market. For this reason, we need key players who want to sell this for us so we can focus on developing the product."*

At the early days of development, AquaTech joined many competitions and subsidy programs to get recognition in the field. Since they have a very 'likable' product (a clean-tech solution solving a social issue), they were able to get this recognition quickly. Being on the top of one program (for example they won, enabled them to join other programs. Although their existence and network grew in the clean-tech industry, they lacked in building a broad network required for sales. Based on social ties they were able to manage one of their first pilot projects in Nepal, however they are far from familiar in the worldwide agriculture industry. They have large needs to get in contact with local municipalities, as well as national governments. In the upcoming years, they still expect a slow growth because they first need to develop their distributor network before they can grow sales.

5.3.3 Growth at WebTech

WebTech was able to develop its business rapidly. The YES!Delfts' LaunchLab program that focuses on lean business development practices contributed by gaining their first customers quickly. Also, the use of component-based technology made it possible of WebTech to develop quickly. The company obtained pre-developed parts of the overall solution from so-called technology stacks and software libraries. This made them able to quickly and cheaply develop a solution that corresponds to the needs of the customer. The faster they could recognize the problem and solve it, the faster they were able to communicate their product to their market. That is why they managed to grow fast to over 12 customers in one year. The technology thus is already well evolved. They have the expertise in-house to adjust further and fine-tune their product, but they do not need further assistance in order to grow further develop their technology.

Because a large part of the technology is already developed, the firm primarily focuses on getting sufficient customers. The interviewee had a background as a consultant in the e-commerce and, for this reason, was able to get in contact with these first customers. He also found one of his co-founders via this network. One could say that his he already had a developed network before he started his company. Although he has a well-developed network, he cannot say that this contributes to increasing sales. To sell his product he applies cold-calling strategies that do not require any network. He sees his network as facilitating rather than enabling. Since WebTech uses a cold calling strategy to approach customers and hence grow business, they are not necessarily restrained by network needs.

WebTech says that they do need support on sales. At the moment, they lack human resources that could support them by selling. His suggestion is to open a vacancy agency inside the incubator that connects students for example with start-ups. Also, networking events organized by the Incubator are focused on inviting mainly large industries because WebTechs' market is merely at the SME level. They need some business assistance to this extent. They already obtained a VC funding, so they need to make sure that growth targets are reached.

> **WT**: *"At the moment we are hampered by expertise/support on sales (not marketing) and finding employment. Why is there still no vacancy agency present, for example."*

5.3.4 The Spread of Firm Needs

From the results of the survey, it became clear that firms have high needs in all directions in the first moments of development (finance, business, and network). However, from the interview it became clear that the needs of early firm stages seem to be spread over time. For example, AquaTech needs time for testing. As long as they are testing they are not in need for particular types of incubator support. It is expected that, as the AquaTech becomes more mature, the business needs might increase because the firm is lead by engineers and possible lack managerial expertise to further develop the business. Also at CompositeTech, needs seem to be a spread in needs over time. CompositeTech needed an entrance in their industry in order to collaboratively develop their technology. They now need time to build-up sufficient understanding of the process technology development in order to make products scalable. Once they have gained sufficient understanding, they are expected to have finance needs to grow the company. Last, because of the quick growth WebTech was able to make, needs did not seem to spread over a longer time. However, there was a sequence in needs. By means of joining the pre-incubation program, WebTech obtained the required business needs. Once obtained sufficient understanding of lean software development they, had a (network) need to find a launching customer and a key partner. Also, these needs were satisfied quickly. Before the end of the year, they managed to solve their finance needs by getting an investor on board.

Key insights of Chapter 5

Results of the survey

1) The need for incubator support drops as the firm develops (both in phase and age); in particular, the need for network and business (coaching) as support drop drastically in the first two years.
2) A stronger focus on R&D is positively associated with a higher need for network support, business coaching as support, and support in obtaining financing for product/technology development.
3) A higher capital intensity is positively associated with a higher need for support in obtaining financing for product/technology development.
4) Companies with higher growth orientation do not directly have a higher need for some kind of support.
5) No particular NTBF profile seem to be in higher need for financing intended for developing organization (instead of product /technology).

Results of the interviews

6) Start-ups who are still in their product test and development phase need less support from the incubator but might need the support later on.
7) There are start-ups who quickly utilize all available incubator support.

6 Discussion

This chapter addresses the different directions to improve current incubatee evaluation models. The findings, as discussed in chapter 5, are used to substantiate the argument. Interpretation and reflection by myself are of high importance since this gives handholds for further research and incubation managers. As has become apparent, this is rather difficult because younger firms or firms at earlier stages need to be evaluated differently compared to older firms or firms in mature stages. Evaluation is thus still a 'grey' area that is open for discussion. First, I will discuss the results based on what is known from literature. A proper theoretical reflection is required before designing a new evaluation tool (6.1). In the next section, a new format for an evaluation tool is developed (6.2). Section 6.3 describes the practical implementation of the new developed tool in the case of YES!Delft (6.3). The last sections will use a theoretical model to find out what the practical implications are when implementing the new tool at technology incubators (6.4).

6.1 Theoretical reflection of the results

The function of a technological incubator is to help reduce the early start-up problems and barriers of technological start-ups by satisfying their need for support (Hackett & Dilts, 2004a). As discussed in the previous chapter, the needs for critical problems decline proportionally within the first 1-2 years. On this way, the incubator works, as it should. It is furthermore found that network needs remain high until the commercialization phase. After this point, they drop significantly. It is expected that, when an incubator is commercializing its products, it gets in contact with customers from the industry, and therefore, becomes more embedded in the ecosystem (Autio & Yli-Renko, 1998). Now, current customers possible recommend the product or solution to new clients and relevant parties, and hence, the less network support is needed. Also, the finance needs remain relatively high during all stages of development and for all ages. Naturally, firms are always looking for funding as a way to grow (Politis et al., 2012). This implies that financing needs are likely to remain as the firm graduated from the incubator. Instead, an incubator should investigate whether financing required for a particular goal is satisfied. As discussed in chapter 5, financing for product and technology development seems to be critical especially for the highly R&D focused and capital-intensive firms. Last, business coaching is very expensive and has the most impact for younger firms, for they still deal with more generic problems such as administration, grant and certification application (Merges, 2006). A coach can help in satisfying these needs. However, as the firm matures the business needs will become more specific (Scillitoe & Chakrabarti, 2010). Therefore, an improved incubatee evaluation looks at the nature of the business needs – i.e. are these business needs generic or already specific? When they are already specific, the question is, to what extent the incubator can still be of value to the tenant.

In this study, different evaluation moments are discussed, those at early incubation and those at late incubation. Both evaluation moments have a different intent. In section 6.1.1 it is discussed what the results of this study say about improving evaluate incubatees at early moments. Section 6.1.2 does the same in for improving evaluation of incubatees at late moments.

6.1.1 Improvements for Early Incubatee Evaluation Moments

When evaluation incubatees at early moments (e.g. during incubation in the first years), there are a few aspects open for discussion. First, these formative evaluation moments are specified on the question whether the needs are satisfied. However, as described by the results of this study, these needs might not directly visible and tend to be spread out over a couple of years. This spread is especially visible at firms that deal with a long trajectory of developing and testing technologies. During this period, the focus lies on the development of technology and testing it, and not on further developing the business. These developments and tests are essential to make sure the first customer pays for it, or to generate a product performance-level that is required to make the business model viable (S. G. Blank & Dorf, 2012; Ries, 2011). AquaTech is a great example of a firm that is currently hampered by time, time required to test and develop a first prototype. On top of that, their technology is subjected to environmental conditions, which makes them sometimes unable to execute tests. As a result, AquaTech indicated that they have currently no business, finance, and network needs at all. After the development period, they aim to commercialize and scale the business. At this point, they likely need the support from the incubator more than ever to find investors or get coaching on more managerial issues. If the incubator gets a notice during evaluation that the incubatee needs time for development or testing, it could, for example, postpone the next evaluation moment. As described, these evaluation moments are time and resource consuming, an incubator needs to evaluate when it is most effective (Bizzotto, 2003).

Furthermore, during incubatee evaluations incubator managers should also consider that needs might remain for a longer time and are not always satisfied after the first time the incubator granted support; as a result, these needs tend to be more 'structural'. For example, AquaTech's needs for the development of their product get in contact with a network of the agriculture industry in developing countries. YES!Delft could not directly provide a connection with a key player in this industry because their network was limited to that extent. As a result, they advised joining entrepreneurship communities. AquaTech joined these communities and, through that, was able to build a broader network. However, the network they developed was different to the network they ideally require to get in contact with their customers. This implies that the perceived solution provided by YES!Delft was perceptual. In this period, an incubator should help as long as the needs are satisfied. However, if an incubator is unaware of the 'structural' presence of needs, it might stop supporting the firm as it lost its interest. As described, incubatee evaluation managers might not always have the required industry specific knowledge that enables them to take into account such issues.

The results of the study suggest that firms that have a strong focus on R&D or are highly capital intensive do not have necessarily high finance needs. A possible reason is that more R&D focused firms received more money from competitions and grants. 75% of the highly R&D focused firms received money from grants compared to 69% of the lower R&D focused firms. 55% of the highly R&D focused firms received money from competitions compared to 32% of the lower R&D focused firms. The latter, from the interviews it became clear that the social value of a product has a positive effect, said AquaTech. AquaTech was able to receive money multiple awards mainly because they have a sustainable product. On the other hand, it was found that the highly R&D focused and capital intensive firms, in particular, have high finance needs for product/technology development related activities. Finance needs for development can possibly be solved by for example money from competitions or subsidies just like AquaTech did. Financing for the product/technology development for these types of companies is essential to bridge the first development stage. It has become an essential skill to find lucrative ways of financing, when no bank or investor wants to invest in a high-risk company.

6.1.2 Late incubatee evaluation

When evaluating incubatees at later stages, the focus of the incubator is not on whether needs are satisfied, but one the questions whether the incubator targets were reached (assumptive). The incubator needs to have tacit evidence that the firm was able to grow in the given time. As discussed in chapter 2, criteria that are applicable to all are easy to communicate, cost-efficient, and do not provoke discussion among other tenants. However, one of the main disadvantages of this evaluation method is that it leads to assumptions. The Incubator might decide to further support those who do not need the support anymore, or even worse, decide outplace incubatees who possibly hold a much greater potential to contribute the economic growth of the region. Incubatees must be pressured to grow within a given time (Bizzotto, 2003). Without such pressure, or having fewer strict criteria, might lead to lower performance. The question is, however, how to improve late incubatee evaluation with conditions that it is easy to communicate with other tenants, still give tenants pressure, and lastly, give the incubator tacit evidence that the firm was able to make it.

Once the firm approaches the end of its incubation period and has not grown as was expected, the incubator can, for example, concluded that the underperforming firm is still obstructed by finance needs, or is still in its development stage. In that case, the incubator can connect the firm to an industry player to let it develop the technology in a more collaborative matter. Through a pilot or project, the firm can then still generate a cash flow and further develop its technology. A good example of this strategy is CompositeTech. YES!Delft connected this firm to an industry player because it had no focus on what to do with the technology they were developing. The introduction to the industry and doing paid projects collaboratively with a partner made it possible for the firm to pay for the expenses for further development. After the introduction, they managed to further secure their cash flow by finding new connections themselves via the industry. Now, when they need a new connection, they can rely on their own network. Capital-intensive firms, in particular, are dependent on such connection, as they need money to further develop the core of their business. Fortunately, already 75% of the firms that deal with more costly development and production practices (the higher capital intensive firms) have managed to partner up with a key player (compared to 57% of the lower capital-intensive firms).

6.2 Tool design

The objective of this study is to develop a tool that can be used as a practical handhold for incubator managers. In the previous section, important notions of incubatee evaluation (in general and at the two moments) are discussed. The next step is to develop a framework that describes how a better incubatee evaluation should take place within an incubator. In Chapter 1, the limits of current evaluation practices are stressed out. Current evaluation practices are limited in taking the complexity and nonlinearity of NTBF development in consideration, as a result:

- The chances of ineffective evaluation increase (selection of false positives).
- The chances of inefficient evaluation increase (evaluation biases).
- The chances of inefficient incubation increase (missed support opportunities).

The aim is to find a solution that covers all three problems. Thus, in doing so, a solution needs to better take into account the heterogenic development of NTBF. The tool should satisfy the following criteria as discussed in Chapter 1:

- It takes into account the heterogenic and non-linear development of (academic) NTBFs.
- The use of the tool should lead to better / faster achievement of the goals of the incubator.
- Realistic to implement and not too costly to implement and maintain.

Tool development

In the perspective of an incubator the 'ideal' development path of an incubatee is when it has high needs at entrance and have reduced their needs when it is mature at the end of the incubation period (*Figure 19*).

Of the incubatees that have already low needs at entrance can be questioned if they really do have the ambition to grow. It is possible that these firms have low needs because they have a low growth-ambition (Amit, Glosten, & Muller, 1990). On the other hand, when newly admitted firms have already at their early stage have low needs it can be questioned if they really do need the incubator (Hytti & Maki, 2007). The previous sections also stressed out that at earlier stages needs might not be visible at firms because they are spread over time. There are also firms where the needs do not drop as they mature. Perhaps these firms are not able to build internal capabilities themselves and rely on the incubator for their existence (Schwartz, 2008). These firms might also hamper from longer development trajectories, or are characterized by the fact that they still have certain needs because of their nature. In order to improve current incubatee evaluation practices, an improved model for evaluation can be constructed based on the knowledge from this study. The improved model uses the two identified progress evaluation moments as discussed in chapter 2 and has several attention points. The early evaluation moment should evaluate whether the firm has particular needs (covers group 1 and 2 from the figure). The late evaluation method should evaluate whether the needs are solved (covers group 3 and 4 from the figure). The attention points per group are discussed below.

1) Young firm has high needs

- These firms are found ideal for incubation; evaluation should address whether the firm' has a specific amount of need that can be satisfied by the incubator.

2) Young firm has low needs

- Evaluate if the incubatee has the ambition to grow. A low growth ambition will negatively contribute to the attainment of the incubator objective (Amit et al., 1990; Forbes, 2005).
- Evaluate if the firm needs to heavily test/develop its technology. Needs might be spread over time as in the case of AquaTech and CompositeTech. They possible need other services of the incubator later on.
- Evaluate whether the firm was it able to obtain all services vastly. These firms are already outgrown the incubator in an early stage. These firms can enter a new phase or may graduate.

3) Mature firm has high needs

- A) Evaluate whether the incubatee is R&D focused and has high network or business needs. These firms still need network or business support as R&D focused firms have higher network and business needs.
- B) Evaluate whether the incubatee is R&D focused or capital intensive, and has high finance needs for product/technology development related activities. These firms still need finance support as capital intensive and R&D focused firms have higher finance needs for product/technology development related activities.

4) Mature firm has low needs

- These firms are ready to leave the incubator. Evaluate whether these firms obtain little value from the network, finance, business support offered by the incubator. And look to ways on how to further support the firm.

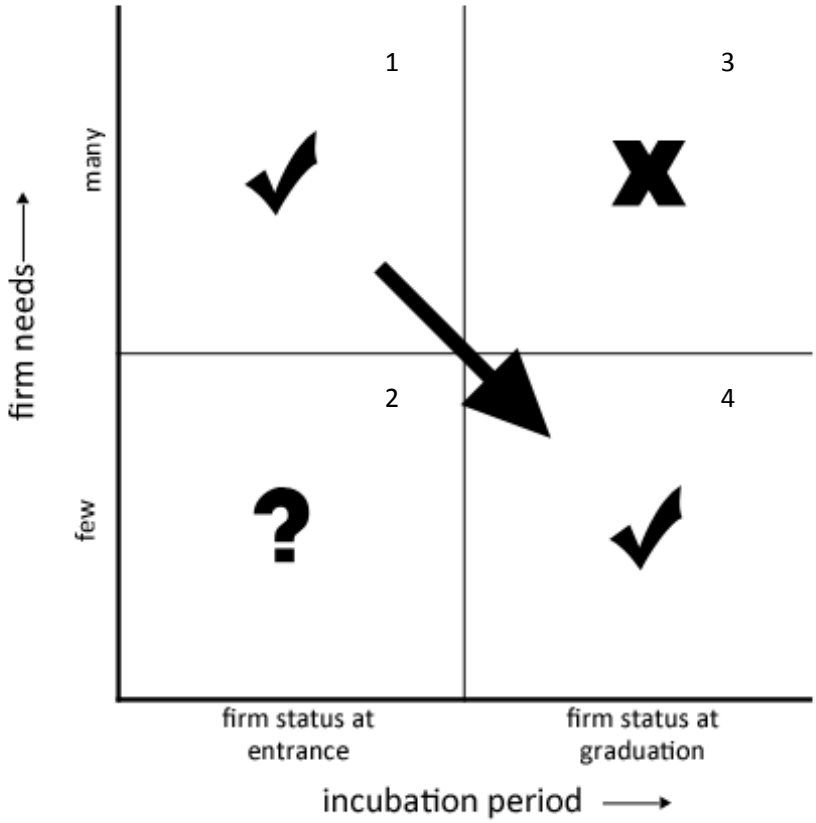


Figure 19: The ideal shift of incubatee needs during their incubator stay

How the tool satisfies the criteria of the tool

1) Criterion 1 (heterogenic and non-linear development). The above stated model is an ideal representation of how an incubator should develop within an incubator. Evaluation should thus ideally be based on this representation. However the needs per type of NTBFs differ. For example, firms that are more R&D focussed have overall higher incubator needs. For these firms a special arrangement must be made to balance support. They either receive more intensive support or their incubation period is stretched.
2) Criterion 2 (Goal achievement) The eventual incubator goal is to increase the economic development in the region. YES!Delft is achieving this goal by letting firms grow as quickly as possible to €1 million in revenue. Naturally, mobilizing support to those where growth is most visible gives tacit proof that (at least) these firms will maximize the attainment of the incubator objective. However, another approach is to first support those that really rely on incubator support and hope they will grow much faster. This model uses this approach to balance evaluations (and thus support) to reach a higher efficiency.

3) Criterion 3 (Realistic and not too costly). The above stated model calls for an evaluation moment at earlier stages and late stages. On this way the model is cost-effective and realistic to implement. No specific requirements are needed from the evaluators other than look to the needs and characteristics of the companies.

6.3 Evaluation Implementation at YES!Delft

At the 25th of March 2015, the results were discussed with Daan Domhof. YES!Delft agrees that the heterogeneity among start-ups needs to be well-addressed. He describes that YES!Delft currently looks at ways to revise their current evaluation practices: "*We are well aware that not every start-up is the same, and thus we will strive to tailor our services*". With the limited resources they have, the first step is to have a more dynamic criterion towards fast growers. Where in the past all firms first needed to pass the first three incubation years before they could join the growth program, growers that make €200.000 in turnover may now directly join the growth program. In the new approach it will be evaluated whether the firm makes €200.000 or not. This new approach is relatively easy, cost-efficient to implement and increases the attainment of the incubator, e.g. let technological firms grow as fast as possible by providing more support.

However, the adaptions do still not account for the heterogeneity of firms. With the new '*grow or go*'-policy support to firms that not make a €200k turnover terminates after three years. What this study aims to let realize is that it is of high importance to consider the nonlinearity and diversity of NTBFs development. When this is not well addressed the stated problem is still not solved. When I discussed this issue with Daan, he said that YES!Delft is also looking for ways to tailor the support and evaluation for these groups. For example, he stated that "*firms that have higher financial needs (in this case the more capital intensive and R&D focussed firms) can follow a investor readiness program"*. In this program, incubatees become prepared to successfully obtain an investment for their business idea. I countered the argument by stating that this still does not say anything about a more tailored evaluation. Daan refutes, and said that a tailored evaluation program is difficult to realize. YES!Delft remains a facilitator of support. As Daan argues: "*We also expect from the entrepreneurs to come to us when they need something, we cannot always decide what they need. Here at YES!Delft we believe that entrepreneurs need to show ambition, when they come to us and ask for support we still know the entrepreneur really wants to grow; if you do not have the ambition to grow you are not in the right place".* He also describes that in reality the incubator is really flexible towards the provisioning of support and for example granting more time. Every ambitious firms has the opportunity to grow; as long as you show you have ambition coaches and peers will help you. In the past, multiple times firms could extent their stay if there was enough room.

Thu, zDaan rules out the possibility that there are firms that are not able to generate revenues in the first three years but clearly have the ambition to grow. The discussion here is thus not about whether some firms are able to grow or not, but about how fast they grow instead. From the perspective of the incubator: firms that developed rapidly are at different phases and need different support. From the perspective of the incubatee support should ideally go to those who create highly innovative technologies and have major difficulties at earlier stages. It thus can be questioned whether the focus should be on using the limited resources to support the fast growers, or giving more support at for example the slow growing R&D and capital intensive firms.

Daan describes that the only aim of YES!Delft is to accelerate firms to their €1 million revenue. If firms show early signs of growth, YES!Delft decides to further support these firms. In my opinion YES!Delft should at least balance the support for fast growers and the more slow growers that are still in their development phase.

Overall, YES!Delft admits that a better consideration towards the capital-intensive and R&D focused firms is needed in the future. Because some firms remain unnecessarily for too long periods in certain phases YES!Delft wants to apply an intensive and frequent evaluation program for the new entrants. By means of continuous monitoring, it will be assessed whether incubatees reach certain milestones. These milestones reflect certain steps in the technology or business development instead of summative indicators like revenue and size.

Attention points for tool implementation:

- For YES!Delft the entrepreneurial ambition is leading for obtaining support. YES!Delft can decide to tailor support and evaluations, however, if the ambition to grow is low, these firms are not suited for in the incubation program. YES!Delft thinks that if the ambition is high enough, firms will be able to generate sufficient revenue to participate in the growth program. This implies that the implementation of the tool might bring some difficulties as the tool describes a merely organized and planned approach to funnel potentiality.
- The clear objective of bringing companies as quick as possible to the €1 million revenue is leading for YES!Delft. They do every thing to facilitate this at firms where this growth is most visible. The money-driven mind-set provokes a bias. As fast-growth firms are rewarded by more support, firms that invest in long-term returns (by means of innovating and executing R&D strategies) are thus less stimulated. Over the long term, only firms that are looking for short-term gains will dominate within the incubator. As a result, also the culture changes from a open and free culture to a more winning culture. It can be questioned if the winning culture YES!Delft is creating is found most ideal for having a pleasant atmosphere.

6.4 Practical implications at Tool Implementation

The implementation of a new tool should, according to this paper, improve current incubation evaluation and the incubator as a whole. Unfortunately, a change in an existing structure such as a change of the current evaluation policy is often not that easy. Structural changes have large influences on the actors involved. An incubator should consider:

- There are always transformation costs included (employ new routines cost money and might obstruct current business operations)
- Big bang - changes are risky, there are many 'unknown treats' that jeopardize the new model. A sudden implementation obstructs learning on the fly.
- As a result, there will always be new sub-optimizations. Though the new model, though the old model will be entirely used but often a mix of both models.

In decision-making theory, there are two important notions or instruments that need to be considered when changing the structure (de Bruijn, 2012). The first notion (instrument 1) describes that when changing the way on how evaluation takes place not only should address the model but also in reality. The second notion (instrument 2) is that a structural change is not a linear issue but merely a dilemma. Below the two instruments and their impact on changing the current evaluation structure is addressed deliberately.

Instrument 1 – conceived situation vs. reality

The implications of structural changes:

- The effects of structural changes are often under-estimated (see above)
- In doing so, often the conceived situation is compared with reality, which is incorrect.
- Because models are ideals and reality is almost always less beautiful and more complex.
- A fair comparison is one with the current reality and the new reality.
- Though, the new reality still unknown. Note, based on current knowledge of the present reality a prediction of how the new reality will become can be made.

The question at a model/reality analysis is twofold:

- How likely is the chance that the shortcomings of the current situation are circumvented on one hand, and realizing the benefits of the new model on the other?
- How to avoid constant looking for a new model, when both models are disadvantageous?

Instrument 2

- Structural changes often involve dilemmas; the perfect structure or procedure of control does not exist (There is no good or bad, there is a 'one hand and on the other' instead)
- Often, disadvantages provoke new solutions for a new structure; this leads to an endless change in model.
- Therefore, create a 'dilemma box' with arguments for and against the current and new situation or structure.
- Then check whether it is possible to find a solution between the extremes to come to a new structure.

The question with a dilemma analysis is twofold:

- How likely is it we realize the pros of the new situation and avoid the cons?
- How do we prevent a constantly moving through this scheme?

For the implementation a dilemma box is created (*Figure 20*). With the new evaluation tool, the slow growing incubatees are better supported. It also gives a better prognosis about the development of the NTBF to the incubator. With a better understanding of NTBF development the chances of selecting false positives is lower. On the other hand, the new evaluation method might be more costly to implement. The benefits of the old model are that it is easier to maintain and communicate. A non-balanced evaluation approach also maintains the quality of the incubator model as the incubator might become vulnerable when there is no strict regulation about who may stay or not. If it is clear for every-one everybody needs to accept the rules stated by the incubator. The downside however, is that with a non-balanced evaluation approach the human dimension might be lost. The focus might be only on performance and money and not on the entrepreneurs themselves. With this in mind, the following scenario might occur:

	New tool evaluation (A more balanced way of evaluating)	**Current evaluation approach** (Supporting only the fast growers in terms of size and turnover)
Pro's	+ The slow growers are better helped in their period due to a balanced and more fair way of evaluating + Gives better growth prognoses for the incubator. Lower likelihood of selecting false positives	+ Easier to maintain and communicate + Single policy also provokes a better quality standard, incubator model becomes more vulnerable when there is debate about who may stay and who not.
Con's	- More costly to implement and maintain	- The human dimension is lost

Figure 20: Dilemma box of the dilemma analysis

Example scenario when implementing the new tool

What can happen is that when the new standard is implemented it is promised that the incubator should get a better grip on selecting the false positives, however, it might appear that only a few cases fall under these criteria and a new structure might be way too costly compared to the benefits (*Figure 21*). Also, the discrimination of the few incubatees leads to protests within the incubator. As a result, the incubator waives off the new structure. However over the years the number of R&D focused firms for example grows and need to be better evaluated on their slow growth. These firms might protest because the incubator became too large and the human dimension is lost in evaluating firms. As a result, the incubator needs to consider the new model again.

	Situations under the new regime	Situations under the old regime
Base situation	Too few cases for the new tool to work. No real improved growth prognoses	Incubator grew and assesses incubatees with one benchmark
Consequence situation	Implementation too costly and protests of discrimination	Protest because of lack of the human dimension in evaluation

Figure 21: Scenario associated with implementation.

Attention points for tool implementation:

- When implementing the new tool, consider that is a difference between the conceived situation vs. reality.
- As a result, the new tool is likely to be fully installed. Benefits of the old approach out-rule the implications of the new approach and visa versa. As a result, incubation managers should consider that a new optimum or a mix of the benefits of both approaches is likely to happen in real-life.

7 Conclusions & implications

In this final chapter, the conclusions and implications are presented. Section 7.1 starts by giving an answer to all research questions. In section 7.2 the limitations, research contributions, and recommendations of this study are presented.

7.1 Conclusions

SQ1: What is an NTBF in the context of a UTBI?

New technology-based firms have a high potential to have an impact on the economic development in the region. These companies deal with high-end a technology that attracts well-schooled personnel and fosters the formation of innovations in the region. Before these NTBFs are able to have such an impact, they are challenged to overcome many start-up problems and obstacles. Especially in the context of a university, where high-end technologies arise as a result of a scientific research, these barriers are clearly present (Vohora et al., 2004). A UTBI can help by providing support for these critical obstacles. By giving incubatees access to a number of valuable resources such as network, business coaching, and financing they lower the chances of failure and stimulate growth. However, the services and support offered by a UTBI are very costly (Mian, 1994). However, they are offered to incubatees far below market rents (Hamdani, 2006). To operate profitably, a UTBI believes in the possible growth potential of these type of firms. NTBFs have a high potential for stimulating growth in the regional economy by exploiting innovative technologies (Etzkowitz, 2002). The growth potential of these innovative technologies can be seen as the central operator to realize this growth. These companies attract well-schooled employment and foster the creation clusters of high-tech firms around the NTBF (Lin & Tzeng, 2009), which, in its turn boosts the economy (Etzkowitz, 2002). To make sure that this growth is realized, the incubator needs to make sure that technologies are commercial viable, hence they need to show a certain sales growth or employment growth. When an incubator gets the impression that an incubatee runs the risk of not achieving such growth during the granted incubation time, the incubator can decide to release the firm and terminate further support. This way of funnelling support gives the incubator more certainty that its objective will be achieved.

SQ2: What is a UTBI in the context of an NTBF?

University Technology Incubators have an important role in the development of the regional economy. They reduce the likelihood of failure of academic spin-offs or new technology-based firms (NTBFs). These type of companies in particular face larger obstacles and challenges compared regular firms. A UTBI provides this support during the critical phase of development: the start-up phase. By providing support for issues in this development phase incubator, enlarges the growth potential of its tenants keeping the cost at a minimum.

Technology start-ups deal with greater extent with managerial, network and financing issues. These types of firms are often led by a team of engineers, or in case of an academic spin-off, a team of researchers or

university alumni's. Although these people are experts in their field, they often lack the managerial expertise to run a business. An incubator provides business coaching to advise the firms on several business-related issues such as administration, legal, or strategy. Next, technology development requires often much capital before any revenue is made. An incubator can support by providing ways of funding or provide a funding at very favourable conditions. Last, technological start-ups also have issues in finding the right persons such as investors, key partners, or first customers. Because the market often not yet understands the new technologies of these firms, they face difficulties in finding a first customer. Also, new technologies require often industry specific knowledge that can only be obtained by collaboration with a partner. An incubator can support by providing a network that has links to the industry. An industry player can function as customer or partner to this extent. Additionally, because banks often disregard technology as risky, technological start-ups face difficulties in obtaining funding, the same network can be used to find investors.

SQ3: What are the various incubatee evaluation practices in the world and what are the benefits and shortcomings of these?

In this research two main evaluation practices are identified: evaluation based on incubatee qualities, and based on incubatee progress. The focus of this study is on evaluation of incubatee progress. Therefore, only the latter is further discussed.

Evaluation of incubatee progress typically takes place after pre-incubation, during incubation, after incubation, and sometimes after graduation. It is found that earlier evaluation moments i.e. at pre-incubation and during incubation are focused on evaluating 'what is needed', whereas late evaluation moments i.e. after incubation and after graduation is focused on 'what is achieved'. Each way of evaluation has its own function. Because the evaluation during incubation and after incubation is most applied and also most important to reach efficient incubation, only these are further discussed:

1) *The evaluation of incubatee progress during incubation* is focused on assessing if incubator support had an effect on the development of the start-up. Because at this moment technological start-ups are often unable to show commercial returns, it is difficult to assess the commercial viability based on for example sales and employment growth. The benefit for the incubator of this evaluation moment is that they get a much better grip on the development of the incubatee. The advantage is that incubators now have a better understanding of the firms' development and is therefore able to make better decisions regarding granting further support or not. The benefit for the incubatee is that it can give a better description of the context and negotiate incubator decisions. On the other hand, this type of evaluation is costly, and consumes valuable incubatee time without the certainty that the coaches or mentors who take the evaluation have a full understanding of the situation at hand.

2) *The evaluation of incubatee progress after incubation* is focused on assessing if the incubatee managed to grow. At the end of the day, the incubator needs to make sure that the incubator objective is realized. This incubation evaluation is aimed to funnel further support to the most potential firms. Generally, at this moment well-performing start-ups can remain in the incubator, whereas support to low performing is terminated. The evaluation is based on summative benchmarks such as sales and size. The benefit for incubators of evaluating progress based on summative benchmarks gives the incubator tangible evidence of its commercial potential, and hence continued support most likely pay-off further incubation. Also, this evaluation method is easy to communicate with tenants and gives tenants a natural pressure to get a turnover as quickly as possible. The

shortcoming of this evaluation moment is that it still causes a bias when not differentiate between different types of start-ups. Low-performing firms after three years are not necessarily low performing in the long run. This is especially the case at highly technological firms since these firms often need more time for developing and testing technology before they are able to commercialize it. Possibly these firms still hold a great, and maybe a much greater, potential in the near future. On this way rejecting the 'wrong' companies leads to false positives. The benefit for incubatees is that, as said, hard evaluation criteria give pressure to incubatees to reach their targets. This keeps the flow in the firm. The downside, however, is that this pressure increases the changes for entrepreneurs of taking the wrong decisions. In my perspective, incubators need to hold to strong evaluation criteria. As said, this increases the pressure to perform and gives tacit evidence of the most potential firms. However, as this study suggests, in case the incubatee is not able to satisfy the criteria, the incubator needs to be more flexible towards particular types of NTBFs (for example those with a strong focus on R&D or those faced with a longer period of development).

SQ4: What types of NTBFs are present within a UTBI?

A UTBI is characterized by the fact that it hosts office space to different start-ups within different high-tech industries such as IT, biomedical, aerospace, nanoscience etc. Many start-ups derive as spin-off from the nearby university. In many cases spin-offs that derive from different faculties of the technological university cause thus this diverse influx of start-ups. Although incubatees within UTBIs deal with different technologies, products, and markets, they all face (initial) start-up problems related to the commercialization of technology.

A technological incubator selects those firms that deal with new technologies and have the ambition to grow. As a result, the firms present within an UTBI are typically characterised by firms that have a high focus on R&D, deal with new and capital-intensive technologies, or have a high growth orientation. An incubator does not only support these firms because they deal with the many obstacles and barriers, but also because the new technology exploited by the NTBF eventually fosters a maximum growth in the region and creation employment (Gordon & McCann, 2005). They hold the potentiality to disrupt markets (Yli-Renko et al., 2001), increase the *entry barriers* for competition (Barney, 1991; Tushman & Anderson, 1986), last pursue *technology leadership strategies* (Amit et al., 2001; Clark, 1989). Because these types hold a great potential to extensively contribute to the attainment of the incubator objective (e.g. foster innovation, growth, and employment in the region).

SQ5: What are the NTBF development phases and how can they be measured?

NTBF development or growth is unpredictable and dependent on many factors. A unique combination of the right resources, team, and the product-market mix, and luck describes eventual growth (Brush, Greene, & Hart, 2001). In general, the different development stages of a NTBF are: 1) the conception and development phase, followed by 2) the commercialization phase, then the 3) growth phase, and last 4) the stabilization phase (Kazanjian & Drazin, 1989). In case the NTBF is also an academic spin-off the phases can also be expressed as: 1) research phase, 2) opportunity framing phase, 3) pre-organization, 4) re-orientation, and 5) sustainable returns (Vohora et al., 2004).

The question that follows is how to measure the current position of the incubatee. In other words, which measurement unit can be used? An incubator can, for example, look at the firm's growth in sales and size (in terms of employment) to get an indication of the development phase. However, technological firms are characterized by the fact that they deal with a long development trajectory of their technology (Kazanjian,

1988). In this period the firm is likely to make commercial growth, and hence traditional business indicators such as sales and size can hardly measure early NTBF development.

When looking to the literature, different studies described how particular NTBF problems can be connected to specific stages of development (Kazanjian & Drazin, 1989). This was also done for academic substantiated NTBFs, in terms of critical barriers (Vohora et al., 2004). Based on these models a different way of looking at NTBF development is disclosed. The two studies described how a particular solution to an early stage problems or barriers leads to a development in one of the phases. On this way, it is possible for an incubator to look to the problems, or rather, needs of an incubatee in order to estimate their current position in the development process.

SQ6: What factors play a role when evaluating incubatee development in an incubator?

Incubatee evaluation is a very important element of a modern technology incubator (Aerts et al., 2007). A proper incubatee evaluation policy enables the incubator to steer the course of an incubator towards its overall goal (Bergek & Norrman, 2008). The commercial viability of a technology is an important criterion for such policies (Phillips, 2002). If an NTBF is unable to commercialize technologies with a pace as specified by the incubator, the NTBF disproportionally contributes to the attainment of the incubator objective (Schwartz & Göthner, 2009; Schwartz, 2013). Hence, a possible more potential firm cannot use the resources and incubator efforts obtained by underperforming firms (Bruneel et al., 2012). Second, assessing progress of incubatees within a university incubator is complex. The heterogeneity of NTBFs compromise large differences in growth paths (Rizzo, 2012). Within an incubator, different firms deal with different problems; a good evaluation should address these different problems individually. However, evaluation is costly and sometimes the incubator needs to be strict when evaluating progress.

In this study, two common evaluation moments are identified that are measuring incubatee progress. One that is measuring progress during incubation and one that is measuring progress after incubation. Different factors play a role at each evaluation moment. On this way, at early evaluation coaches need to look carefully consider the firm needs at each moment.

1) *At early evaluation moments* the firm needs to evaluate whether:
    a. There is (still) ambition to grow; if the ambition of the firm is low, it is not suited for the incubator.
    b. The firm has low needs and deals with a long trajectory of testing and development; needs might not be adequately present because of different priorities, but the needs for incubator support are expected to come back later on.
    c. All incubator needs for support is already satisfied by the incubator; these firms obtain little value from the incubator. These firms are ready for graduation of for admission to growth incubation program.
2) *At late evaluation*, the incubator team needs to carefully consider the nature of the NTBF. More R&D focused firms have higher network and business needs over during their stay in the incubator. Furthermore, together with the more capital-intensive firms they also have higher finance needs for product/technology development over their incubation period.

RQ: ***How can incubatee evaluation be improved within a university technology incubator?***

This study expressed an urgency to improve current progress evaluation practices at university technology incubators. In theory, technology incubators can adds value in terms of support to NTBFs as long as the services of an incubator are essential for the development and ultimate success of a starter. However, because the services are costly, but free to use, an incubator must ensure that certain growth is achieved among its tenants. This means that in practice assistance is mobilized to those where growth is most visible, not where help is most needed. This study discusses why this is a problem:

- It increases the chances of ineffective evaluation (slow growers can still be potential).
- It increases the chances of inefficient evaluation (wrongly plan and execute evaluation is costly).
- It increases chances of inefficient incubation (not understand the dynamics of NTBF growth leads to missed support opportunities and hence a slower overall firm development).

This study aimed to solve these problems by developing a tool that can be used by incubator managers to improve current evaluation practices. On the question: *How can incubatee evaluation be improved within a university technology incubator* the following things can be concluded:

1) Improved incubatee evaluation can be reached when incubators carefully consider the heterogeneity and nonlinearity of NTBF development. The underlying problem is that incubators currently do not have adequate insights in the complexity and nonlinearity of NTBF development. This study tried to better outline the heterogeneity different types of firms. The study describes that within an UTBI there are different types of firms that each follow their own development path. Some firms are able to grow faster than others. Also, UTBIs host in many cases an office to academic NTBFs. The development path of academic NTBFs is nonlinear. This implies, that although they might grow fast, they possibly need to go back[12] to their development stage later on to continue their growth. Only looking to time, revenue, and firm size as evaluation criteria is inadequate. Instead, incubators should keep a more dynamic approach towards evaluating firms. Firms that, in theory, hold a substantial potential to become a market leader, but have high incubator needs should be better evaluated and supported. The way in which this study approached this issue, is by looking to different types of needs of the different firms present within an incubator. If some firm types have higher needs, the incubator can accelerate the development process by increase the support supply. As it appeared the highly R&D focussed and capital-intensive have higher needs in certain directions. Because an incubator has often limited resources the evaluation and support must be balanced between firms that already grow fast and firms that are expected to grow fast after they have received the required incubator support. The way how this is can be cost-efficient be balanced for the two evaluation moments is described below:
2) Improved incubatee evaluation can be reached when incubators apply a balanced evaluation method at early incubation. This can, for example, be in the form of continuous monitoring. These evaluations might be expensive, but are highly important to reach efficient incubation:
    - At these moments the incubator can evaluate whether the firm has ambition to grow. The earlier the incubator knows whether the firm has no ambition to grow, the sooner it can take action. Non-ambitions firms disproportional contribute to the achievement of the incubator objective.
    - At these moments the incubator can evaluate whether some firms rapidly used all the services available. In this case the firm was able to accelerate quickly. The sooner rapid firms are

[12] As for example their technology is not well understood by the market

admitted to the growth incubation programs, the sooner the firm is able to continue its growth; which enhances the achievement of the incubator objective.
- At these moments firms can identify firms of which the needs are not directly visible because they are in their development and testing phase and have all required expertise in-house to bridge this phase.
- Overall, during these evaluation moments incubators can learn from firms and use the knowledge to substantiate future decisions.

The downside of this evaluation moment is that it harms the creativity of the entrepreneur (Bergek & Norrman, 2008). Having a guided approach in evaluating and granting support limits the entrepreneur to solve problems on its own. This is important for building internal capabilities and become independent.

3) Improved incubatee evaluation can be reached when incubators apply a balanced evaluation at late incubation evaluation moments. This enables the incubator to:
    - Make sure that no possible potential firms are outplaced from the incubator. It is found that R&D focused firms deal with a greater extent of having business and network needs during their incubation period. Together with the capital-intensive firms, they also have increased finance needs for product/technology development related activities. A possible slow growth can be related to these higher needs. Because these firms are in their first years of development highly dependent on the services of the incubator, a possible removal from the incubator after the 3 year incubation period leads in many cases to firm failure (Schwartz, 2008).

    The downside of this evaluation moment is that it still remains a gamble for incubators to hold these firms. Therefore, incubators should address a wider spectrum of criteria as R&D focus or capital intensity alone.

7.2 Implications

7.2.1 Limitations / Reflection

Limitations can be identified in three directions: theory, research design, and measurement.

- *Theoretical Limitations*

The main theory used for this study (Kazanjian & Drazin, 1989) is a rather old. Logically it can be considered if the applied constructs, relations, and theories still apply to modern situations. Hence the study needs to make sure that the study is credible enough to bear the present spirit of the time. As a matter of fact, during the entire study I looked to the most actual studies on NTBF growth and UTBI effects. Unfortunately, he was unable to find more actual notions of. Associated research directions were whenever possible included. For example for this study the theory of Kazanjian (1989) is used because it best describes firm development in terms of problems for NTBFs particularly. A more recent paper by Vohora (2004), on the other side, uses a more updated model.

- *Limitations on research design*

The quantitative part of the study is executed by obtaining a single dataset from one incubator. Due to time constrains I was not able to enrich the data with a longitudinal substantiation and data from other incubators.

As a result, the outcome of this study does not take into account the longitudinal effect on the sample. For example, the incubator management might have introduced special programs for the new entrants that possible effected their growth or needs. Furthermore, this study is based on data from one technology incubator. Little is known about how this is the case at other technology incubators. Incubator specific factors such as financial climate of the incubator, culture, history etc. have a large impact on the development of firms and hence the outcome of this study. Therefore this study is low in generalizability.

- *Limitations on measurement*

One of the main implications of the entire research was the small sample size. After a preliminary literature study, I found out that discourse on incubatee growth is rather fragmented (Rothaermel et al., 2007). As a result, my focus was primary on exploring the present dissertation and creating a foundation for new theories. This exploration consumed much time and resources that could not be used for broadening the sample size.

Furthermore, a critical side note on measuring needs is that needs are can be a perception. The data used for this study only provides a snapshot of the situation at hand. It does not unveil NTBF needs over time. This implies that there can be firms within the sample that have lower needs because they just obtained the resources or support that diminishes their needs for it. In addition, there might be companies present that are not aware of their needs and them, for this reason, do not have these needs. In the statistical analysis, control variables were introduced to increase the reliability of the results.

In the analysis, the characteristics of different NTBF profiles are discussed. It is assumed that over the entire stay the characteristics of these firms remain the same. However, it is possible that mainly the younger start-ups are R&D focused and the older they get the more growth-oriented they will become. More research should be done on the change of profile characteristics of different NTBFs during their development. Because an incubator is able to quickly accelerate firms, the nature and characteristics of firms can change vastly from gestalts.

Although this study is rather practical oriented, there are yet undiscovered research directions for future scholars and researchers to further address incubatee evaluation. More and more is known about the benefits of university incubation (Rothaermel et al., 2007). Firms that are now entering an incubator have a much greater likelihood of becoming potential than decades ago. To continue improving future incubators models, studies should not only address the effects of support, but look to efficient ways of allocating and controlling this support. The importance of incubatee evaluation is already well-recognized in incubation literature (McMullan et al., 2001), yet little is known about applying them efficiently. Therefore, a deeper understanding is needed about other important factors that relate to incubatee evaluation. Ideally these factors should be analysed in a quantitative manner with a substantive data set; lateral but certainly longitudinal.

7.2.2 Contributions

This study made an attempt to make the NTBF development more measurable to improve current incubatee evaluation practices within UTBIs. This study shows that there are opportunities for university technology incubators to improve evaluation. The findings of the study hereby improve the incubator as a whole, this in benefits both incubator and incubatee. Incubators benefit because with the designed tool they are able to better funnel potentiality and become more certain about decisions for support. Incubatees benefit because with the new tool they are treated more righteous and receive more tailored support, which, in its turn, enhances the chances of survival. Furthermore, the study contributed by well-addressing to following topics related to incubatee evaluation:

- This study outlined two incubatee progress evaluation practises that are of high importance to run a university technology incubator efficiently: evaluation during incubation (early evaluation) and evaluation after the incubation period (late evaluation). Literature gave an overview of various current evaluation practices applied at various leading technology incubators in the world. However, no researcher made a generalization of the purpose of different evaluation moments. This study addressed clearly the purpose of early evaluation methods (formative) over late evaluation methods (assumptive). Formative methods are aimed to evaluate whether the needs are satisfied, whereas assumptive methods are aimed to evaluate whether the firm achieved in realizing growth. To achieve efficient incubation the incubator needs to look how to accelerate firms as quickly as possible, but also outplace non-potential firms eventually. This is important because without having proper evaluation practices the incubator might operate inefficiently.
- This study also discussed firm development in the perspective of an incubatee. On this way, the study looked at the start-up needs. Most incubator studies discuss firm development in the perspective of an incubator, i.e. what factors/best-practices lead to firm growth. However, because the success of the incubator is eventually dependent on the success of the NTBF it is important to look at the development in the perspective of the incubatee. On the other hand, an incubator can be of value as long as the firm needs for support are high.
- The study outlined three different types of NTBFs. The R&D focussed, capital-intensive, and the growth-oriented firms. These three NTBF profiles hold a strong potentiality to disrupt markets (Yli-Renko et al., 2001), increase the *entry barriers* for competition (Barney, 1991; Tushman & Anderson, 1986), last pursue *technology leadership strategies* (Amit et al., 2001; Clark, 1989). For this reason, these firms are welcomed at UTBIs. However, on the other hand, these firms often deal with intensive periods of R&D or are capital intensive. Furthermore, different levels of R&D or capital intensity leads to particular higher needs for support. When evaluating firms, the incubator should know that the strong R&D focussed firms have higher needs for all types of support. Firms that are highly capital-intensive have a strong need for financial support.
- Last, this study gave practical handholds on how to improve incubatee evaluation at university technology incubators. Incubator studies often rely on best practices as a benchmark for improving incubation practices. However, best practices alone do not fully give a deep understanding of underlying principles. This study identified and used the underlying principles such as the objective of the incubator, purpose of progress evaluation, and dynamics of NTBF development to substantiate the results. As a result, in order to reach effective incubation a stronger focus when evaluating incubatees is required on the first period of incubation. Besides, a benchmark is needed for different NTBFs.

7.2.3 Recommendation

Recommendations are made for incubator managers of UTBIs as well as for incubatees hosted in a UTBI.

7.2.3.1 Recommendations for incubator managers

First to say, incubatees that follow a slower growth path are not necessarily less potential. Contrary, these firms might grow slower in the early stage of development, but in most cases hold a great potential later on (Baron & Hannan, 2002; Buisson & Silberzahn, 2010). As this study suggests, evaluation practices within UTBIs can be improved if the incubator gets a better notion of the development process of (different types of) firm. In order to do so it is advised to continuously evaluate them in their early stages of development. As already suggested by Geenhuizen (2009) conscious screening of highly innovative academic spin-offs is highly recommended since they require more time to get sustainable returns (van Geenhuizen & Soetanto, 2009). If

the incubator does not have the resources to do so, at least evaluate incubatees in the beginning (in the first year) during incubation and after the incubation period (after 2 to 3 years). During the evaluations, it is recommended to pay attention to the following aspects:

Early evaluation moment (i.e. first year)

- Listen carefully to the needs of the incubatee and assess and analyse whether the incubator can satisfy the needs. Incubators should after this evaluation moment become able to satisfy the most critical firm needs to accelerate the firm.
- Also, when incubatees have no ambition to grow it is recommended to, for example, replace the founder in order to still continue the support to the firm.
- When firms deal with longer periods of development and testing, needs might be spread over time. It is advised to delay the upcoming evaluation moment, and give the incubatee more time. Evaluation moments, where no needs are addressed because the incubatee does not have them yet, are both costly in time and money for incubatee and incubator.
- When firm obtained the support vastly, the incubatee is perhaps already ready to leave the incubator. It is recommended to look if it can go to a next incubation program/stage.

Late evaluation moment (after the incubation period)

- When evaluating firms during after incubation it is recommended to first look if the graduation criteria are met. In case criteria are met, it is important to look whether incubator services satisfy the needs of these firms to further help them.
- When criteria are not met, look if the firm still has needs that can be satisfied by the incubator. If firms are at older stages and still have high needs it is recommended to look at the characteristics of the firm. R&D focused or capital-intensive firms have overall higher finance needs for product/technology development. R&D focused firms have overall higher network and business needs. If these firms have still very high needs in any direction and are low performing, it is recommended outplacing the firm. If needs are only limited to network and business (in the case of R&D focused firms) and finance for product/technology development (in the case of R&D focused and capital intensive firms) and are performing moderately, an incubator can consider to further support these firms. Hence, these firms still need critical support from the incubator.

7.2.3.2 Recommendations for technological incubatees

Start-ups benefit as well from improved progress evaluation.

Early evaluation moment (i.e. first year)

- Express needs at the beginning so the incubator can help. In this phase context can be explained, everything is still flexible. Incubator managers and managers do often lack the precise context and specialist understanding to fully understand/support the firm. Try to be concise as possible.
- Express to the incubator as soon as possible that you deal with long testing trajectories (that are possible hindered by environmental factors). The time required for testing and development lowers the direct needs.

Late evaluation moment (after the incubation period)

- When the firm at older stages is unable to meet the criteria, express to the incubator managers if the firm is still in its development phase, or has high network, finance, or business needs when being R&D focused or capital intensive.

At earlier evaluation moments	**At late evaluation moments**
Incubation managers • Listen to needs • Evaluate Ambition • Evaluate test trajectory • Quick absorption of support *Incubatees* • Express needs • Express test trajectory	*Incubation managers* i. Evaluate if incubator criteria are met ii. Understand type of firm *Incubatees* • Express development made

7.2.4 Recommendation for YES!Delft

This study particularly addressed improving evaluation practices in the case of YES!Delft. The findings and recommendations are therefore specifically aimed at YES!Delft. This does not imply that the purport of this recommendation is not applicable to other UTBIs. The following recommendations are made for YES!Delft:

Based on a conversation with an incubation manager from YES!Delft, three key criteria are identified a improved evaluation tool needs to satisfy. In the recommendation for YES!Delft it must become clear if and how the criteria are satisfied.

> *The use of the tool should lead to better / faster achievement of the goals of YES!Delft.*
> *Realistic to implement*
> *And not too costly to implement and maintain*

The theoretical part describes that evaluation takes place at different moments. Because evaluation is time and resource consuming, incubators need to make a trade-off on when to evaluate. YES!Delft can have most impact with limited resources when it evaluates firms in the first year (by means of intensive and frequent evaluations) and after the incubation period. The recommendations for each evaluation moment are discussed below.

Early evaluation moment (i.e. first year)

YES!Delft currently maintains limited evaluation to this extent; there is little incubator-initiated interaction between firms and the incubator. It is advised to YES!Delft to apply a continuous monitoring in the beginning of the incubation program (i.e. only the first year to save costs). At this moment the start-up problems are highest and YES!Delft can quickly get an indication about which company needs more time for development and which company is able to grow quickly. It is recommended to postpone evaluation sessions at those dealing with longer times of development and do not adequately need support from the incubator. It is also important for YES!Delft to monitor if start-ups have sufficient ambition to grow. Evaluation moments in early stage already address the presence of sufficient ambition. As said, this is one of the main criteria for YES!Delft to give support. The application of an intense early evaluation moment satisfies the following criteria:

- *Addresses the non-linearity of NTBFs* – early evaluation enables incubators to postpone sessions of firms that have no needs because of intensive testing & development.
- *Enhances incubator objective* - When YES!Delft has a better view on what is needed by firms at an early stage, it can accelerate firms already in an early stage. The faster the firms are able to accelerate the higher the attainment of the incubator objective.
- *Realistic to implement* – Coaches only have to look whether the firm is testing technologies and whether the entrepreneurs have ambition to grow; this without needing to fully understand the entire context of each firm.
- *Not to costly* – In case the start-up is in development and does not have needs, evaluation moments can be postponed. This saves time and money for incubatee and incubator.

Late evaluation moment (after the incubation period)

Second, it is also important for YES!Delft to apply an late evaluation moment. Currently all firms within YES!Delft receive an equal period of 3 years. If this period terminates the incubator stay terminates. However, some firms that are making a certain amount of revenue are admitted to the growth incubation program. At this moment, a certain revenue benchmark is thus the criterion to be admitted to these programs. However, this report stresses out the importance of taking the diversity and non-linearity of NTBF development into account. This means that not every firm has equal chances to grow. Especially, firms dealing with a stronger focus on R&D and capital intensiveness have higher needs. The developed tool describes that the need for support must have decreased when the firm is ready for graduation. YES!Delft needs to evaluate whether the firm is strongly R&D focussed. These firms overall deal with overall higher network, business, and finance needs during the entire development. The capital-intensive firms deal with higher finance needs during the entire development. It is advised to YES!Delft to take this into consideration when evaluating firms at later stages. YES!Delft needs to take a more dynamic attitude towards granting further support. YES!Delft can for example design special programs for the highly R&D focussed firms. These programs are open for R&D focussed firms that still not managed to make sufficient turnover[13] and have a strong the ambition to grow. Visa versa, the high ambitious and capital-intensive firms that did not managed to grow sufficiently to be admitted to the growth program can be linked to a financial partner or personal investor.

- *Addresses the non-linearity of NTBFs* – late evaluation enables incubators to better address firms that have higher needs but still hold a large potential to become market leaders (i.e. the highly capital intensive and R&D focussed firms). When these firms did not managed to make the required turnover to be admitted to the growth program, YES!Delft is advised to arrange special arrangements to still:
  keep the diversity in the incubator
  and enlarge the chances of postponed growth at these firms.
- *Maintains incubator objective* – With the new tool YES!Delft can maintain the three-year incubation period. Underperforming firms that do not have a strong R&D focus or are not capital intensive are detained from the incubator. However, because highly capital-intensive firms and strongly R&D focussed firms hold a large potential to become market leaders (and thus favours the attainment of the incubator objective), it is advised to more dynamically evaluate these firms later on.
- *Realistic and cost-effective to implement* – The development of special programs for R&D focussed firms might be a challenge. However, this special program can also be an extension to the 3-year period. On this way no investments must be made in training coaches or acquiring new resources.

[13] To be admitted to the growth program

In the end, it is on the incubator management team to decide if and how incubatee evaluation can be enhanced. As a final recommendation to YES!Delft: YES!Delft is characterized by its diverse culture of different types of incubatees. Hence, this distinguishes them from, for example, a more corporate incubator[14]. YES!Delft should keep the diverse inflow of firms in order to maintain the current entrepreneurial spirit. Coaches and various companies continue to learn from each other and come to unique insights. Key for YES!Delft is to ensure that the diversity is kept through a more dynamic approach towards evaluating firms. Among these firms certainly not all slow growing companies will become a success, but neither the apparent fast growing.

[14] Where focus lies on supporting specific industries

References

Aaboen, L. (2009). Explaining incubators using firm analogy. *Technovation*, *29*(10), 657–670.

Aerts, K., Matthyssens, P., & Vandenbempt, K. (2007). Critical role and screening practices of European business incubators. *Technovation*, *27*(5), 254–267.

Akçomak, İ. S. (2009). *Incubators as tools for Entrepreneurship Promotion in Developing countries*. Research paper/UNU-WIDER.

Amit, R., Glosten, L., & Muller, E. (1990). Entrepreneurial ability, venture investments, and risk sharing. *Management Science*, *36*(10), 1233–1246.

Amit, R., MacCrimmon, K. R., Zietsma, C., & Oesch, J. M. (2001). Does money matter?: Wealth attainment as the motive for initiating growth-oriented technology ventures. *Journal of Business Venturing*, *16*(2), 119–143.

Anderson, Ph. (1999). Venture capital dynamics and the creation of variation through entrepreneurship. *Variations in Organization Science: In Honour of Donald T. Campbell, Sage, Thousand Oaks*, 137–153.

Aram, J. D. (1989). Attitudes and behaviors of informal investors toward early-stage investments, technology-based ventures, and coinvestors. *Journal of Business Venturing*, *4*(5), 333–347.

Aspelund, A., Berg-Utby, T., & Skjevdal, R. (2005). Initial resources' influence on new venture survival: a longitudinal study of new technology-based firms. *Technovation*, *25*(11), 1337–1347.

Atkinson, A. B., & Stiglitz, J. E. (1969). A new view of technological change. *The Economic Journal*, 573–578.

Autio, E. (1997). New, technology-based firms in innovation networks symplectic and generative impacts. *Research policy*, *26*(3), 263–281.

Autio, E., & Yli-Renko, H. (1998). New, technology-based firms in small open economies—an analysis based on the Finnish experience. *Research Policy*, *26*(9), 973–987.

Barbero, J. L., Casillas, J. C., Ramos, A., & Guitar, S. (2012). Revisiting incubation performance: How incubator typology affects results. *Technological Forecasting and Social Change*, *79*(5), 888–902.

Barney, J. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management*, *17*(1), 99–120. doi:10.1177/014920639101700108

Baron, J. N., & Hannan, M. T. (2002). Blueprints for Success in High-Tech Start-Ups. *California Management Review*, *44*(3), 8.

Bergek, A., & Norrman, C. (2008). Incubator best practice: A framework. *Technovation*, *28*(1), 20–28.

Berger, A., & Udell, G. (1998). The economics of small business finance: The roles of private equity and debt markets in the financial growth cycle. *Journal of Banking & Finance*, *22*(6), 613–673.

Birch, D., Gundersen, J., Haggerty, A., & Parsons, W. (1999). Corporate demographics. *Cambridge, MA: Cognetics*.

Birley, S., & Westhead, P. (1990). Growth and performance contrasts between "types" of small firms. *Strategic management journal*, *11*(7), 535–557.

Bizzotto, C. E. N. (2003). The incubation process. *InfoDev Incubator Support Center (IDISC): Brasília. Online. Disponível em< www. idisc. net>. Acesso em*, *3*(05), 2004.

Blair, D. M., & Hitchens, D. M. W. N. (1998). *Campus companies--UK and Ireland*. Ashgate Aldershot, UK.

Blank, S., & Dorf, B. (2012). *The startup owner's manual*. K&S; Ranch.

Blank, S. G., & Dorf, B. (2012). *The startup owner's manual: the step-by-step guide for building a great company*. K&S Ranch, Incorporated.

Bonnet, J., Cieply, S., & Dejardin, M. (2005). *Financial constraints on new firms: looking for regional disparities*. Papers on entrepreneurship, growth and public policy.

Boschma, R. A., & Weterings, A. B. R. (2005). The effect of regional differences on the performance of software firms in the Netherlands. *Journal of Economic Geography*, *5*(5), 567–588.

Brandkamp, M. (1997). Characteristics of technologies and their meaning for new technology-based firms (NTBF). In *Innovation in Technology Management-The Key to Global Leadership. PICMET'97: Portland International Conference on Management and Technology* (pp. 213–217). IEEE.

Brockhoff, K. (2003). Exploring strategic R&D success factors. *Technology Analysis & Strategic Management*, *15*(3), 333–348.

Bruneel, J., Ratinho, T., Clarysse, B., & Groen, A. (2012). The Evolution of Business Incubators: Comparing demand and supply of business incubation services across different incubator generations. *Technovation*, *32*(2), 110–121.

Brush, C. G., Greene, P. G., & Hart, M. M. (2001). From initial idea to unique advantage: The entrepreneurial challenge of constructing a resource base. *The Academy of Management Executive*, *15*(1), 64–78.

Buisson, B., & Silberzahn, P. (2010). Blue Ocean or fast-second innovation? A Four-breakthrough model to explain successful market domination. *International Journal of Innovation Management*, *14*(03), 359–378.

Burnett, H. H. M., & McMurray, A. J. (2008). Exploring business incubation from a family perspective: how start-up family firms experience the incubation process in two Australian incubators. *Small Enterprise Research*, *16*(2), 60–75.

Cammarata, K., Erlewine, M., & Association, N. B. I. (2003). *Self-evaluation Workbook for Business Incubators*. NBIA publications.

Chandler, A. D. (1962). Strategy and structure: The history of American industrial enterprise. *MIT Press, Cambridge, Mass.(1977) The Visible Hand, Harvard University Press, Cambridge, Mass.(1980) The Growth of the Transnational Industrial Firm in the United States and the United Kingdom: a Comparative Analysis', Economic History Review*, *33*, 396–410.

Christensen, C. (2013). *The innovator's dilemma: when new technologies cause great firms to fail*. Harvard Business Review Press.

Clark, K. B. (1989). What strategy can do for technology. The five rules of technology leadership. *Harvard Business Review*, *67*(6), 94.

Clarysse, B., Wright, M., Lockett, A., Mustar, P., & Knockaert, M. (2007). Academic spin-offs, formal technology transfer and capital raising. *Industrial and Corporate Change*, *16*(4), 609–640.

Clarysse, B., Wright, M., Lockett, A., Van de Velde, E., & Vohora, A. (2005). Spinning out new ventures: a typology of incubation strategies from European research institutions. *Journal of Business venturing*, *20*(2), 183–216.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: a new perspective on learning and innovation. *Administrative science quarterly*, 128–152.

Colbert, C., & Association, N. B. I. (2010). *Best Practices in Action: Guidelines for Implementing First-class Business Incubation Programs*. NBIA Publications.

Colombo, M. G., & Delmastro, M. (2002). How effective are technology incubators?: Evidence from Italy. *Research Policy*, *31*(7), 1103–1122.

Cooke, P. (2004). The role of research in regional innovation systems: new models meeting knowledge economy demands. *International Journal of Technology Management*, *28*(3), 507–533.

Cooper, A. C. (1986). The role of incubator organizations in the founding of growth-oriented firms. *Journal of Business venturing*, *1*(1), 75–86.

Cooper, R. G. (1979). The dimensions of industrial new product success and failure. *The Journal of Marketing*, 93–103.

Cooper, R. G. (1990). Stage-gate systems: a new tool for managing new products. *Business horizons*, *33*(3), 44–54.

Covin, J. G., Green, K. M., & Slevin, D. P. (2006). Strategic process effects on the entrepreneurial orientation–sales growth rate relationship. *Entrepreneurship Theory and Practice*, *30*(1), 57–81.

Cyert, R. M., & March, J. G. (1963). A behavioral theory of the firm. *Englewood Cliffs, NJ*, *2*.

Davila, A., Foster, G., & Gupta, M. (2003). Venture capital financing and the growth of startup firms. *Journal of business venturing*, *18*(6), 689–708.

Delapierre, M., Madeuf, B., & Savoy, A. (1998). NTBFs—the French case. *Research Policy*, *26*(9), 989–1003.

DoBell, D. C. (2009). *An Interpretive Study of Client Graduation Thresholds in the University-sponsored Technology Incubator*. ProQuest.

Dodgson, M. (1991). Technology learning, technology strategy and competitive pressures. *British Journal of Management*, *2*(3), 133–149.

Donckels, R., & Segers, J. P. (1990). New technology based firms and the creation of regional growth potential. *Small Business Economics*, *2*(1), 33–44.

Druilhe, C., & Garnsey, E. (2004). Do academic spin-outs differ and does it matter? *The Journal of Technology Transfer*, *29*(3-4), 269–285.

Elfring, T., & Hulsink, W. (2003). Networks in entrepreneurship: The case of high-technology firms. *Small business economics*, *21*(4), 409–422.

Erlewine, M. (2004). Beyond Loans: Where Nontechnology Start-Ups Find Cash - A Comprehensive Guide to Business Incubation. *Edition, NBIA publications*, pp. 259–264.

Etzkowitz, H. (2002). Incubation of incubators: innovation as a triple helix of university-industry-government networks. *Science and Public Policy*, *29*(2), 115–128.

Etzkowitz, H. (2008). *The triple helix: university-industry-government innovation in action*. Routledge.

European Commission. (2002). *Enterprise Directorate General - Benchmarking of Business Incubation*. Retrieved from http://europa.eu.int/comm/enterprise/entrepreneurship/support_measures/incubators/

Evans, D. S. (1987). The relationship between firm growth, size, and age: Estimates for 100 manufacturing industries. *The journal of industrial economics*, 567–581.

Feeser, H. R., & Willard, G. E. (1990). Founding strategy and performance: A comparison of high and low growth high tech firms. *Strategic Management Journal*, *11*(2), 87–98.

Ferguson, R., & Olofsson, C. (2004). Science parks and the development of NTBFs—location, survival and growth. *The journal of technology transfer*, *29*(1), 5–17.

Forbes, D. P. (2005). Are some entrepreneurs more overconfident than others? *Journal of Business Venturing*, *20*(5), 623–640.

Franco, M., & Haase, H. (2011). The Role of Networks for Small Technology-Based Firms. In *Proceedings of the 6th European Conference on Innovation and Entrepreneurship: ECEI 2011* (p. 309). Academic Conferences Limited.

Franco, M. rio, & Haase, H. (2011). Network embeddedness: a qualitative study of small technology-based firms. *International Journal of Management and Enterprise Development*, *11*(1), 34–51.

Gaibraith, J. (1982). The stages of growth. *Journal of Business Strategy*, *3*(1), 70–79.

Garnsey, E. (1998). A theory of the early growth of the firm. *Industrial and corporate change*, *7*(3), 523–556.

Garnsey, E. (2002). Growth of new ventures: Analysis after Penrose.

Garnsey, E., Stam, E., & Heffernan, P. (2006). New firm growth: Exploring processes and paths. *Industry and Innovation*, *13*(1), 1–20.

Garud, R., & Kumaraswamy, A. (1995). Technological and organizational designs for realizing economies of substitution. *Strategic Management Journal*, *16*(S1), 93–109.

Glaser, B. G. (2005). *German Association of Technology Centres*. Huber.

Gompers, P. (1995). Optimal investment, monitoring, and the staging of venture capital. *The journal of finance*, *50*(5), 1461–1489.

Gompers, P., & Lerner, J. (1999). The Venture Capital Cycle.

Gordon, I. R., & McCann, P. (2005). Innovation, agglomeration, and regional development. *Journal of Economic Geography*, *5*(5), 523–543.

Granstrand, O. (1998). Towards a theory of the technology-based firm. *Research policy*, *27*(5), 465–489.

Gregory, B. T., Rutherford, M. W., Oswald, S., & Gardiner, L. (2005). An empirical investigation of the growth cycle theory of small firm financing. *Journal of Small Business Management*, *43*(4), 382–392.

Greiner, L. E. (1972). Evolution and revolution as organizations grow.

Grimaldi, R., & Grandi, A. (2005). Business incubators and new venture creation: an assessment of incubating models. *Technovation*, *25*(2), 111–121.

Grübler, A., & Messner, S. (1998). Technological change and the timing of mitigation measures. *Energy economics*, *20*(5), 495–512.

Hackett, S. M., & Dilts, D. M. (2004a). A systematic review of business incubation research. *The Journal of Technology Transfer*, *29*(1), 55–82.

Hackett, S. M., & Dilts, D. M. (2004b). A real options-driven theory of business incubation. *The Journal of Technology Transfer*, *29*(1), 41–54.

Hackett, S. M., & Dilts, D. M. (2008). Inside the black box of business incubation: Study B—scale assessment, model refinement, and incubation outcomes. *The Journal of Technology Transfer*, *33*(5), 439–471.

Hamdani, D. (2006). *Conceptualizing and measuring Business Incubation*. *Cancer* (Vol. 1). doi:10.1002/1097-0142(19910201)67:3+<774::AID-CNCR2820671404>3.0.CO;2-I

Hannon, P. D. (2005). Incubation policy and practice: building practitioner and professional capability. *Journal of Small Business and Enterprise Development*, *12*(1), 57–75.

Harrison, R. T., Mason, C. M., & Girling, P. (2004). Financial bootstrapping and venture development in the software industry. *Entrepreneurship & Regional Development*, *16*(4), 307–333.

Heirman, A., & Clarysse, B. (2004). How and why do research-based start-ups differ at founding? A resource-based configurational perspective. *The Journal of Technology Transfer*, *29*(3-4), 247–268.

Hickson, D. J., Hinings, C. R., Lee, C. A., Schneck, R. E., & Pennings, J. M. (1971). A strategic contingencies' theory of intraorganizational power. *Administrative science quarterly*, 216–229.

Hippel, E. (1988). VON (1988) The Sources of Innovation. *New York*.

Hytti, U., & Maki, K. (2007). Which firms benefit most from the incubators? *International Journal of Entrepreneurship and innovation management*, *7*(6), 506–523.

Kakati, M. (2003). Success criteria in high-tech new ventures. *Technovation*, *23*(5), 447–457.

Karlsson, C., & Olsson, O. (1998). Product innovation in small and large enterprises. *Small Business Economics*, *10*(1), 31–46.

Kazanjian, R. K. (1988). Relation of dominant problems to stages of growth in technology-based new ventures. *Academy of management journal*, *31*(2), 257–279.

Kazanjian, R. K., & Drazin, R. (1989). An empirical test of a stage of growth progression model. *Management Science*, *35*(12), 1489–1503.

Kirihata, T. (2007). The Commercialization Process of Intellectual Property by New Technology Based Firms in Japan. *The Kyoto Economic Review*, *76*(2), 241–249.

Kirwan, P., van der Sijde, P., & Groen, A. (2006). Assessing the needs of new technology based firms (NTBFs): An investigation among spin-off companies from six European Universities. *Springer Science + Business Media, LLC 2006*. doi:10.1007/s11365-006-8683-1

Kline, S. J., & Rosenberg, N. (1986). An overview of innovation. *The positive sum strategy: Harnessing technology for economic growth*, *275*, 305.

Knopp, L. (2006). Keeping Things in Check: Tracking Progress Can Help Ensure Clients Become Graduates. *NBIA Review*, (June 2006).

Lalkaka, R. (2000). Assessing the performance and sustainability of technology business incubators. *International Centre for Science & High Technology, Trieste, Italy*, 4–6.

Lechner, C., Dowling, M., & Welpe, I. (2006). Firm networks and firm development: The role of the relational mix. *Journal of Business venturing*, *21*(4), 514–540.

Lee, C., Lee, K., & Pennings, J. M. (2001). Internal capabilities, external networks, and performance: a study on technology-based ventures. *Strategic management journal*, *22*(6-7), 615–640.

Lee, S. S., & Osteryoung, J. S. (2004). A comparison of critical success factors for effective operations of university business incubators in the United States and Korea. *Journal of Small Business Management*, *42*(4), 418–426.

Lerner, J. S., & Tetlock, P. E. (1999). Accounting for the effects of accountability. *Psychological bulletin*, *125*(2), 255.

Lewis, D. A., Harper-Anderson, E., & Molnar, L. A. (2011). Incubating success. Incubation best practices that lead to successful new ventures. *Ann Arbor: Institute for Research on Labor, Employment, and Development*, 1–144.

Lewis, V. L., & Churchill, N. C. (1983). The five stages of small business growth. *Harvard business review*, *61*(3), 30–50.

Liao, J., Welsch, H., & Stoica, M. (2003). Organizational absorptive capacity and responsiveness: an empirical investigation of growth-oriented SMEs. *Entrepreneurship Theory and practice*, *28*(1), 63–85.

Lin, C.-L., & Tzeng, G.-H. (2009). A value-created system of science (technology) park by using DEMATEL. *Expert Systems with Applications*, *36*(6), 9683–9697.

Lindelöf, P., & Löfsten, H. (2003). Science park location and new technology-based firms in Sweden–implications for strategy and performance. *Small Business Economics*, *20*(3), 245–258.

Lindstrom, G., & Olofsson, C. (2001). Early stage financing of NTBFs: an analysis of contributions from support actors. *Venture Capital: An International Journal of Entrepreneurial Finance*, *3*(2), 151–168.

Link, A. N., Siegel, D. S., & Bozeman, B. (2007). An empirical analysis of the propensity of academics to engage in informal university technology transfer. *Industrial and Corporate Change*, *16*(4), 641–655.

Löfsten, H., & Lindelöf, P. (2002). Science Parks and the growth of new technology-based firms—academic-industry links, innovation and markets. *Research Policy*, *31*(6), 859–876.

Löfsten, H., & Lindelöf, P. (2005). R&D networks and product innovation patterns—academic and non-academic new technology-based firms on Science Parks. *Technovation*, *25*(9), 1025–1037.

Luggen, M., & Tschirky, H. (2003). A conceptual framework for technology and innovation management in new technology-based firms (NTBF). In *Management of Engineering and Technology, 2003. PICMET'03. Technology Management for Reshaping the World. Portland International Conference on* (pp. 342–347). IEEE.

Lumpkin, J. R., & Ireland, R. D. (1988). Screening practices of new business incubators: the evaluation of critical success factors. *American Journal of Small Business*, *12*(4), 59–81.

Lundvall, K., & Battese, G. E. (2000). Firm size, age and efficiency: evidence from Kenyan manufacturing firms. *The journal of development studies*, *36*(3), 146–163.

Malerba, F. (1992). Learning by firms and incremental technical change. *The economic journal*, 845–859.

Markman, G. D., Phan, P. H., Balkin, D. B., & Gianiodis, P. T. (2005). Entrepreneurship and university-based technology transfer. *Journal of Business venturing*, *20*(2), 241–263.

Mason, C., & Harrison, R. (2004). Does investing in technology-based firms involve higher risk? An exploratory study of the performance of technology and non-technology investments by business angels*. *Venture Capital: An International Journal of Entrepreneurial Finance*, *6*(4), 313–332.

McAdam, M., Galbraith, B., McAdam, R., & Humphreys, P. (2006). Business processes and networks in university incubators: A review and research agendas. *Technology analysis & strategic management*, *18*(5), 451–472.

McAdam, M., & McAdam, R. (2008). High tech start-ups in University Science Park incubators: The relationship between the start-up's lifecycle progression and use of the incubator's resources. *Technovation*, *28*(5), 277–290.

McGee, J. E., & Dowling, M. J. (1994). Using R&D cooperative arrangements to leverage managerial experience: A study of technology-intensive new ventures. *Journal of Business venturing*, *9*(1), 33–48.

McGowan, P., Cooper, S., van der Sijde, P., Agnete Alsos, G., Hytti, U., & Ljunggren, E. (2011). Stakeholder theory approach to technology incubators. *International Journal of Entrepreneurial Behavior & Research*, *17*(6), 607–625.

McMullan, E., Chrisman, J. J., & Vesper, K. (2001). Some problems in using subjective measures of effectiveness to evaluate entrepreneurial assistance programs. *Entrepreneurship theory and practice*, *26*(1), 37–54.

Merges, R. P. (2006). Patents, entry and growth in the software industry. *Available at SSRN 926204*.

Merriam, S. B. (2014). *Qualitative research: A guide to design and implementation*. John Wiley & Sons.

Meyer, J. (2004). Conceptual issues in the study of dynamic hazard warnings. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *46*(2), 196–204.

Mian, S. A. (1994). US university-sponsored technology incubators: an overview of management, policies and performance. *Technovation*, *14*(8), 515–528.

Mian, S. A. (1996a). The university business incubator: a strategy for developing new research/technology-based firms. *The Journal of High Technology Management Research*, *7*(2), 191–208.

Mian, S. A. (1996b). Assessing value-added contributions of university technology business incubators to tenant firms. *Research Policy*, *25*(3), 325–335.

Mian, S. A. (1997). Assessing and managing the university technology business incubator: An integrative framework. *Journal of Business Venturing*, *12*, 251–285.

Michelacci, C. (2003). Low Returns in R&D Due to the Lack of Entrepreneurial Skills*. *The Economic Journal*, *113*(484), 207–225.

Minola, T., & Giorgino, M. (2011). External capital for NTBFs: the role of bank and venture capital. *International Journal of Entrepreneurship and Innovation Management*, *14*(2), 222–247.

Molleman, A., & Strijbosch, M. (2014). *Valorisatie Agenda - TUDelft 2020*. Delft. Retrieved from http://www.tudelft.nl/fileadmin/Files/tudelft/over/strategie/kerndocumenten/valorisatieagenda_final_Nederlands_20april_2014.pdf

Murray, G. C., & Marriott, R. (1998). Why has the investment performance of technology-specialist, European venture capital funds been so poor? *Research Policy*, *27*(9), 947–976.

Mustar, P. (1997). How French academics create hi-tech companies: the conditions for success or failure. *Science and Public Policy*, *24*(1), 37–43.

Mustar, P., Renault, M., Colombo, M. G., Piva, E., Fontes, M., Lockett, A., … Moray, N. (2006). Conceptualising the heterogeneity of research-based spin-offs: A multi-dimensional taxonomy. *Research policy*, *35*(2), 289–308.

NBIA. (2008). NBIA. Retrieved from www.nbia.org

Ndonzuau, F. N., Pirnay, F., & Surlemont, B. (2002). A stage model of academic spin-off creation. *Technovation*, *22*(5), 281–289.

Nicolaou, N., & Birley, S. (2003). Social networks in organizational emergence: The university spinout phenomenon. *Management Science*, *49*(12), 1702–1725.

Ogenio, T. B. (2013). Innovation high-tech firm development within business incubators.

Olson, P. D., & Terpstra, D. E. (1992). Organizational structural changes: Life-cycle stage influences and managers' and interventionists' challenges. *Journal of Organizational Change Management*, *5*(4), 27–40.

Patwardan, R. (2003). *Best Practices for Managing Incubators*.

Penrose, E. (1959). *The Theory of the Growth of the Firm*. The Economic Journal .

Peters, L., Rice, M., & Sundararajan, M. (2004). The role of incubators in the entrepreneurial process. *The Journal of Technology Transfer*, *29*(1), 83–91.

Phan, P. H., Siegel, D. S., & Wright, M. (2005). Science parks and incubators: observations, synthesis and future research. *Journal of Business venturing*, *20*(2), 165–182.

Phillips, R. G. (2002). Technology business incubators: how effective as technology transfer mechanisms? *Technology in Society*, *24*(3), 299–316.

Politis, D., Gabrielsson, J., & Shveykina, O. (2012). Early-stage finance and the role of external entrepreneurs in the commercialization of university-generated knowledge. *Venture Capital*, *14*(2-3), 175–198.

Porter, M. E. (1998). *Clusters and the new economics of competition* (Vol. 76). Harvard Business Review Boston.

Ratinho, T., Harms, R., & Groen, A. (2009). Technology business incubators as engines of growth: towards a distinction between technology incubators and non-technology incubators.

Rhenman, E., & Adler, N. (1973). *Organization theory for long-range planning*. Wiley London.

Ries, E. (2011). *The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses*. Random House LLC.

Rizzo, U. (2012). Why do scientists create academic spin-offs? The influence of the context. *The Journal of Technology Transfer*, 1–29.

Rizzo, U., Nicolli, F., & Ramaciotti, L. (2014). The Heterogeneity of the Development Process of New Technology-Based Firms. Implication for Innovation Policies. *Journal of the Knowledge Economy*, *5*(1), 114–132.

Rothaermel, F. T., Agung, S. D., & Jiang, L. (2007). University entrepreneurship: a taxonomy of the literature. *Industrial and corporate change*, *16*(4), 691–791.

Rothaermel, F. T., & Thursby, M. (2005a). University–incubator firm knowledge flows: assessing their impact on incubator firm performance. *Research Policy*, *34*(3), 305–320.

Rothaermel, F. T., & Thursby, M. (2005b). Incubator firm failure or graduation?: The role of university linkages. *Research Policy*, *34*(7), 1076–1090.

Rothwell, R., & Dodgson, M. (1991). External linkages and innovation in small and medium-sized enterprises. *R&D Management*, *21*(2), 125–138.

Saemundsson, R. J. (2003). The interaction between growth intentions, access to resources and growth in new technology-based firms. *The International Journal of Entrepreneurship and Innovation*, *4*(2), 85–95.

Schwartz, M. (2008). *Incubator age and incubation time: Determinants of firm survival after graduation?* IWH-Diskussionspapiere.

Schwartz, M. (2009). Beyond incubation: an analysis of firm survival and exit dynamics in the post-graduation period. *The Journal of Technology Transfer*, *34*(4), 403–421.

Schwartz, M. (2013). A control group study of incubators' impact to promote firm survival. *The Journal of Technology Transfer*, *38*(3), 302–331.

Schwartz, M., & Göthner, M. (2009). A multidimensional evaluation of the effectiveness of business incubators: an application of the PROMETHEE outranking method. *Environment and Planning C: Government and Policy*, *27*(6), 1072–1087.

Schwartz, M., & Hornych, C. (2010). Cooperation patterns of incubator firms and the impact of incubator specialization: Empirical evidence from Germany. *Technovation*, *30*(9), 485–495.

Scillitoe, J. L., & Chakrabarti, A. K. (2010). The role of incubator interactions in assisting new ventures. *Technovation*, *30*(3), 155–167.

Scott, M., & Bruce, R. (1987). Five stages of growth in small business. *Long range planning*, *20*(3), 45–52.

Shane, S. A. (2004). *Academic entrepreneurship: University spinoffs and wealth creation*. Edward Elgar Publishing.

Sharpe, W. F., Alexander, G. J., & Bailey, J. V. (1999). *Investments* (Vol. 6). Prentice Hall New Jerse^ eNJ NJ.

Shepherd, D. A., Douglas, E. J., & Shanley, M. (2000). New venture survival: Ignorance, external shocks, and risk reduction strategies. *Journal of Business Venturing*, *15*(5), 393–410.

Sherman. (1999). Assessing the intervention effectiveness of business incubation programs on new business start-ups. *Journal of Developmental Entrepreneurship*, *4*, 117–133.

Siegel, D. S., Thursby, J. G., Thursby, M. C., & Ziedonis, A. A. (2001). Organizational issues in university-industry technology transfer: An overview of the symposium issue. *The Journal of Technology Transfer*, *26*(1), 5–11.

Siegel, D. S., Waldman, D., & Link, A. (2003). Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: an exploratory study. *Research Policy*, *32*(1), 27–48.

Siegel, D., Waldman, D., & Link, A. (1999). *Assessing the impact of organizational practices on the productivity of university technology transfer offices: An exploratory study*. National bureau of economic research.

Silva, E. S., Salomão, I. L., McIntyre, J. P., Guerreiro, J., Pires, M., Albuquerque, P. P., … VAZ, S. C. (2003). Panorama do cooperativismo brasileiro: história, cenários e tendências. *Revita uniRcoop*, *1*(2), 75–102.

Smilor, R. W. (1987). Managing the incubator system: critical success factors to accelerate new company development. *Engineering Management, IEEE Transactions on*, (3), 146–155.

Somsuk, N. (2010). A review of inter-firm technology transfer through the lens of the resource-based view. In *IEEM2010 - IEEE International Conference on Industrial Engineering and Engineering Management* (pp. 891–895). doi:10.1109/IEEM.2010.5674205

Sood, A., & Tellis, G. J. (2005). Technological evolution and radical innovation. *Journal of Marketing*, *69*(3), 152–168.

Spencer, A. S., & Kirchhoff, B. A. (2006). Schumpeter and new technology based firms: Towards a framework for how NTBFs cause creative destruction. *International Entrepreneurship and Management Journal*, *2*(2), 145–156.

Stankiewicz, R. (1994). Spin-off companies from universities. *Science and Public Policy*, *21*(2), 99–107.

Stevenson, H. H., & Jarillo, J. C. (1990). A paradigm of entrepreneurship: entrepreneurial management. *Strategic management journal*, *11*(5), 17–27.

Tamasy, C. (2007). Rethinking Technology-Oriented Business Incubators: Developing a Robust Policy Instrument for Entrepreneurship, Innovation, and Regional Development? *Growth and Change*, *38*(3), 460–473.

TECHNOLOGY INOVATION CENTRE. (2015). Universidade de Tecnologia da Jamaica. Incubadoras de Empresas (Business Incubators). Retrieved from http://www.utech.edu.jm/entrep/Incubator.htm

TEIXEIRA, D. de S. (2001). *Incubadora de empresas de software e internet: consideracaoes para implantacao e operacao*. ANPROTEC.

Thierstein, A., & Willhelm, B. (2001). Incubator, technology, and innovation centres in Switzerland: features and policy implications. *Entrepreneurship & Regional Development*, *13*(4), 315–331.

Thursby, J. G., & Thursby, M. C. (2002). Who is selling the ivory tower? Sources of growth in university licensing. *Management Science*, *48*(1), 90–104.

Todorovic, Z. W. (2010). Tenant firm progression within an incubator: Progression toward an optimal point of resource utilization. *Academy of Entrepreneurship Journal*, *16*(1), 23–40.

Tötterman, H. (2004). Capitalisation of new growth oriented technology-based firms–The role of early stage business support. In *NCSB 2004 Conference in Tromsö/Norway*.

Tushman, M. L., & Anderson, P. (1986). Technological discontinuities and organizational environments. *Administrative science quarterly*, 439–465.

Tyebjee, T. T., & Bruno, A. V. (1980). Strategic Implications for Technology Based Firms Entering Consumer Markets. *Management Decision*, *18*(7), 391–402.

Uma Sekaran & Bougie, R. (2010). Research Methods For Business: A Skill Building Approach. John Wiley & Sons.

Van de Ven, A. H., Hudson, R., & Schroeder, D. M. (1984). Designing new business startups: Entrepreneurial, organizational, and ecological considerations. *Journal of management*, *10*(1), 87–108.

Van Geenhuizen, M., & Soetanto, D. P. (2009). Academic spin-offs at different ages: A case study in search of key obstacles to growth. *Technovation*, *29*(10), 671–681.

Van Osnabrugge, M., & Robinson, R. J. (2000). *Angel Investing: Matching Startup Funds with Startup Companies--The Guide for Entrepreneurs and Individual Investors*. John Wiley & Sons.

Vanacker, T., Manigart, S., & Meuleman, M. (2009). Early Differences et Persistence in the Entrepreneurial Finance Process: Evidence from High-et Low-Growth Biotechnology Startups. *Financing Unquoted High-Growth Companies: From Extending Existing Finance Theory Towards an*, 140.

Vanderstraeten, J., & Matthyssens, P. (2010). Measuring the performance of business incubators: A critical analysis of effectiveness approaches and performance measurement systems. In *ICSB conference, Cincinnati, US, June, published in conference proceedings-USB, ISBN* (pp. 970–978).

Veryzer, R. W. (1998). Discontinuous innovation and the new product development process. *Journal of product innovation management*, *15*(4), 304–321.

Viale, R., & Etzkowitz, H. (2010). *The capitalization of knowledge: a triple helix of university-industry-government*. Edward Elgar Publishing.

Vohora, A., Wright, M., & Lockett, A. (2004). Critical junctures in the development of university high-tech spinout companies. *Research Policy*, *33*(1), 147–175.

Voisey, P., Gornall, L., Jones, P., & Thomas, B. (2006). The measurement of success in a business incubation project. *Journal of Small Business and Enterprise Development*, *13*(3), 454–468.

Warren, L., Patton, D., & Bream, D. (2009). Knowledge acquisition processes during the incubation of new high technology firms. *International Entrepreneurship and Management Journal*, *5*(4), 481–495.

Westhead, P., Batstone, S., & Martin, F. (2000). Technology-Based Firms Located on Science Parks: The Applicability of Bullock's' Soft-Hard'Model. *Enterprise and Innovation Management Studies*, *1*(2), 107–139.

Westhead, P., & Storey, D. J. (1997). Financial constraints on the growth of high technology small firms in the United Kingdom. *Applied Financial Economics*, *7*(2), 197–201.

Wheelwright, S. C. (1992). *Revolutionizing product development: quantum leaps in speed, efficiency, and quality*. Simon and Schuster.

Wolfe, C., Adkins, D., & Sherman, H. (2000). Best practices in business incubation. *NBIA report for TEDCO*.

Wong, W.-K., Cheung, H.-M., & Venuvinod, P. K. (2005). Assessing the Growth Potential of High-Technology Start-Ups: An Exploratory Study from Hong Kong. *Journal of Small Business & Entrepreneurship*, *18*(4), 453–470.

Wright, M. (2007). *Academic entrepreneurship in Europe*. Edward Elgar Publishing.

Wu, D. J., Kleindorfer, P. R., & Zhang, J. E. (2002). Optimal bidding and contracting strategies for capital-intensive goods. *European Journal of Operational Research*, *137*(3), 657–676.

Wulung, R. B. S., Takahashi, K., & Morikawa, K. (2014). An interactive multi-objective incubatee selection model incorporating incubator manager orientation. *Operational Research*, *14*(3), 409–438.

YES!Delft. (2013). YES!Delft.

Yin, R. K. (2011). *Applications of case study research* (Vol. 34). Sage Publications, Incorporated.

Yli-Renko, H., Autio, E., & Sapienza, H. J. (2001). Social capital, knowledge acquisition, and knowledge exploitation in young technology-based firms. *Strategic management journal*, *22*(6-7), 587–613.

Zedtwitz, M. von. (2003). Classification and management of incubators: aligning strategic objectives and competitive scope for new business facilitation. *International Journal of Entrepreneurship and innovation management*, *3*(1), 176–196.

Zucker, L. G., & Darby, M. R. (2006). *Movement of star scientists and engineers and high-tech firm entry*. National Bureau of Economic Research.

Zucker, L. G., Darby, M. R., & Armstrong, J. (1998). Geographically localized knowledge: spillovers or markets? *Economic Inquiry*, *36*(1), 65–86.

Concepts, Definitions, Terms & Appendices

Terms

GICS	Global Industry Classification Standard
IP	Intellectual Property
NTBF	New Technology Based Firm
R&D	Research & Development
PE	Private Equity
TTO	Technology Transfer Office
UTBI	University Technology Business Incubator
VC	Venture Capitalist

Appendix I Outcome preliminary research YES!Delft support

Incubator support between different ages (N=50)

Table 1 shows that on average the younger firms are more supported by the incubator or external parties as their older counterparts (56% over 46%). Implying that older firms had more often the need for support, but did not got it from the incubator or incubator network. However, when looking to the average number of supporters both younger and older firms are supported by an equal amount of supporters (2.7). When looking to *figure 1* it can be remarked that the industry is the most important supporter for the older companies (37% of the cases). At younger firms this is the University of Technology in Delft that most supported them (24% of the cases). Older firms are most supported in estimating market potential (25%) and approaching their first customer (25%)(*Figure 2*). Younger firms are most supported in estimating market potential and (26%) and technology development (22%).

	Received support for issues	Asked but received no support	Number of supporters (average)
<3 (N=20)	56%	44%	2,7
>3 (N=30)	46%	54%	2,7
Incubator average	50%	50%	2,7

Table 1: Support differences between ages at YES!Delft (N=50)

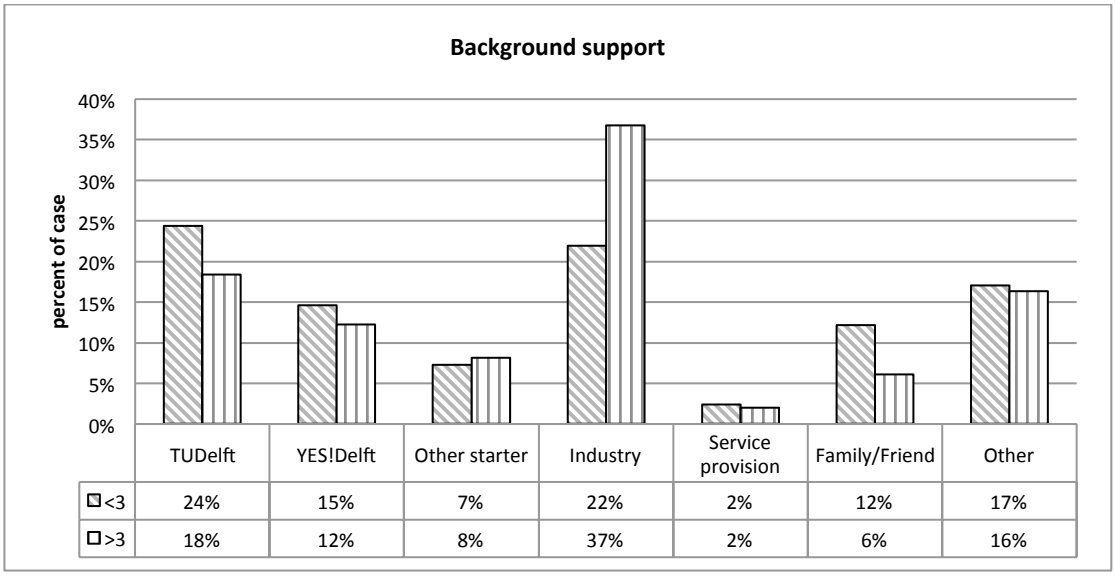


Figure 1: Background of supporter between ages at YES!Delft (N=50)

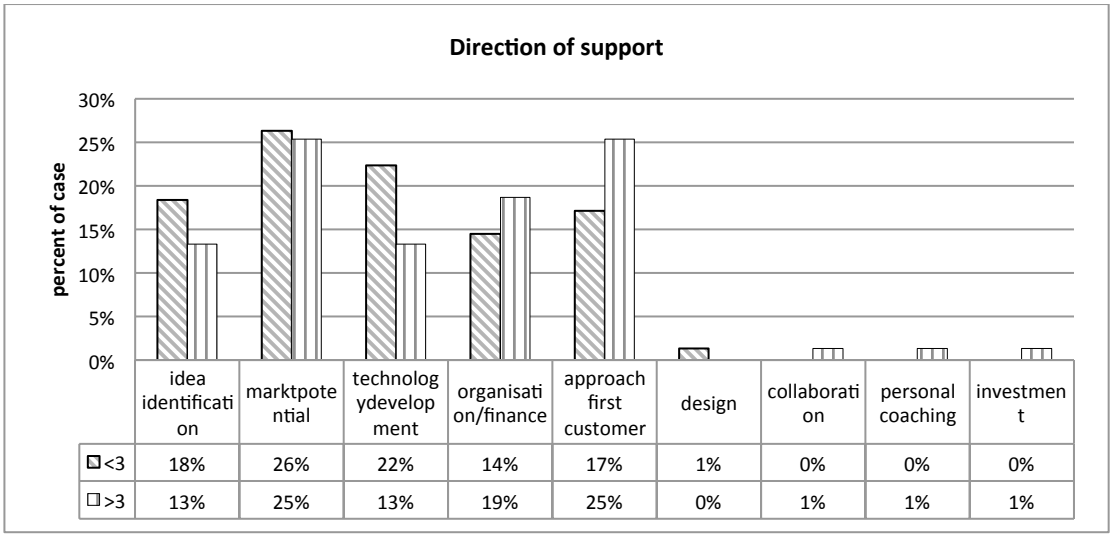


Figure 2: Direction of support between ages at YES!Delft (N=50)

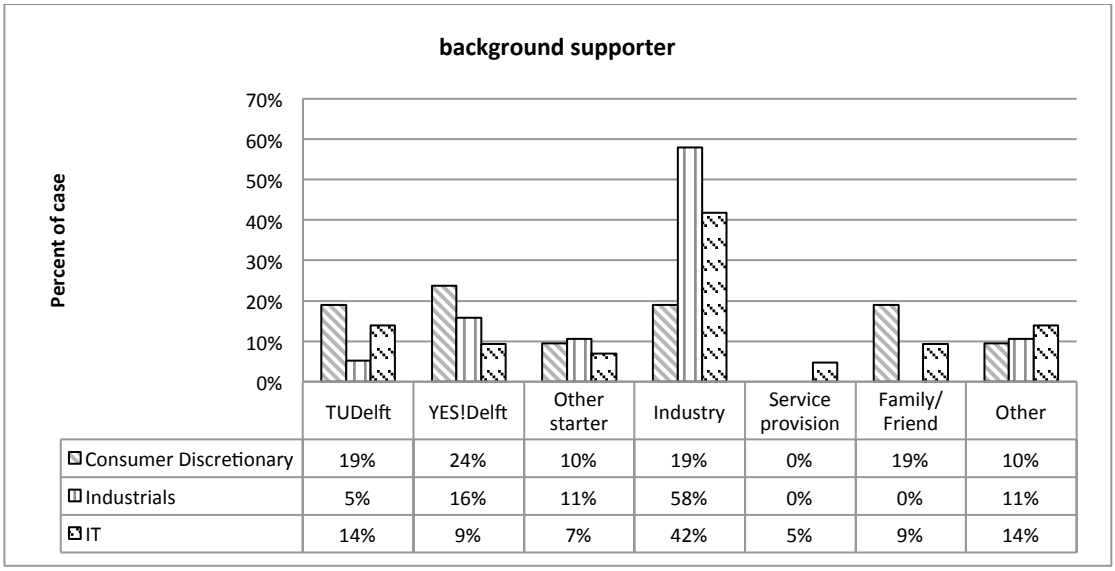
Incubator support between different industries (N=44)

Table 1 shows that on average, firms in the consumer discretionary sector are more supported by the incubator or external parties compared to other industries (56% over 44% in Industrials and 38% in IT). Implying that firms in this sector solved percentage wise the most amount of issues. When looking to the number of supporters of this sector, they do not received more support then for example IT (who had the highest number of issues but did not received support); i.e. both the consumer discretionary and IT sector are on average supported by 3.2 people. When looking to *figure 1* it can be remarked that the industry is the most important supporter for the sectors industrials and IT. The consumer discretionary sector receives most support from the YES!Delft team. When looking to the direction of support (*Figure 2*) it is shown that most support concerns idea identification (in case of consumer discretionary) and estimating the market potential (in case of IT and industrials).

	Received support for issues	Asked but received no support	Number of supporters (average)
Consumer Discretionary (N=9)	56%	44%	3,2
Industrials (N=19)	44%	56%	2,4
IT (N=16)	38%	62%	3,2
Incubator average	50%	50%	2,7

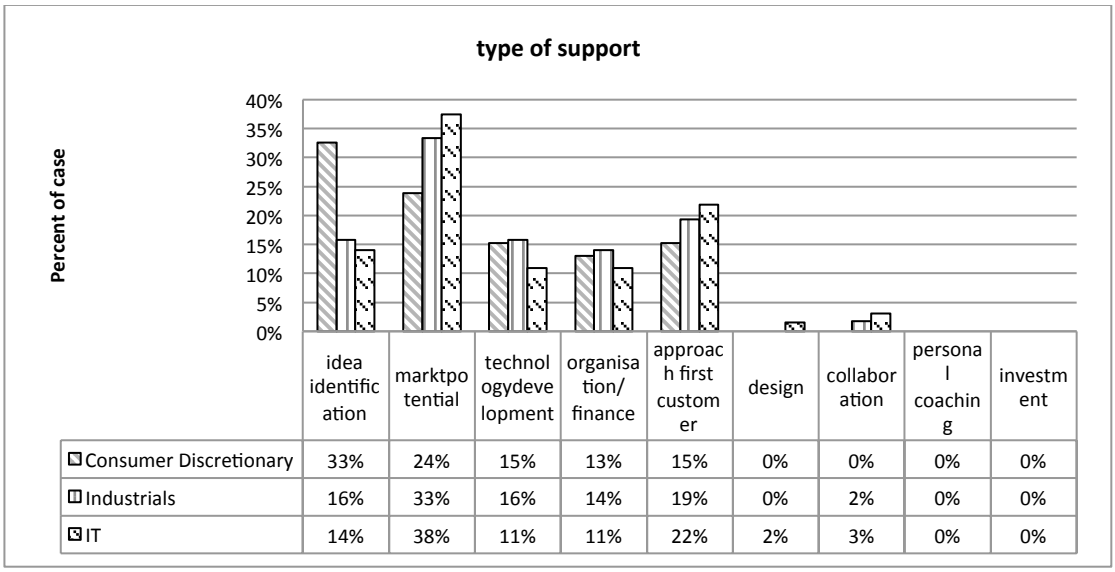
Table 1: Support differences between industry[15]s at YES!Delft (N=44)

[15] Indusries are classified according to the Global Industry Classification Standard (GICS)



	TUDelft	YES!Delft	Other starter	Industry	Service provision	Family/ Friend	Other
Consumer Discretionary	19%	24%	10%	19%	0%	19%	10%
Industrials	5%	16%	11%	58%	0%	0%	11%
IT	14%	9%	7%	42%	5%	9%	14%

Figure 1: Background of supporter between industries at YES!Delft (N=44)

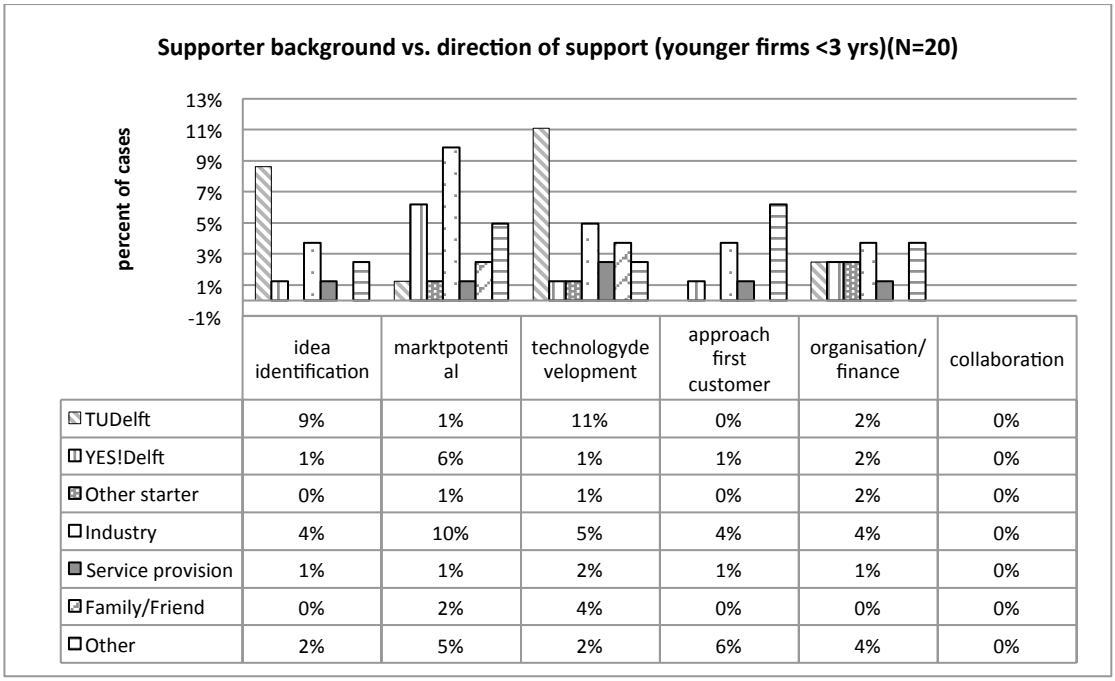


	idea identification	marktpotential	technologydevelopment	organisation/ finance	approach first customer	design	collaboration	personal coaching	investment
Consumer Discretionary	33%	24%	15%	13%	15%	0%	0%	0%	0%
Industrials	16%	33%	16%	14%	19%	0%	2%	0%	0%
IT	14%	38%	11%	11%	22%	2%	3%	0%	0%

Figure 2: Direction of support between industries at YES!Delft (N=44)

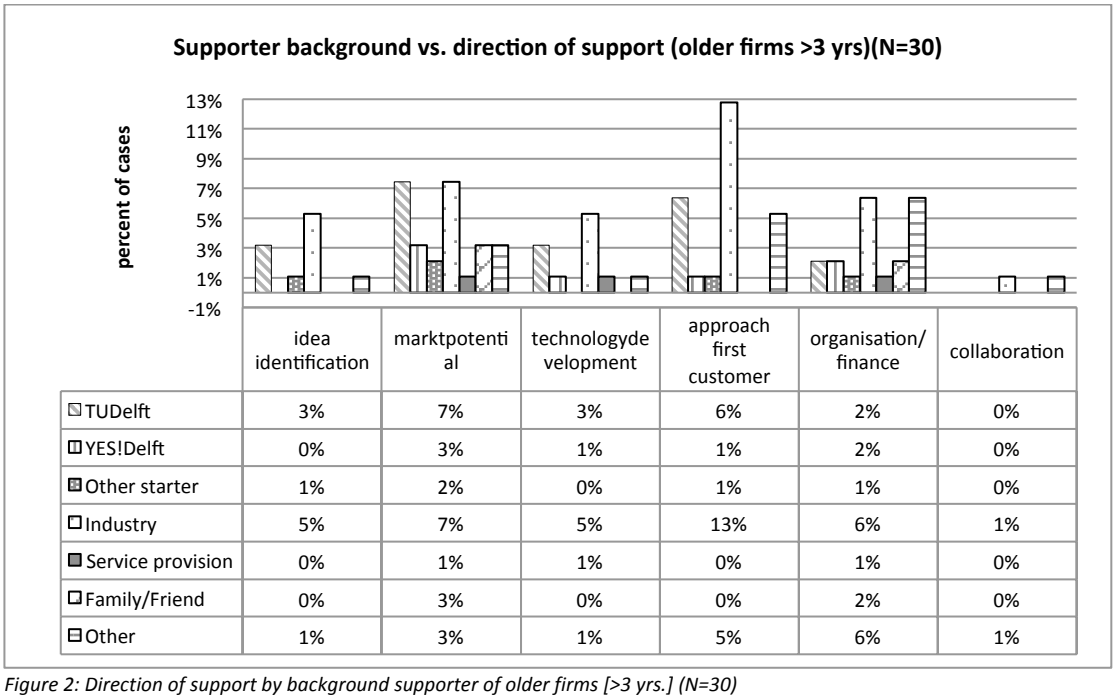
Supporter background vs. direction of support (N=50)

Figure 1 shows which type of supported provided which direction of support of the younger firms. It is shown that at younger firms the Delft University of Technology has an important role in the development of technology (11%) as well as idea identification (9%). YES!Delft on the other hand has a bigger role in estimating the market potential (6%) together with the industry (10%). *Figure 2* shows that at older firms are in 13% of the cases supported by the industry to get in contact with new (launching) customers.



	idea identification	marktpotential	technologydevelopment	approach first customer	organisation/ finance	collaboration
TUDelft	9%	1%	11%	0%	2%	0%
YES!Delft	1%	6%	1%	1%	2%	0%
Other starter	0%	1%	1%	0%	2%	0%
Industry	4%	10%	5%	4%	4%	0%
Service provision	1%	1%	2%	1%	1%	0%
Family/Friend	0%	2%	4%	0%	0%	0%
Other	2%	5%	2%	6%	4%	0%

Figure 1: Direction of support by background supporter of younger firms [<3 yrs.] (N=20)



	idea identification	marktpotential	technologydevelopment	approach first customer	organisation/ finance	collaboration
TUDelft	3%	7%	3%	6%	2%	0%
YES!Delft	0%	3%	1%	1%	2%	0%
Other starter	1%	2%	0%	1%	1%	0%
Industry	5%	7%	5%	13%	6%	1%
Service provision	0%	1%	1%	0%	1%	0%
Family/Friend	0%	3%	0%	0%	2%	0%
Other	1%	3%	1%	5%	6%	1%

Figure 2: Direction of support by background supporter of older firms [>3 yrs.] (N=30)

Appendix II Studies assessing the effect of incubator on tenants

Overview of findings of literature assessing incubator performance (Akçomak 2009)

	Survival	Sales growth	Employment growth	Innovativeness
Physical infrastructure	+	+ / O	O	O
Management support	+ / O	O	O	O
Administrative support	+ / O	O	O	O
Incubator image	+	+ / O / -	O	O
Financial support	+ / O	+ / O	+ / O	O
Networking with university	O	O	O	+ / O
Networking with business	+ / O	+ / O	+ / O	+ / O
Networking with incubator firms	O / -	O / -	O / -	O / -

Appendix III Network development of NTBFs

NTBF network develops from link to network to clusters (Yli Renko and Autio, 1998, p.258).

	**1 New, technology-based firm is founded** • a new, technology-based firm is founded as a spin-off or as a private venture to exploit new technological solutions
	**2 New, technology-based firm is linked to network or chain** • new, technology-based firm develops initial customer and other connections • some of these connections become intensive • new, technology-based firm starts to become embedded in an innovation network or a manufacturing chain
	**3 Cluster develops** • positive externalities develop in the network; development and growth starts to feed itself • many new, technology-based firms are founded • locomotive effect takes place • locking-in into paradigmatic technological stage • firm is manufacturing and or technologically embedded
	**4 New, technology-based firm is able to link into other networks and clusters** • new, technology-based firm has developed firm-specific distinctive competencies • new, technology-based firm has reached critical mass • it is possible for the firm to link into other networks and clusters and become less dependent on the initial cluster

Appendix IV Interview transcription

Company: CompositeTech
Name interviewee: ****
Function: Co-owner
Duration: 18 min.

1. Did you ever heard about incubatee evaluation within incubators?

   "no"

2. YES!Delft applies a incubatee evaluation after a three year incubation time. What is your opinion about this measure?

   "It is good that YES!Delft at least applies such measure, it keeps the value of YES!Delft its network high.

3. YES!Delft measures progress based on revenue and company size. What is your opinion about this way of measuring? In other words, is this the right way of measuring?

   "The point is that companies need to be assessed based on the extent they are able to make fast innovative loops, it is difficult to find a good measure for that other than revenue… possible revenue growth"

4. Do you have a certain need that hampers your development? If yes, elaborate?

   "Not that I know, YES!Delft supported us by introducing us to a key partner in the field."

5. To which extent can YES!Delft in your opinion grant support to your company?

   "YES!Delft can be supportive by offering generic services, but at the end of the day companies are challenged to be innovative what makes them valuable"

Now I am going to ask you some in-depth questions. These questions relate to specific sub-development domains: development in network, financing, and business. Developments in these areas say much about an early stage development of a technological start-up.

NETWORK

6. Can you give an indication on how your network developed?

   "Already since the beginning we heavily rely on industry ties. Unlike most other companies we rely on a few key ties that got our attention to develop new products collaboratively.

7. Can you indicate how important your network is for your entire development? i.e.: important, I constantly need to look for people in my network to make progress, *or* not important, for the development four our technology we do not need a network

   "Moderate, we need a network to find new markets to apply our knowledge to make new business models. Having a strong network certainty works in our benefit, but is not key to survive"

a. In case you rely much on your network, what is the underlying reason why you need to rely much on your network? Customers are rare, Lack of financiers etc.
b. In case you rely to a less extent on your network, what is the underlying reason? We can in get in contact via other networks.

[not answered]

8. Can you elaborate on your network needs? What kind of network needs do you have? Why is it important?

"Since the beginning we are dependent on expertise we gain when collaboratively develop products with our client. We cannot pitch our solutions to a wide audience. Our solutions are tailored made. We have found an effective way to develop our products at a limited number of key players, the aim is to stay within these environments with key players to eventually have a great position and scale our business quickly.

FINANCING

9. Can you give an indication on how your way of financing developed?

[not answered, became clear after one of the previous questions]

10. Can you indicate how important your financing is for your entire development? i.e.: important, I constantly need financing at every step I take, *or* not important, for the development four our technology we do not need a financing at all

"We try to generate a cash-flow at one of our projects that enables us to fund new projects. As long as we do not have a particular scalable product we are not dependent on an investment"

a. In case you rely much on your financing, what is the underlying reason why you need to rely much on your financing? For example, you are dealing with expensive assets
b. In case you rely to a less extent on your financing, what is the underlying reason? I already obtained a good investor.

"We work based on the question of the customer. We deliver them knowledge to reinvent construction components. That is what they are paying for. We learn how to do this faster and faster, that is our key to success.

11. Can you elaborate on your finance needs? What kind of finance needs do you have? Why is it important?

[not asked]

BUSINESS

12. Can you give an indication on how your business developed?

    "We do not have a single product that evolved. We use our knowledge in designing composite components. We do this in collaboration with the industry. Already in the beginning we relied on this industry to further develop or knowledge about the technology. Now we are looking for the most suitable technology to further scale the business.

13. Can you indicate how important your business expertise is for your entire development? i.e.: important, me and my team constantly learn and apply our knowledge, *or* not important, I already obtained much skills in my previous career

    "Technology knowledge is one of the most important components of our business, it takes time to fully understand the technology, once we fully understand the process we can use our expertise as core capability for a fast way of developing technologies on a large scale"

14. Can you elaborate on your business needs? What kind of business needs do you have? Why is it important?

    "Currently we are not hampered by any particular business needs"

OTHER

15. Is there something else you are hampered by?
    [none]

16. Do you have something else to add or do you have any questions?
    [none]

Company: WebTech
Name interviewee: ****
Function: Co-founder
Duration: 21 min.

1. Did you ever heard about incubatee evaluation within incubators?

   "no"

2. YES!Delft applies a incubatee evaluation after a three year incubation time. What is your opinion about this measure?

   "At the moment YES!Delft does nothing at all, YES!Delft seems to be merely a PR machine."

3. YES!Delft measures progress based on revenue and company size. What is your opinion about this way of measuring? In other words, is this the right way of measuring?
   "How many customers do you have, besides sales and employment"

4. Do you have a certain need that hampers your development? If yes, elaborate?
   "At the moment we are hampered by expertise/support on sales (not marketing) and finding employment. Why is there still no vacancy agency present"

5. To which extent can YES!Delft in your opinion grant support to your company?

   "More growth support by i.e. ask entrepreneurs what they need, sales-driven events with innovative companies instead inviting of the traditional companies"

Now I am going to ask you some in-depth questions. These questions relate to specific sub-development domains: development in network, finance, and business. Developments in these areas say much about an early stage development of a technological start-up.

NETWERK

6. Can you give an indication on how your network developed?

   "Friends to acquaintance, form acquaintance to acquaintance of acquaintance"

7. Can you indicate how important your network is for your entire development? i.e.: important, I constantly need to look for people in my network to make progress, *or* not important, for the development four our technology we do not need a network

   "Not relevant, we do cold calling so network is irrelevant for us"

   a. In case you rely much on your network, what is the underlying reason why you need to rely much on your network? Customers are rare, Lack of financiers etc.
   b. In case you rely to a less extent on your network, what is the underlying reason? We can in get in contact via other networks.

8. Can you elaborate on your network needs? What kind of network needs do you have? Why is it important?

"None, it can help facilitating, but the main focus is on selling and having paying customers"

FINANCIERING

9. Can you give an indication on how your way of financing developed?

"we went from own money to VC"

10. Can you indicate how important your financing is for your entire development? i.e.: important, I constantly need financing at every step I take, *or* not important, for the development four our technology we do not need a financing at all

"Everything, without money we can't do anything."

    c. In case you rely much on your financing, what is the underlying reason why you need to rely much on your financing? For example, you are dealing with expensive assets
    d. In case you rely to a less extent on your financing, what is the underlying reason? I already obtained a good investor.

"Our sales team and cold calling is quite expensive in operation, also the initial development costs of the application is expensive"

11. Can you elaborate on your finance needs? What kind of finance needs do you have? Why is it important?

"The choice of finance is driven by what it eventually costs, risks are, and the business model. We as a firm do not have many choice in selecting our finance, banks think that our kind of businesses are too risky and therefore we are narrowed down to VC or PE, those two do not differentiate from each other"

BUSINESS

12. Can you give an indication on how your business developed?

"By participating in the pre-incubator programme (LaunchLab) we ware able to make a quick MVP. Based on component-based and of the shelf technologies we were able to quickly get our first customer"

13. Can you indicate how important your business expertise is for your entire development? i.e.: important, me and my team constantly learn and apply our knowledge, *or* not important, I already obtained much skills in my previous career

"Myself had a previous career in sales. The programming team has business skills that relate to writing software. They understand the technology and use special technology stacks in which you can choose between components and ways of visualizing etc."

14. Can you elaborate on your business needs? What kind of business needs do you have? Why is it important?

    "We have all the expertise in-house. With the insights from LauchLab we were able to quickly obtain lean business principles such as business model verification as said, we need more business support in sales, but not necessarily advice, more in terms of human capital"

OTHER

15. Is there something else you are hampered by?
    "no"

16. Do you have something else to add or do you have any questions?
    "no"

Company: AquaTech
Name interviewee: ****
Function: Co-founder
Duration: 31 min.

1. Did you ever heard about incubatee evaluation within incubators?

   "no"

2. YES!Delft applies a incubatee evaluation after a three year incubation time. What is your opinion about this measure?

   "I expected that YES!Delft would measure progress after each year, YES!Delft can improve to this extent. Maybe in some cases not that relevant because you have to give much direction and risk that you don't make progress at all, at least you can make things more transparent.

   When I look to my company, we raise deadlines to further develop our product, but this is something that cannot be applied by YES!Delft, it is merely something for the companies itself."

3. YES!Delft measures progress based on revenue and company size. What is your opinion about this way of measuring? In other words, is this the right way of measuring?

   "It is difficult to measure the potentiality of an idea based on too simple criteria. YES!Delft can look to turnover, but to a certain extent is also needs to look at other criteria such as IP (is there value in portfolio), this is dependent on the industry"

4. Do you have a certain need that hampers your development? If yes, elaborate?

   "Time, we have sufficient demand, support, and finance, our product needs to be further developed"

5. To which extent can YES!Delft in your opinion grant support to your company?

   "Networking, draft pathways, provide access to finance"

Now I am going to ask you some in-depth questions. These questions relate to specific sub-development domains: development in network, finance, and business. Developments in these areas say much about an early stage development of a technological start-up.

NETWORK

6. Can you give an indication on how your network developed?

   "We started at TU-delft, our network has developed by joining competitions (Philips innovation award), this was key to become under attention. Also within Delft (i.e. TTO, VP Delta, Kairos Society) we brought our product under attention, likewise at Dutch and Nepal (using social network) governmental ministries"

7. Can you indicate how important your network is for your entire development? i.e.: important, I constantly need to look for people in my network to make progress, *or* not important, for the development four our technology we do not need a network.

   "Much, especially as strategy to get a reputation and secure projects, we need strategic partners (distributors i.e. US Eight) to test Beta version"

   a. In case you rely much on your network, what is the underlying reason why you need to rely much on your network? Customers are rare, Lack of financiers etc.
   b. In case you rely to a less extent on your network, what is the underlying reason? We can in get in contact via other networks.

   "We have a specific product with a very big market, therefore we need key players who want to sell this, we only aim to make develop the product"

8. Can you elaborate on your network needs? What kind of network needs do you have? Why is it important?

   "It must have a strategic fit with the company"

FINANCE

9. Can you give an indication on how your way of financing developed?

   "We relied on competition money (20k for prototype), STW (valorization grant €250k), ClimateKick → KennisVoucher, USAID (SWFF) $500k. In 2015 they plan to get an investment."

10. Can you indicate how important your financing is for your entire development? i.e.: important, I constantly need financing at every step I take, *or* not important, for the development four our technology we do not need a financing at all

    "To a moderate extent, we got a lot of money from competitions, we are currently not hampered by a lack of it"

    a. In case you rely much on your financing, what is the underlying reason why you need to rely much on your financing? For example, you are dealing with expensive assets
    b. In case you rely to a less extent on your financing, what is the underlying reason? I already obtained a good investor.

    "We have a likable and subsidy-friendly product, which makes it rather easy to raise money at competitions"

11. Can you elaborate on your finance needs? What kind of finance needs do you have? Why is it important?

    "Although we received much money from competitions and grants we need to make the step towards other ways of finance because it is unattainable on the long run. Because we are likeable we got ourselves some time to develop our products but eventually to thrive-up sales we need conventional

ways of finance, so at the moment we can scale-up our business it is of strategic importance to scalable finance such as VCs"

BUSINESS

12. Can you give an indication on how your business developed?

    "We first started by building a prototype, followed by a Patent application (PCT), Sub-parts. Scientific understanding developed was present along the entire process. There is a lot of knowledge packed in the product itself that is also patented, if the project gets a delay specific sub-parts can be commercialized separately to provide them with revenues and do not put them at risk. The main aim is to commercialize the patented product"

13. Can you indicate how important your business expertise is for your entire development? i.e.: important, me and my team constantly learn and apply our knowledge, *or* not important, I already obtained much skills in my previous career

    "Business expertise related to technology is the most important part of the entire process. We rely on scientists and calculations in order to make our product a success"

14. Can you elaborate on your business needs? What kind of business needs do you have? Why is it important?

    "Business needs are not that crucial at the moment, we are currently focus on the development of one products and we need time to learn from it before we can scale"

OTHER

15. Is there something else you are hampered by?

    "The environment, in some countries we cannot plan testing periods because of the weather, environmental conditions"

16. Do you have something else to add or do you have any questions?

    "no"

Appendix V Survey questions

In this appendix a cut out of the survey questions used for this research is shown. All questions in the survey are coded. If a question contains multiple answers, each answer is alphabetically denoted.

Finance needs[16] (CAP_GOAL_A until CAP_GOAL_F) – *To what extent do you need additional financing for…*

A	*… further research*	(1) (2) (3) (4) (5) (6) (7) disagree agree	( ) N/A
B	*… prototype building*	(1) (2) (3) (4) (5) (6) (7) disagree agree	( ) N/A
C	*… product launch*	(1) (2) (3) (4) (5) (6) (7) disagree agree	( ) N/A

D	*… attract personnel*	(1) (2) (3) (4) (5) (6) (7) disagree agree	( ) N/A
E	*… running current business processes*	(1) (2) (3) (4) (5) (6) (7) disagree agree	( ) N/A
F	*… expansion of the market*	(1) (2) (3) (4) (5) (6) (7) disagree agree	( ) N/A

Business needs (CAP_ADVICE_A until CAP_ADVICE_F) – *We need more support on…*

A	*… writing a proposal for a grant*	(1) (2) (3) (4) (5) (6) (7) disagree agree	( ) N/A
B	*… recruiting and selecting employees*	(1) (2) (3) (4) (5) (6) (7) disagree agree	( ) N/A
C	*… doing employee administration*	(1) (2) (3) (4) (5) (6) (7) disagree agree	( ) N/A
D	*… doing financial administration*	(1) (2) (3) (4) (5) (6) (7) disagree agree	( ) N/A
E	*… a certification application request*	(1) (2) (3) (4) (5) (6) (7) disagree agree	( ) N/A
F	*… the development of a prototype*	(1) (2) (3) (4) (5) (6) (7) disagree agree	( ) N/A

Network needs (CAP_ADVICE_G until CAP_ADVICE_I) – *We need more support on…*

G	*… finding/approaching a partner*	(1) (2) (3) (4) (5) (6) (7) disagree agree	( ) N/A
H	*… finding/approaching a (launching) customer*	(1) (2) (3) (4) (5) (6) (7) disagree agree	( ) N/A
I	*… lobbying for our products or services*	(1) (2) (3) (4) (5) (6) (7)	( )

[16] Finance are divided in finance required for product/technology development (A-C) and for organisational development (D-F)

		disagree agree	N/A

Growth orientation (RESP_INNOV_J until RESP_INNOV_L) – *At the development of our innovation:*

J	*We have a time horizon for investments and make decisions within one year*	(1) (2) (3) (4) (5) (6) (7) disagree agree
K	*We have a time horizon for investments and make decisions within a timeframe of two to three years*	(1) (2) (3) (4) (5) (6) (7) disagree agree
L	*We have a time horizon for investments and make decisions - over three year*	(1) (2) (3) (4) (5) (6) (7) disagree agree

R&D Focus (ENT_ORIENT_A) – *You can specify whether you more agree with the left or right position*

In general, we place a strong emphasis on marketing of existing and proven products or services	(1) (2) (3) (4) (5) (6) (7) agree agree with this with this	*In general, we place a strong emphasis on R&D, technological leadership, and innovations*

Market Newness (ENT_ORIENT_E) – *You can specify whether you more agree with the left or right position*

We are seldom the first with the introduction of new products, services, and technologies etc.	(1) (2) (3) (4) (5) (6) (7) agree agree with this with this	*In general, we place a strong emphasis on R&D, technological leadership, and innovations*

Appendix VI Factor analysis

In this appendix the SPSS outcome of the factor analysis on different need types is presented.

Finance needs (FIN_NEED)

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Two components extracted. Rotation converged in 3 iterations.

Rotated Component Matrix

	Factor loadings	
Component	1	2
CAP_GOAL_A	.654	.098
CAP_GOAL_B	.833	-.025
CAP_GOAL_C	.861	.105
CAP_GOAL_D	.550	.632
CAP_GOAL_E	.066	.673
CAP_GOAL_F	-.037	.824

Business needs (BUS_NEED)

Extraction Method: Principal Component Analysis. One component extracted.

Component Matrix

	Factor loadings
CAP_ADVICE_A	.808
CAP_ADVICE_B	.480
CAP_ADVICE_C	.804
CAP_ADVICE_D	.799
CAP_ADVICE_E	.660
CAP_ADVICE_F	.748

Network needs (NET_NEED)

Extraction Method: Principal Component Analysis. One component extracted.

Component Matrix

	Factor loadings
CAP_ADVICE_G	.820
CAP_ADVICE_H	.838
CAP_ADVICE_I	.775

Appendix VII Reliability analysis

In this appendix the SPSS outcome of the reliability analysis on different need types is presented.

Finance needs (FIN_NEED)

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.687	.686	6

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
CAP_GOAL_A	22.30	54.492	.405	.225	.651
CAP_GOAL_B	22.34	50.462	.445	.408	.637
CAP_GOAL_C	21.27	48.203	.559	.518	.597
CAP_GOAL_D	21.23	46.877	.632	.484	.571
CAP_GOAL_E	21.75	58.238	.253	.162	.698
CAP_GOAL_F	21.23	58.319	.237	.275	.703

Finance needs for product/technology development (FIN_NEED_DEV)

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.721	.719	3

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
CAP_GOAL_A	8.33	17.773	.438	.194	.747
CAP_GOAL_B	8.42	13.613	.582	.375	.583
CAP_GOAL_C	7.33	13.909	.618	.399	.537

Finance needs for organisational development (FIN_NEED_ORG)

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.591	.589	3

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
CAP_GOAL_D	9.13	11.549	.467	.234	.383
CAP_GOAL_E	9.60	14.116	.309	.097	.617
CAP_GOAL_F	9.11	12.315	.428	.212	.446

Business needs (BUS_NEED)

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.810	.813	6

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
CAP_ADVICE_A	15.13	45.617	.685	.559	.753
CAP_ADVICE_B	14.68	55.876	.343	.205	.831
CAP_ADVICE_C	15.68	49.953	.677	.622	.759
CAP_ADVICE_D	15.09	49.318	.649	.597	.763
CAP_ADVICE_E	15.43	52.789	.493	.326	.797
CAP_ADVICE_F	15.68	50.837	.611	.493	.772

Network needs (NET_NEED)

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.739	.740	3

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
CAP_ADVICE_G	7.43	11.970	.573	.343	.641
CAP_ADVICE_H	7.92	12.154	.602	.369	.609
CAP_ADVICE_I	6.76	12.144	.517	.270	.709

Appendix VIII Sector differences descriptive overview YES!Delft

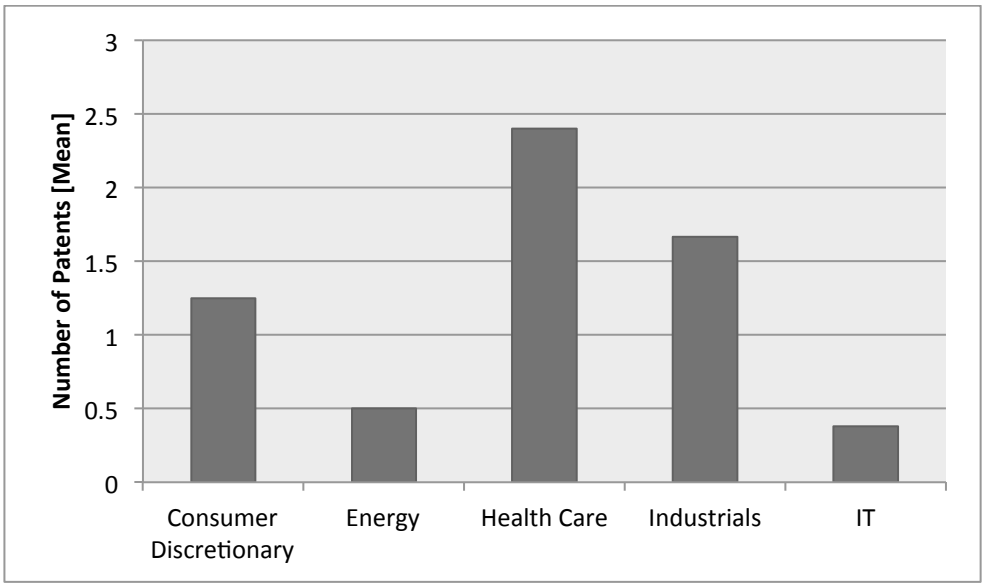


Figure 1: Average number of patents per industry (N=60)

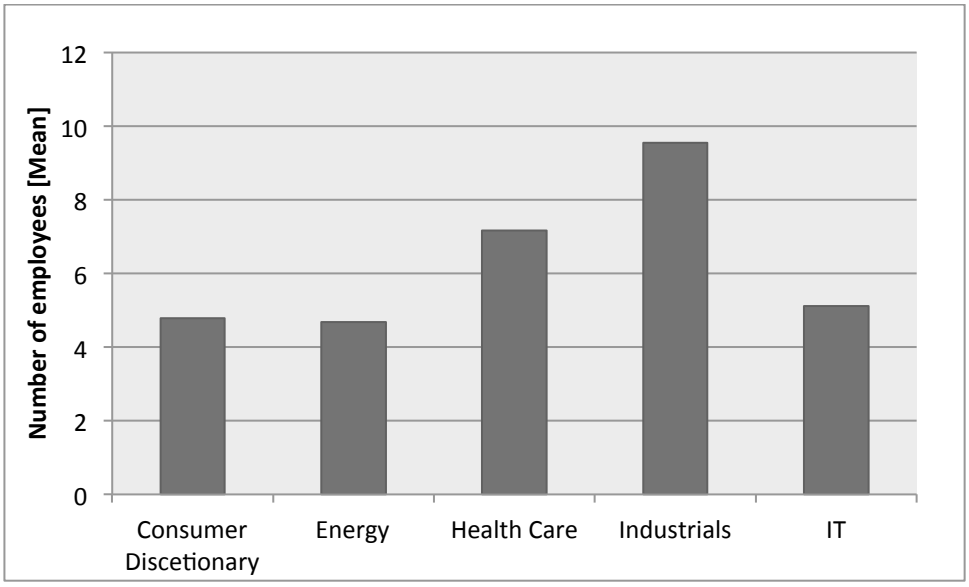


Figure 2: Average number of employees per industry (N=60)

Appendix IX Need for support descriptive overview YES!Delft

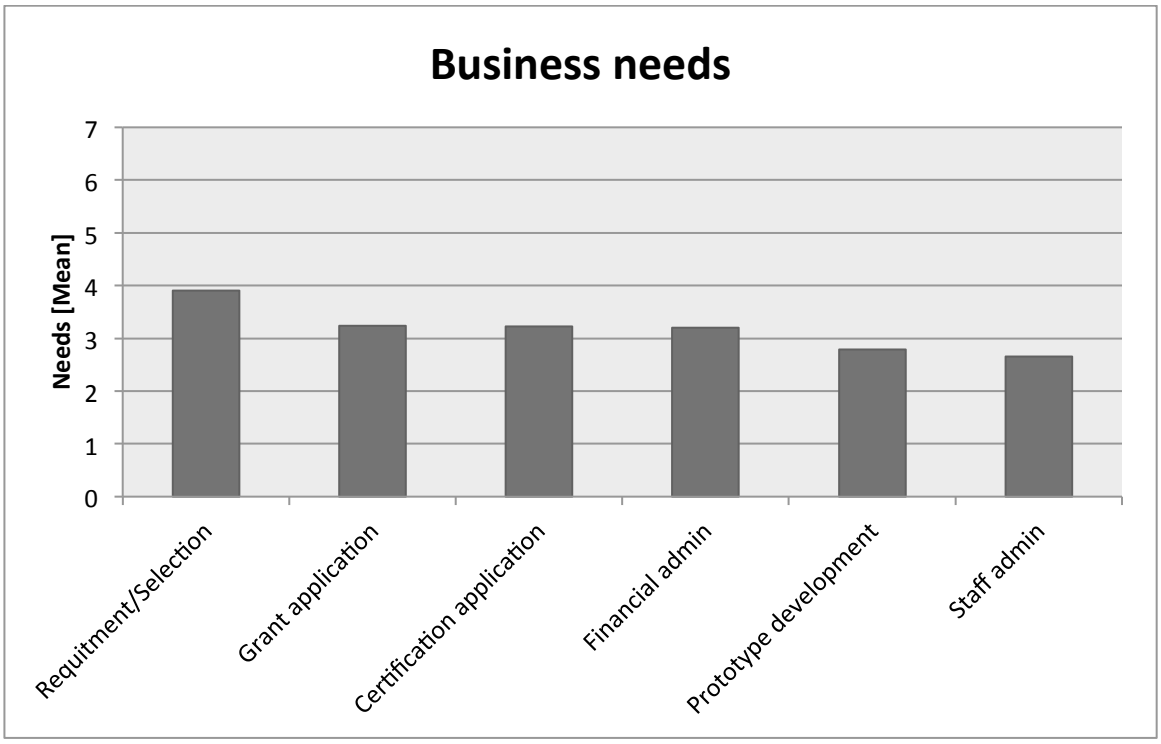


Figure 1: Average business needs (N=50)

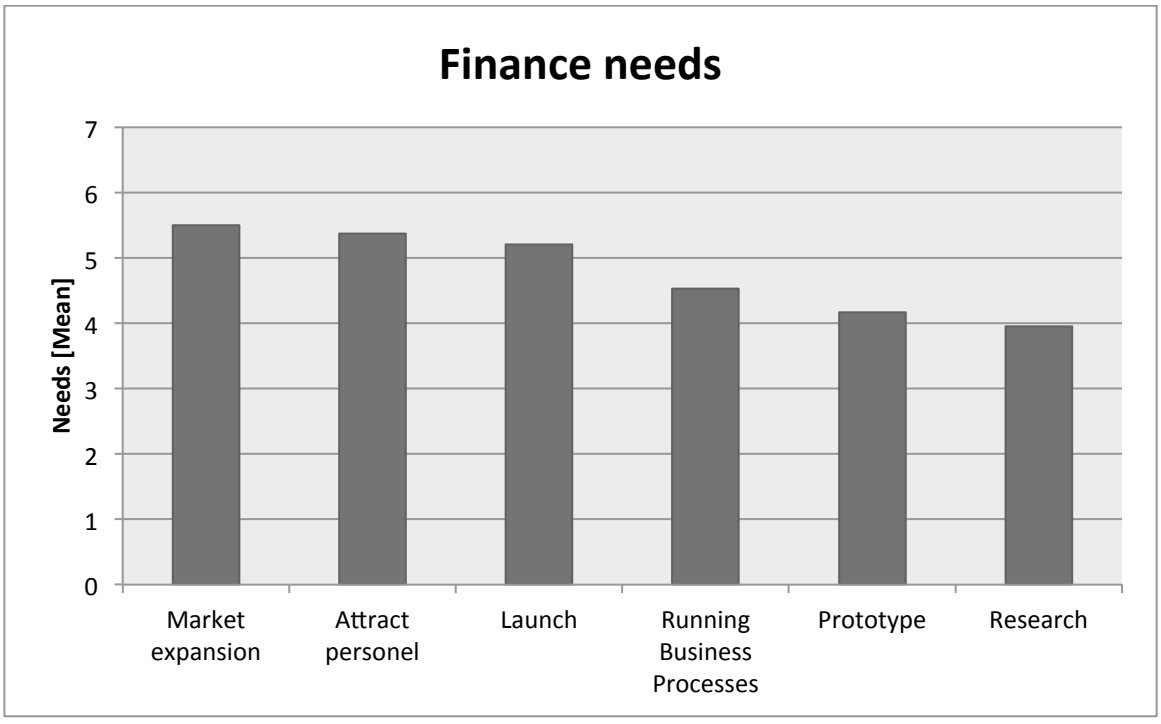


Figure 2: Average finance needs (N=50)

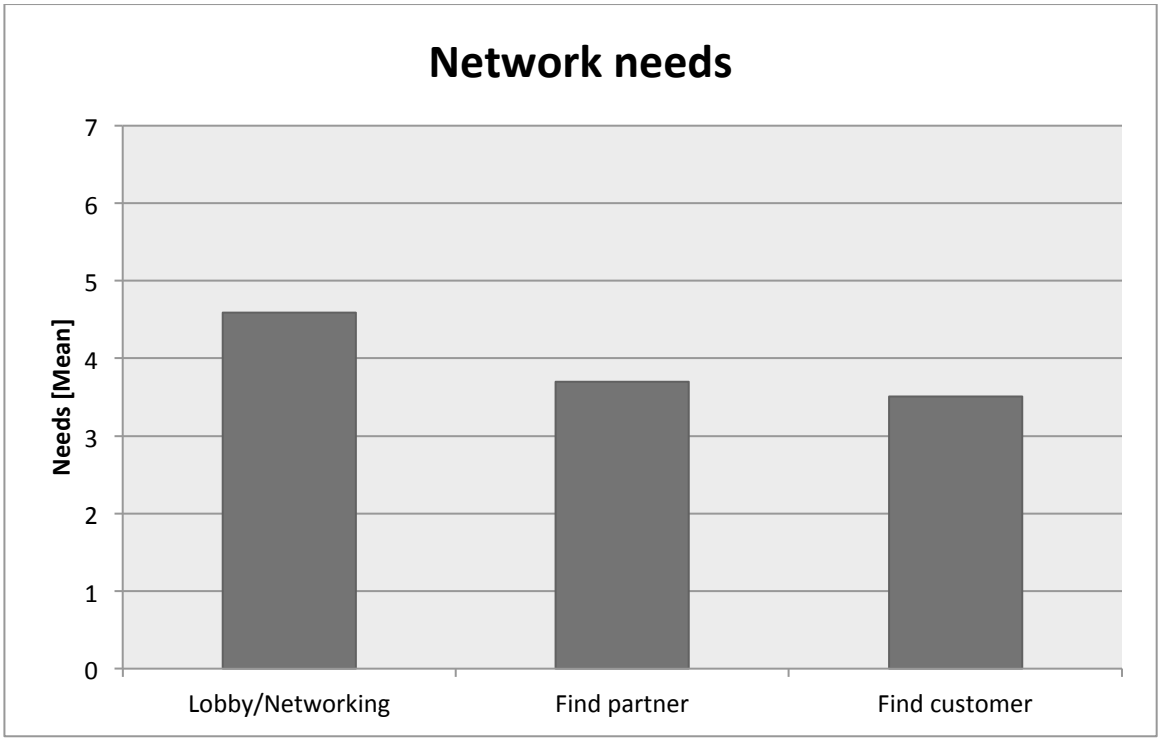


Figure 3: Average network needs (N=50)

Appendix X Comparing means analysis (firm age)

This appendix shows the means, number of observations, and standard deviation per age class.

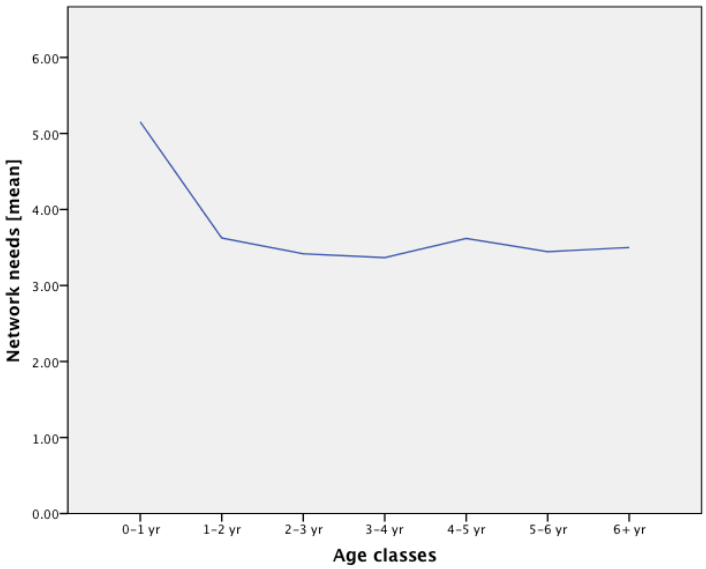
Comparing means analysis

AGE classes		FIN_NEED	NET_NEED	BUS_NEED
0-2 yr	Mean	4.9868	4.2540	3.6083
	N	19	21	20
	Std. Deviation	1.23736	1.97176	1.31598
2-4 yr	Mean	4.2944	3.6222	3.0000
	N	15	15	14
	Std. Deviation	1.97325	1.65648	1.66410
4-6 yr	Mean	4.6333	3.5667	2.8000
	N	10	10	10
	Std. Deviation	.94542	1.41465	1.04763
6-8 yr	Mean	4.1667	3.0000	2.5714
	N	6	7	7
	Std. Deviation	1.24722	1.30526	1.33631
Total	Mean	4.6100	3.7799	3.1405
	N	50	53	51
	Std. Deviation	1.45174	1.72208	1.39697

Appendix XI Comparing means analysis (firm age and network needs)

This appendix shows the means, number of observations, and standard deviation per (detailed) age class of only the network needs. Note that the number of observations is rather low at classes '2-3 years' and '5-6 years'.

AGE classes (detailed)		NET_NEED
0-1 yr	Mean	4.6410
	N	13
	Std. Deviation	1.90254
1-2 yr	Mean	3.6250
	N	8
	Std. Deviation	2.04270
2-3 yr	Mean	3.4167
	N	4
	Std. Deviation	2.20059
3-4 yr	Mean	3.6970
	N	11
	Std. Deviation	1.53807
4-5 yr	Mean	3.6190
	N	7
	Std. Deviation	1.61507
5-6 yr	Mean	3.4444
	N	3
	Std. Deviation	1.07152
6+ yr	Mean	3.0000
	N	5
	Std. Deviation	1.43372
Total	Mean	3.8105
	N	51
	Std. Deviation	1.73750



Appendix XII Comparing means analysis (development stages)

This appendix shows the means, number of observations, and standard deviation per development stage.

Comparing means analysis

STAGE		FIN_NEED	NET_NEED	BUS_NEED
Development/conceptualization	Mean	4.7348	4.2778	3.5909
	N	11	12	11
	Std. Deviation	1.29573	2.27340	1.07073
Commercialization	Mean	4.6905	4.3556	3.3214
	N	14	15	14
	Std. Deviation	1.59306	1.61573	1.70151
Growth	Mean	4.5616	3.4167	2.7778
	N	23	24	24
	Std. Deviation	1.48013	1.43204	1.37320
Stability	Mean	4.0000	3.1111	2.7778
	N	3	3	3
	Std. Deviation	1.92209	1.38778	1.26198
Total	Mean	4.6013	3.8519	3.0962
	N	51	54	52
	Std. Deviation	1.46148	1.71889	1.41281

Appendix XIII Comparing means analysis (Growth orientation)

This appendix shows the means, number of observations, and standard deviation of different growth orientation levels.

Comparing means analysis

Growth orientation (GROWTH_ORIENT)		FIN_NEED	NET_NEED	BUS_NEED
1 (low growth orientation; time horizon for investments and decisions of 3+ years)	Mean		2.6667	2.5000
	N		1	1
	Std. Deviation		.	.
2	Mean	3.5833	3.9333	3.3000
	N	4	5	5
	Std. Deviation	1.77691	1.87676	1.80432
3	Mean	4.7778	4.3889	2.8611
	N	6	6	6
	Std. Deviation	.80737	1.20031	1.19451
4 (moderate growth orientation; time horizon for investments and decisions between 2 to 3 years)	Mean	5.1667	3.8667	3.1071
	N	15	15	14
	Std. Deviation	1.19689	1.54714	1.00980
5	Mean	3.9333	2.7222	2.3000
	N	5	6	5
	Std. Deviation	1.30491	1.21868	.72072
6	Mean	4.3013	3.9231	3.0128
	N	13	13	13
	Std. Deviation	1.49751	2.08679	1.72865
7 (high growth orientation; time horizon for investments and decisions of less then 1 year)	Mean	4.1000	4.3333	3.6333
	N	5	5	5
	Std. Deviation	2.22236	2.35702	1.87972
Total	Mean	4.5122	3.8366	3.0306
	N	48	51	49
	Std. Deviation	1.45622	1.72482	1.37591

Appendix XIV Comparing means analysis (Capital intensive firms)

This appendix shows the means, number of observations, and standard deviation of different type of capital-intensive firms.

Comparing means analysis

Capital intensity (CAP_INTENSE)		FIN_NEED	NET_NEED	BUS_NEED
Software (low CI)	Mean	4.3233	4.0667	2.8750
	N	25	25	24
	Std. Deviation	1.72876	1.81557	1.34797
Advanced materials	Mean	4.7843	3.8333	3.1759
	N	17	18	18
	Std. Deviation	1.24410	1.58527	1.14970
Microsystem technologies	Mean	5.0000	3.2222	3.5625
	N	7	9	8
	Std. Deviation	1.00922	1.77951	2.17478
Biotechnology / Aerospace (high CI)	Mean	5.1250	4.1667	3.1667
	N	2	2	2
	Std. Deviation	.17678	2.12132	1.17851
Total	Mean	4.6013	3.8519	3.0962
	N	51	54	52
	Std. Deviation	1.46148	1.71889	1.41281

Appendix XV Comparing means analysis (R&D Focus)

This appendix shows the means, number of observations, and standard deviation of different degrees of R&D focus.

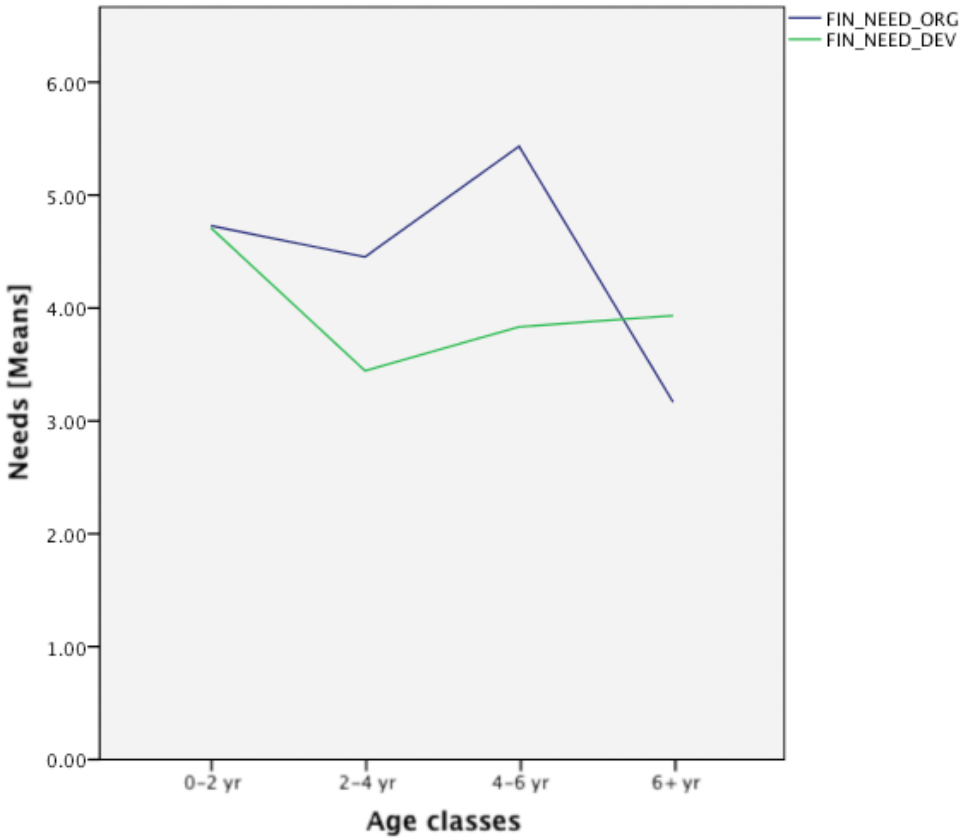
Comparing means analysis

R&D focus (RD_FOCUS)		FIN_NEED	NET_NEED	BUS_NEED
1 (weak R&D focus; emphasis on existing products and technologies)	Mean	5.1667	5.0000	2.6667
	N	1	1	1
	Std. Deviation	.	.	.
2	Mean	.	.	.
	N	0	0	0
	Std. Deviation	.	.	.
3	Mean	3.9722	3.3333	2.2000
	N	6	6	5
	Std. Deviation	2.26671	2.33809	.89287
4 (moderate R&D focus)	Mean	4.7292	2.8519	2.8889
	N	8	9	9
	Std. Deviation	1.33909	1.11941	1.87454
5	Mean	4.2333	4.0222	2.8000
	N	15	15	15
	Std. Deviation	1.30293	1.76143	1.16871
6	Mean	5.3106	4.4848	3.6667
	N	11	11	11
	Std. Deviation	.72274	1.31963	1.19722
7 (strong R&D focus; emphasis on new technologies and products that require intensive R&D)	Mean	4.8333	4.6667	3.6000
	N	4	5	5
	Std. Deviation	1.59861	1.69967	1.02470
Total	Mean	4.6241	3.9078	3.0435
	N	45	47	46
	Std. Deviation	1.39382	1.67923	1.32983

Appendix XVI Finance needs differences per year

Comparing means analysis

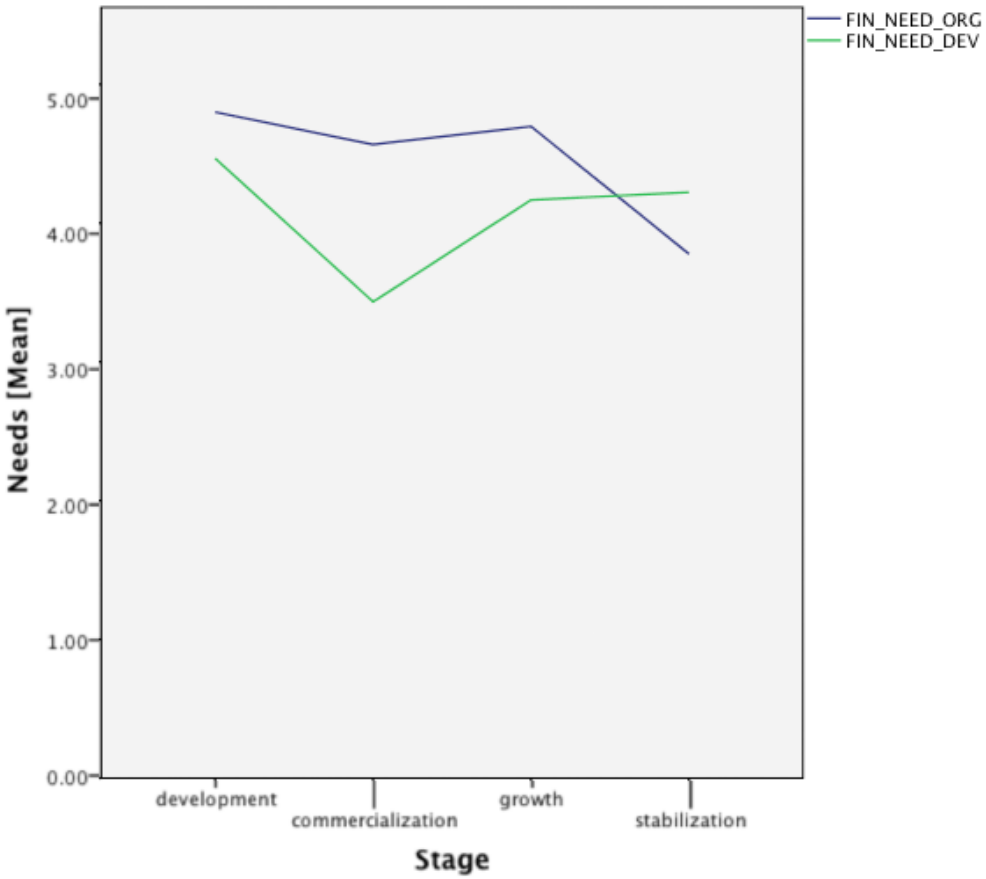
AGE		FIN_NEED_ ORG	FIN_NEED_ DEV
0-2 yr	Mean	4.7292	4.7111
	N	16	15
	Std. Deviation	1.51153	1.67079
2-4 yr	Mean	4.4524	3.4444
	N	14	12
	Std. Deviation	2.17054	2.09537
4-6 yr	Mean	5.4333	3.8333
	N	10	10
	Std. Deviation	.58899	1.49278
6-8 yr	Mean	3.1667	3.9333
	N	4	5
	Std. Deviation	.83887	2.17817
Total	Mean	4.6591	4.0476
	N	44	42
	Std. Deviation	1.64480	1.83399



Appendix XVII Finance needs differences per stage

Comparing means analysis

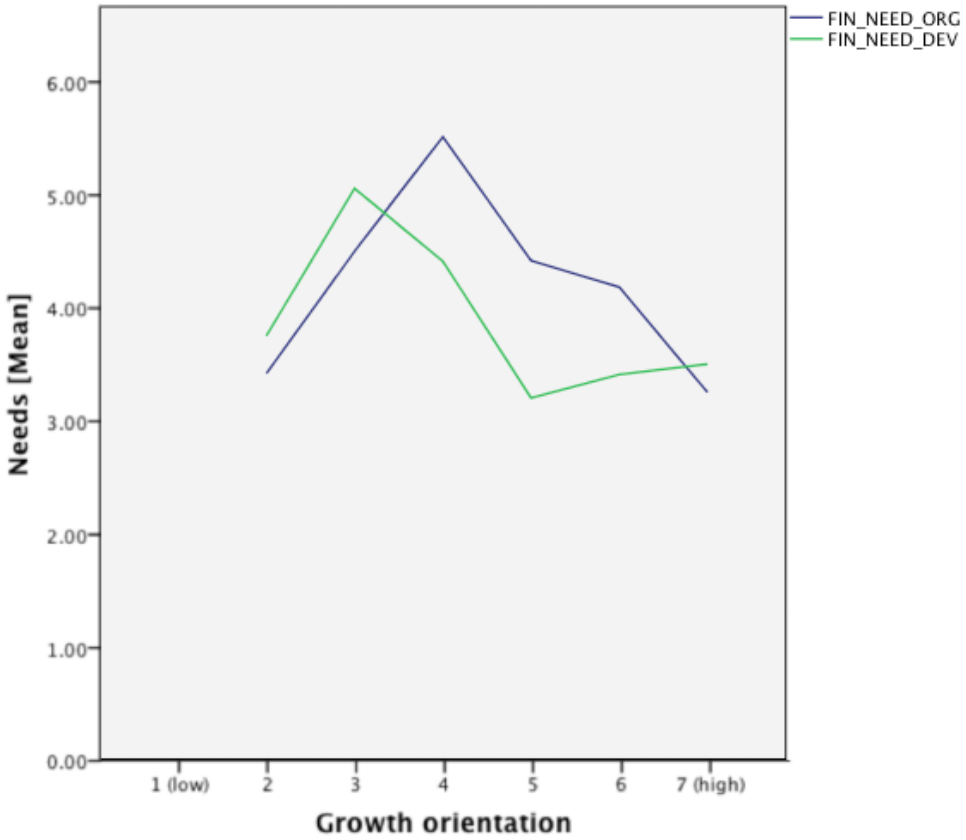
STAGE		FIN_NEED_ORG	FIN_NEED_DEV
Development/conceptualization	Mean	4.8000	4.4667
	N	10	10
	Std. Deviation	1.64204	1.47573
Commercialization	Mean	4.5667	3.4333
	N	10	10
	Std. Deviation	1.49938	1.63337
Growth	Mean	4.6970	4.1667
	N	22	20
	Std. Deviation	1.72718	2.00438
Stability	Mean	3.7778	4.2222
	N	3	3
	Std. Deviation	2.03670	2.79550
Total	Mean	4.6296	4.0698
	N	45	43
	Std. Deviation	1.63797	1.83522



Appendix XVIII Finance needs differences per degree of growth orientation

Comparing means analysis

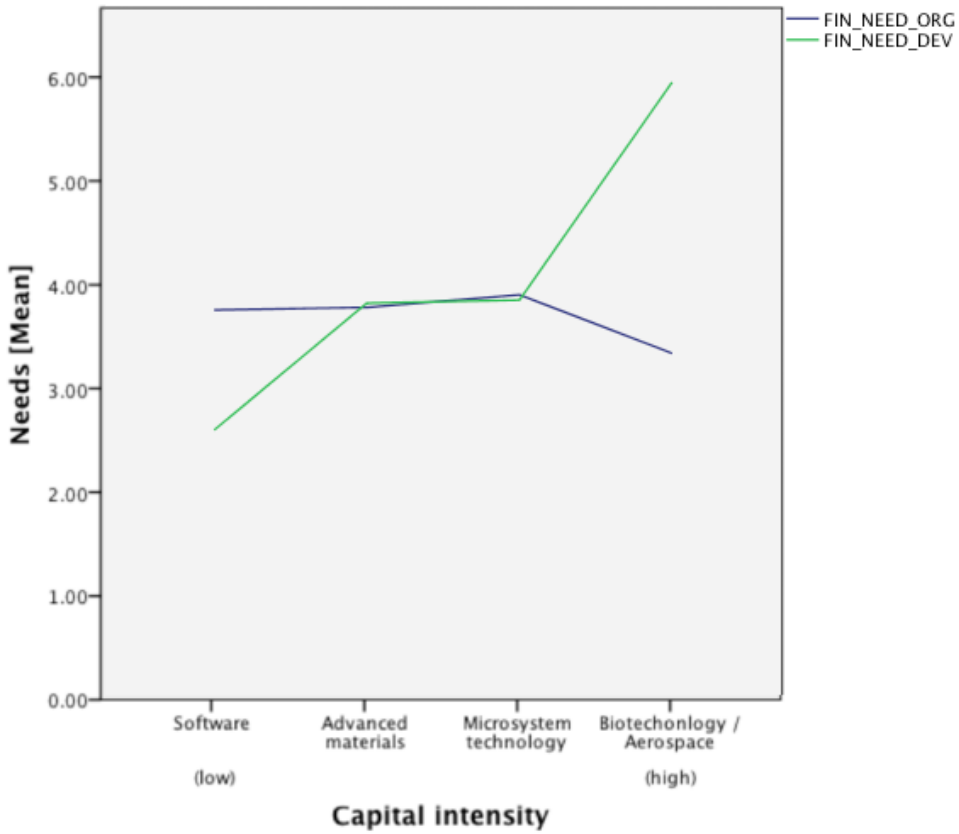
GROWTH_ORIENT		FIN_NEED_ORG	FIN_NEED_DEV
1 (low growth orientation; time horizon for investments and decisions of 3+ years)	Mean		
	N	0	0
	Std. Deviation		
2	Mean	3.4167	3.7500
	N	4	4
	Std. Deviation	1.75066	2.13220
3	Mean	4.5000	5.0556
	N	6	6
	Std. Deviation	1.61589	1.46692
4 (moderate growth orientation; time horizon for investments and decisions between 2 to 3 years)	Mean	5.5128	4.4103
	N	13	13
	Std. Deviation	1.06819	1.66752
5	Mean	4.4167	3.2000
	N	4	5
	Std. Deviation	1.10135	1.75752
6	Mean	4.1818	3.4074
	N	11	9
	Std. Deviation	1.88186	1.61398
7 (high growth orientation; time horizon for investments and decisions of less then 1 year)	Mean	3.2500	3.5000
	N	4	4
	Std. Deviation	1.70783	2.57481
Total	Mean	4.5000	3.9837
	N	42	41
	Std. Deviation	1.63175	1.78411



Appendix XIX Finance needs differences per degree of capital-intensity

Comparing means analysis

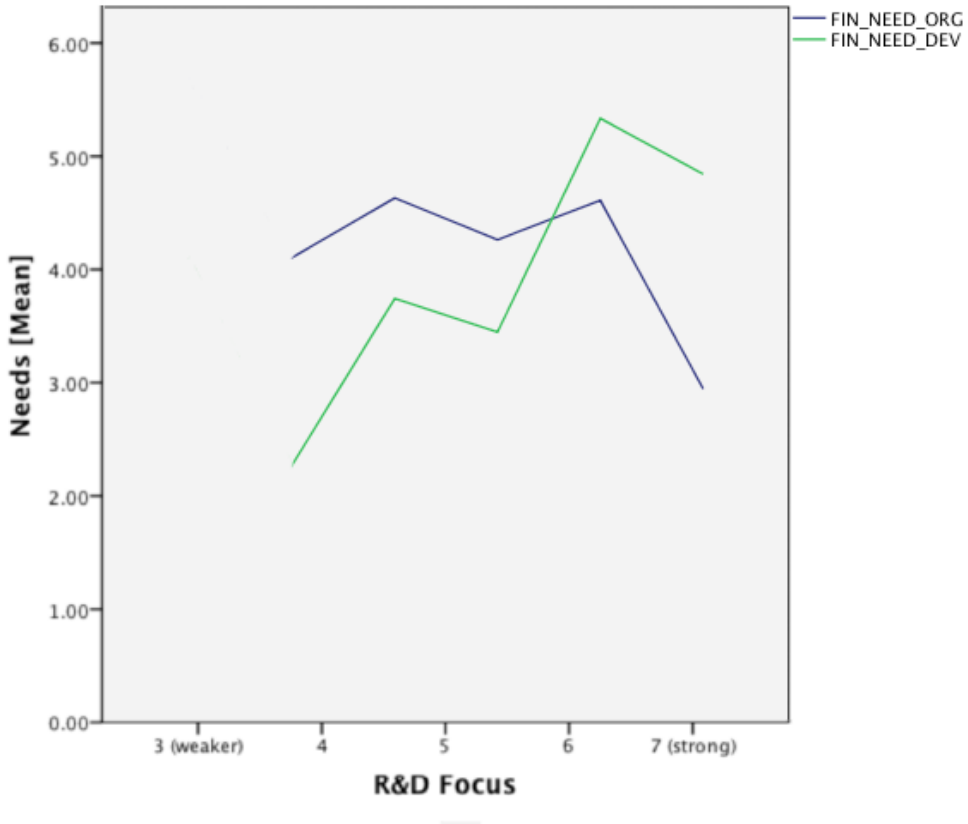
CAP_INTENSE		FIN_NEED_ORG	FIN_NEED_DEV
Software (low CI)	Mean	4.6190	3.3636
	N	21	22
	Std. Deviation	1.84477	1.86562
Advanced materials	Mean	4.6458	4.6905
	N	16	14
	Std. Deviation	1.56095	1.48188
Microsystem technologies	Mean	4.7778	4.7222
	N	6	6
	Std. Deviation	1.42465	1.56938
Biotechnology / Aerospace (high CI)	Mean	4.1667	7.0000
	N	2	1
	Std. Deviation	1.64992	.
Total	Mean	4.6296	4.0698
	N	45	43
	Std. Deviation	1.63797	1.83522



Appendix XX Finance needs differences per degree of R&D focus

Comparing means analysis

RD_FOCUS		FIN_NEED_ORG	FIN_NEED_DEV
1 (weak R&D focus; emphasis on existing products and technologies)	Mean	6.0000	4.3333
	N	1	1
	Std. Deviation	.	.
2			
3	Mean	4.3333	2.4000
	N	5	5
	Std. Deviation	2.35702	1.83182
4 (moderate R&D focus)	Mean	4.8889	3.9524
	N	6	7
	Std. Deviation	1.36083	1.84017
5	Mean	4.5000	3.6410
	N	14	13
	Std. Deviation	1.61589	1.46225
6	Mean	4.8667	5.6296
	N	10	9
	Std. Deviation	1.49237	.67586
7 (strong R&D focus; emphasis on new technologies and products that require intensive R&D)	Mean	3.1111	5.1111
	N	3	3
	Std. Deviation	.50918	2.00924
Total	Mean	4.5641	4.1404
	N	39	38
	Std. Deviation	1.59156	1.74437



Appendix XXI Detailed correlational analysis results

The correlational analysis below shows the correlations between the constructs and their significance. The number of observations (N) is indicated with brackets.

		1	2	3	4	5	6	7	8	9	10
Spearman's rho	1. FIN_NEED	(53)									
	2. FIN_NEED_ORG	.757** (47)	(47)								
	3. FIN_NEED_DEV	.792** (45)	.226 (44)	(45)							
	4. NET_NEED	.253 (53)	.019 (47)	.249 (45)	(56)						
	5. BUS_NEED	.398** (52)	.198 (47)	.267 (45)	.476** (54)	(54)					
	6. CAP_INTENSE	.152 (51)	-.052 (45)	.403** (43)	-.120 (54)	.128 (52)	(63)				
	7. GROWTH_ORIENT	-.109 (48)	-.151 (42)	-.250 (41)	.008 (51)	.013 (49)	.043 (52)	(54)			
	8. RD_FOCUS	.154 (45)	-.128 (39)	.487** (38)	.302* (47)	.384** (46)	.270 (45)	-.064 (47)	(47)		
	9. AGE	-.225 (52)	-.042 (46)	-.184 (44)	-.230 (55)	-.411** (53)	.012 (63)	-.233 (53)	-.306* (46)	(64)	
	10. STAGE	-.037 (51)	-.027 (45)	.069 (43)	-.276* (54)	-.263 (52)	.262* (61)	-.048 (52)	-.169 (45)	.535** (61)	(61)

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).