

Growth phases and critical junctures in the development process of university spin-offs

Master thesis

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Preface

This MSc thesis is written for the chair group Management Studies in order to graduate for the Master Management, Economics and Consumer Studies at Wageningen University. It presents the results of research into the growth phases and critical junctures in the development process of university spin-offs.

First of all I want to thank Emiel Wubben as supervisor and Onno Omta as co-reader for their time and support. They have been very supportive throughout the whole process providing comments and suggestions. I want to thank Hanieh Khodaei as co-reader for her inspiring enthusiasm to the subject of university spin-offs and the very pleasant cooperation with the data-gathering. I want to thank Victor Scholten for his support during the meetings we had. I also want to thank all the persons that participated in the research. And finally I want to thank my family, friends, and my girlfriend Yvonne for their faith and support while writing this thesis.

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Summary

There is an increasing interest in translating technology arising from universities into economic development. University spin-offs are companies which evolve from universities through commercialization of intellectual property and transfer of technology, developed within academic institutions. Different than new technology developed in commercial companies, university spin-offs go through a process of transforming from a non-commercial environment to a commercial environment. In this process, they may lack e.g. commercial skills and resources and face specific obstacles and challenges. University spin-offs may also have extra difficulties with conflicting objectives of key stakeholders such as the university, the academic entrepreneur, the venture's management team and financiers. In this research, a university spin-off is defined as a commercial company from which the intellectual property as well as the founder or founders must come from a university or academic institution and at which the technology is transferred directly from the parent organization to the spin-off company.

The literature study on the phases resulted in a model that identifies typically five phases of development for university spin-offs. The model of Vohora et al. (2004) was used for the basic structure, consisting of: initial idea phase, opportunity framing phase, pre-organization phase, re-orientation phase and sustainability phase. Before moving from one phase to the next, a couple of obstacles called 'critical junctures' have to be overcome. If a company is able to overcome the critical juncture, it will successfully move to the next phase of development. The critical junctures identified are opportunity recognition, entrepreneurial commitment, threshold of credibility and threshold of sustainability. Factors that help university spin-offs in overcoming the critical junctures are human capital, social capital and financial capital. The role of the facilitators is important in overcoming the critical junctures by supporting the university spin-offs.

The empirical research consists of three case studies: Brainport Eindhoven, Food Valley and Delft. For the case study 17 facilitators and 5 university spin-off companies are interviewed. The results from the interviews show that the most important critical juncture are: inability to attract finance, lack of entrepreneurial capabilities, inability to form a well-balanced start-up team and restrictions and unclear policy of the university. Analyzing the results, it turns out that entrepreneurial commitment and threshold of credibility are the most prominent critical junctures to overcome. The critical juncture of sustainable returns was not identified frequently by the facilitators, but due to the fact that this is the last critical juncture in the development process and not many companies reach this phase, it might still be considered as a critical juncture for the companies. Opportunity recognition is not identified frequently and there is no reason to suggest that this critical juncture is a major problem in the development process of USOs in the regions researched.

According to the facilitators, important human factors for the team of a USO are commercial experience, qualified scientific researchers, a well-balanced managerial team, financial experience in management team and serial entrepreneurs. Human factors for the members of the team are entrepreneurial capabilities, personal traits and enthusiasm. The members of the team should have a variance of entrepreneurial, commercial, scientific and financial experience in the management. The different moment that people enter the team (tenure diversity) is important to bring new views into the company.

Both bonding ties (academic network) and bridging ties (industry network) can stimulate the USO. The USO company should keep the contacts with the research organization to benefit from their

knowledge and technology development. The industry network is becoming more important when the USO develops. However, close links with the industry can also be beneficial in the first phases. In table 1, the phases and results categorized by human capital, social capital, financial capital and the other important results in each phase are displayed.

Important reasons to invest in a company are: IP protection; dedicated management team owning a large share of the company; ability to show that the company has large potential. To increase the chance for USOs to attract finance, they should especially focus on these items

Facilitators provide mostly finance, coaching and a network to the USO companies. Education provided at all three universities in the regions to enhance and stimulate entrepreneurship. Reputation/endorsement is only supported by 1 facilitator. The relationship is for 68% based on both formal and informal contact, 28 % on a formal contract and only 4% on informal contact. This shows that in almost all the cases, a formal contract between the facilitator and USO is established and in most cases this involved also informal contact.

The facilitators highly value their active support to USOs in the early stage, especially finance and accommodation. Looking at the most important critical junctures, entrepreneurial commitment and the threshold of credibility, notably is that they highly value their support on finance and accommodation, which stimulates the credibility, but they do not highly value their support on people, finding employees and training people in the team, which should stimulate the entrepreneurial commitment. It has also been found that facilitators rank their support the USO in overcoming the critical juncture of entrepreneurial commitment not very high, but they do see it as a major problem in the development process.

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1. Introduction

This introduction chapter starts with a short description of the background including a definition of university spin-offs (USOs). In paragraph 2.1 the conceptual design consisting of the research objective, research framework and research issue are outlined to give a clear view of the research. In the next paragraph the technical design will be outlined, consisting of research materials and research strategy. In the last paragraph of this chapter, the report outline gives an overview of the report.

1.1 Background

There is more and more interest in valorizing technology created at universities via commercial activities. USOs are companies which evolve from universities through commercialization of intellectual property and transfer of technology, developed within academic institutions (Birley, 2002 according to Djokovic, 2006). Other than new technology developed in commercial companies, USOs go through a process of transforming from a non-commercial environment to a commercial environment. In this process, they may lack commercial skills and face specific obstacles and challenges, and they may lack resources. USOs can also have extra difficulties with conflicting objectives of key stakeholders such as the university, the academic entrepreneur, the venture's management team and suppliers of finance (Vohora et al, 2004).

In this research, a USO company is defined as: a commercial company from which the intellectual property as well as the founder or founders must come from a university or academic institution and at which the technology is transferred directly from the parent organization to the spin-off company. This definition is explained in sub-paragraph 2.1.1.

The literature on the process of commercializing a technology developed within an academic institution is limited. Especially empirical evidence on this topic is scarce. This research will be carried out for the Management Studies Group in Wageningen and will focus on the development process of USOs. The initial idea of researching this process is based on the PhD-thesis of Victor Scholten (2006) and the ongoing PhD-project of Hanieh Khodaei.

1.2 Conceptual design

The key function of the conceptual design is the steering function, which does not only mean the steering of a project, but also the implementation of the project (Verschuren & Doorewaard, 2005). In this paragraph, the research objective, research framework and research issue will be discussed.

1.2.1 Research objective

The research objective indicates in a useful and feasible way the contribution of the research to the theory within the time scheduled (Verschuren & Doorewaard, 2005).

On top of the regular new business development process, USOs face obstacles moving from a non-commercial environment to a commercial environment. In a non-commercial environment or academic environment, the mentality is to perfect academic research and publish results towards a particular scientific community (Vohora et al. 2004). In a business environment, however, a commercial mind set is required. Furthermore, academics generally have a network restricted within academia, which does not extend to business and finance (Vohora et al. 2004). Thus, the academic

entrepreneur faces the challenge of collecting the right knowledge and resources to successfully go through the development process.

Theories on new business development and business growth show that new businesses have to gain knowledge and resources to go through the phases of development.

There is specific literature available on the problems that USOs face during the growth phases, as pointed out by Vohora et al. (2004), Ndonzuau et al. (2002) and Clarysse & Moray (2004) described in chapter 2. The problems that arise during the development process are called critical junctures. The empirical evidence for these growth phases and critical junctures is limited. In this research, the phases that USOs go through in the development process, and the critical juncture that USOs have to overcome, will be researched. The research objective is:

To identify growth phases and critical junctures between the different growth phases in the development process of university spin-offs, and to find out what resources and knowledge the university spin-offs used to overcome these critical junctures.

1.2.2 Research framework

“A research framework is a schematic representation of the research objective and includes the approximate steps that need to be taken in order to realize the objective” (Verschuren & Doorewaard, 2005). In figure 1.1 on the next page, the research framework is presented. Each step is explained in this paragraph.

Part I

Literature on the creation process of a USO (a), on the development process (b) and empirical evidence (c) are used, underpinned by theoretical perspectives on new business development and growth (d) to derive the variables of the phases and critical junctures. The models of Vohora et al. (2004) Ndonzuau et al. (2002) and Clarysse & Moray (2004) will be compared and analyzed. They will form the basic structure of the phases and critical junctures for the USO development process. This basic structure will be underpinned by the available theory on new business development and business growth when discussing the models. This will result in a theoretical framework (e).

Part II

The variables from the theoretical framework will be used as input for the semi-structured interviews. The semi-structured interviews will be carried out with the USO facilitators in Food Valley (g), Brainport Eindhoven (h) and Delft (i). The interviews should identify what phases USOs go through in their development process, what critical junctures they have to overcome and what resources and knowledge they used. Also the role of the facilitator in this process will be identified. The interview consists of a semi-structured face-to-face interview with a representative from the facilitator. After interviewing the facilitators, the results will be verified with the USO companies (j). The inventor entrepreneur (‘founding father’) of the USO will be interviewed through a semi-structured face-to-face interview.

The results from the interviews will be analyzed (k) for each case. By analyzing the results, the phases and critical junctures for the USOs should become clear. The knowledge and resources used to overcome the critical junctures should also become clear. The results will be compared to the theoretical framework.

From the results of the analysis, conclusions and recommendations (l) will be made for future USOs.

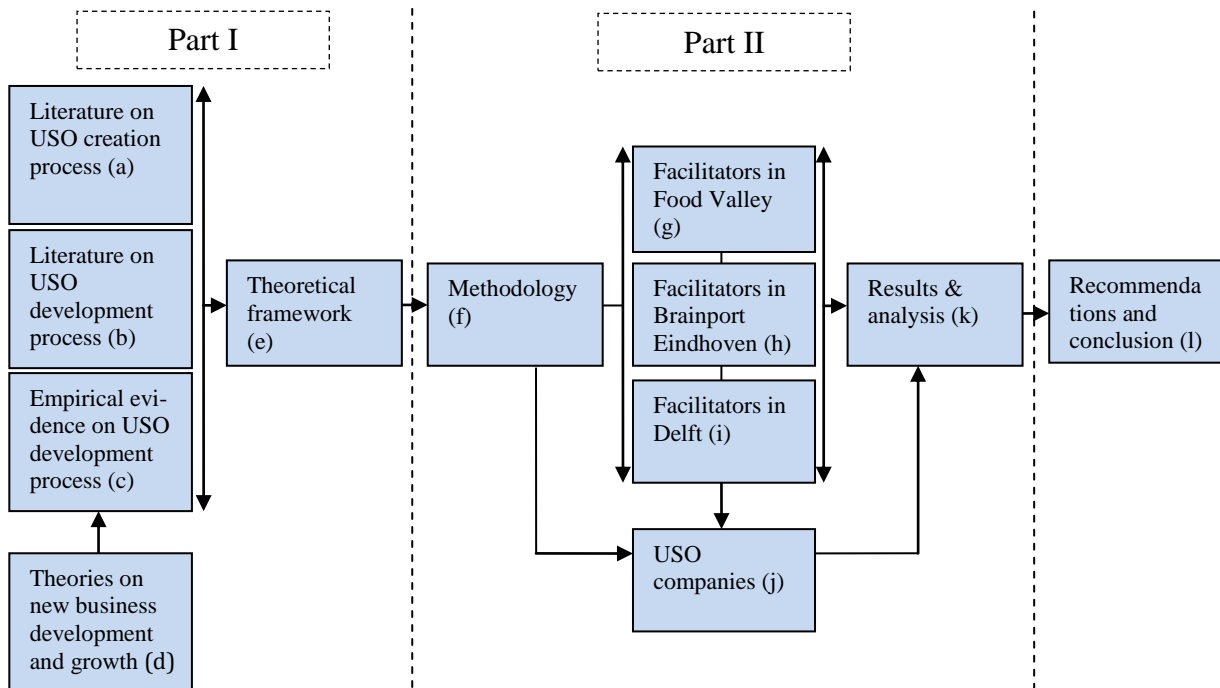


Figure 1.1. Research framework

1.2.3 Research issue

By creating the research framework, the steps to realize the research objective are displayed. By formulating the research issue, knowledge that is useful or necessary to realize the research objective will become clear (Verschuren & Doorewaard, 2005).

The models of Vohora et al. (2004), Ndonzuau et al. (2002) and Clarysse & Moray (2004) will be used to determine the phases and critical junctures that USOs go through in their development, underpinned by the selected theories. Two main research questions are formulated. The first research question is concentrated on identifying phases and critical junctures in the literature. Part I in figure 1.1 will answer this question. The second question is concentrated on the way USOs succeed to go through the phases and overcome the critical junctures through empirical research. Part II in figure 1.1 will answer this question.

Research question 1: What development process do university spin-offs go through according to the literature? (part I)

Research question 2: What development process do university spin-offs go through in Brainport Eindhoven, Food Valley and Delft? (part II)

Sub-questions for research question 1:

- 1.1 What is a university spin-off and what does the development process of a university spin-off look like?
- 1.2 What phases and critical junctures in the development process of university spin-offs are distinguished in the literature?
- 1.3 What methods can be found in the literature that university spin-offs can use to overcome these critical junctures?

Sub-questions for research question 2:

- 2.1 How do university spin-offs develop overtime (phases)?
- 2.2 What critical junctures do university spin-offs face during the development process?
- 2.3 What factors help university spin-offs to overcome the critical junctures?

1.3 Technical design

The technical research design will discuss what is necessary to effectively answer the research questions within a reasonable time span (Verschuren & Doorewaard, 2005). In paragraph 1.3.1 the research material will be discussed, followed by paragraph 1.3.2, the research strategy.

1.3.1 Research material

Based on the research issue, this paragraph contains a selection of the relevant research material (Verschuren & Doorewaard, 2005).

Sources

RQ 1.1

The Development process:

USO creation process
(Shane, 2004)

RQ 1.2, 1.3

USO development process and empirical research (growth phase and critical junctures)
(Vohora et al. 2004, Ndonzuau et al. 2002, Clarysse & Moray 2004)

These growth stages and critical junctures will be underpinned by the resource based view (Johnson et al. 2008, Teece et al. 1997, Barney 2001), social capital theory (Burt 2004, De Carolis et al. 2009) and innovation literature on market opportunity identification (Danneels 2007, Boeker 1989, Gruber 2008), stage-based models (Churchill & Lewis 1983, Roberts & Malone, 1996) and organizational growth (Greiner, 1998).

RQ 2.1, 2.2 and 2.3

In the ideal situation, the respondents that participate will be:

- | | |
|-----------------------------------|-------------------------|
| - Facilitator representative (15) | Face-to-face interviews |
| - Founder of a USO company (9) | Face-to-face interviews |

1.3.2 Research strategy

“By research strategy we mean the coherent body of decisions about the way in which you are going to carry out your research proposal” (Verschuren & Doorewaard, 2005).

Theoretical

Theoretical perspectives on business development and business growth will be analyzed to gain insight into what problems USOs can face while starting their business, and what can be found in literature to overcome these problems. The research from Vohora et al. (2004), Ndonzuau et al. (2002) and Clarysse & Moray (2004) on USO growth phases and critical junctures will form the basic structure of the variables for the phases and critical junctures. The basic structure will be underpinned by the available theory on new business development and business growth. The variables in the theoretical framework will form the input for a semi-structured interview.

Empirical

Qualitative process studies on USOs are useful since they explore the phenomenon in detail, identify constructs, spot relationships and avenues for further confirmatory quantitative work (Djokovic & Souitaris, 2006).

The data gathering at the facilitators will consist of a semi-structured face-to-face interview, to identify the phases and critical junctures that USOs go through in the development process, and what knowledge and resources the USOs used to overcome the critical junctures and the role of the facilitator in this process. The data gathering at the USOs will also consist of a semi-structured face-to-face interview with the inventor entrepreneur(s) and the industrial entrepreneur(s) who participated in the development process of the USO. The data gathering will have a retrospective design, collecting information relating to an extended earlier period (De Vaus, 2001).

1.4 Definition of key concepts

A number of concepts that are used in this research may not be familiar to readers of this report, or are used in a different ways. The paragraph describes four key concepts.

- University spin-off (USO)

Also referred to as academic spin-off (ASO) or academic start-up (ASU). A USO is this research is defined as: a commercial company from which the intellectual property as well as the founder or founders must come from a university or academic institution and at which the technology is transferred directly from the parent organization to the spin-off company.

- Facilitator

An organization that supports the USO company in their development process, helping them to overcome the critical junctures they may face.

- Growth phase

Activities and outcomes that USOs have to complete in their development process can be categorized to different phases. These phase make the description of the development process more clear and can indicate how far a USO is in the development process.

- Critical junctures

Also referred to as ‘obstacles’ or ‘barriers’. These are major factors that can be problematic for USOs in their development process and have to be overcome by the USO to be successful.

1.5 Report outline

This thesis report consists of an introduction (chapter 1), literature study (chapter 2), methodology (chapter 3), results of case study (chapter 4), conclusion and recommendations (chapter 5) and discussion (chapter 6).

Chapter 2 consists of the literature study, which will answer the research questions 1.1, 1.2, 1.3 and 1.4. Chapter 3 consists of the methodology used for the research project. Chapter 4 contains the results and chapter 5 will be the analysis of the results, which will answer the research questions 2.1, 2.2 and 2.3. Chapter 7 will be the conclusion and recommendations, and will answer the two main research questions. Chapter 8 consists of the discussion.

In figure 1.2, the time planning of the research is presented in a Gantt chart. In the months of November 2010, December 2010 and January 2011 the project was delayed because of lack of availability from the researcher. The empirical part of the research took also more time than expected. To make the case study complete, the choice was made to spend more time gathering the data than initially planned.

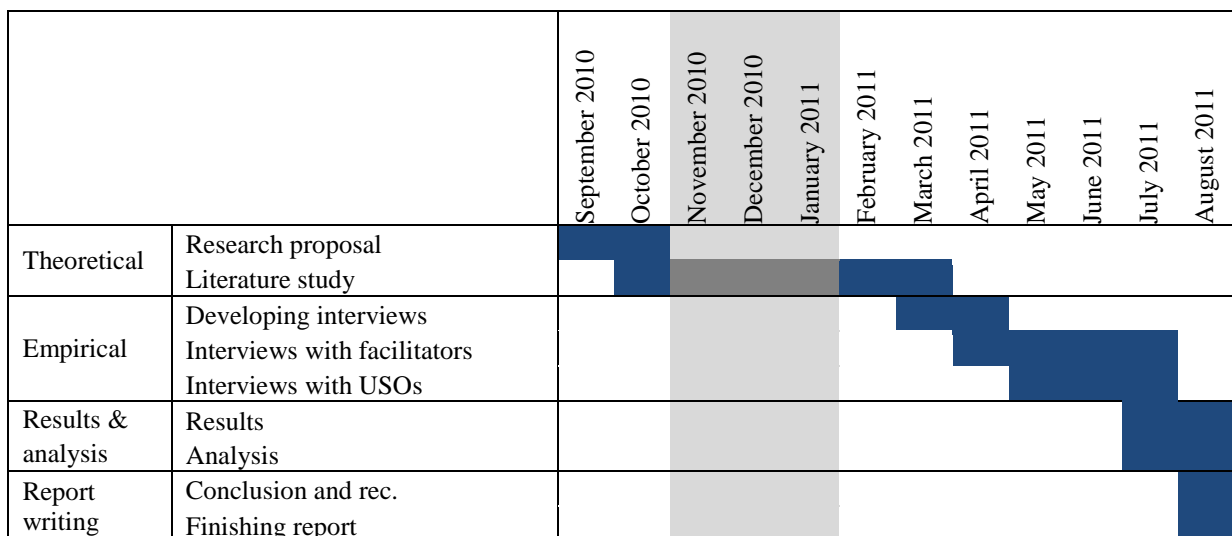


Figure 1.2. Realization time planning

2. Literature study

The first part of this chapter (paragraph 2.1) provides information on the subject of USOs. The definition, importance and the creation process of USOs will be discussed. Research question 1.1, ‘What is a USO and how does the development process of a USO start?’ will be answered.

The second part of the literature study (paragraph 2.2) focuses on the process of university spin-off development. In this part, three research questions will be answered: (1.1) What is a USO and how does the development process of a USO start? (1.2) What phases and critical junctures for the development process of USOs can be found in the literature? (1.3) What can be found in the literature to overcome the critical junctures? After these questions are answered, this chapter ends with the variables identified from the literature study, the theoretical framework and the conclusion.

2.1 University spin-offs

In this paragraph, the definition of USOs is formed in sub-paragraph 2.1.1, the importance of USOs is discussed in sub-paragraph 2.1.2 and the process of USO creation is discussed in sub-paragraph 2.1.3, which will answer research question 1.1.

2.1.1 Definition of university spin-offs

Most of the spin-offs that originate from universities are high technology spin-offs. ‘High technology’ can be defined as: “sectors that have higher than average expenditures on R&D as a proportion of sales or which employ proportionately more ‘qualified scientist and engineers’ than other sectors” (Shearman & Burrell 1988, according to Storey & Tehter 1998). In this research, the focus will be on the high technology spin-offs, because like other high technology start-ups, they face considerable difficulties in creating financial profitability and sustainable returns (Vohora et al., 2004).

The term high technology spin-offs can be narrowed down to spin-offs from academic institutions. USOs “are new firms created to exploit knowledge, technology or research results commercially developed within a university” (Pirney et al. 2003). Birley (2002, according to Djokovic 2006) describes USOs as; companies which evolve from universities through commercialization of intellectual property and transfer of technology, developed within academic institutions. This definition clearly states that technology must be developed within an academic institution. Because this research focuses primarily on the inventor entrepreneur that wants to commercialize the intellectual property and faces obstacles moving from a non-commercial environment to a commercial environment, the intellectual property should ideally originate from a university or academic person. Gübeli (2005) describes the USO as follows: “the company founder or founders must come from the university; the activity of the company must be based on technical ideas generated in the university environment; and the transfer from university to company must be direct and not via intermediate employment of the technology”. This description narrows the definition of a USO down to a technology that is not only developed within a university but also directly developed through a spin-off from the university. This is important, because of the commercialization process that these companies go through. In this commercialization process, it is also important that companies are commercial, thus have a for-profit mission. Combining the definitions from the literature and adjusting them to our research, we define a USO as: *a commercial company from which the intellectual property as well as the founder or founders must come from a university or academic institution and at which the technology is transferred directly from the parent organization to the spin-off company.*

Because the retrospective design or the case study, the spin-offs that are of interest should have started their commercializing activities no longer than 10 years ago.

In the literature, the terms academic spin-offs (ASOs) and academic start-ups (ASUs) are also widely used. However, in this research we consider them as USOs.

In the development process of a USO, there are different parties involved. Franklin (2001) differentiates between inventor entrepreneurs and surrogate (industrial) entrepreneurs. The inventor entrepreneur is the inventor of the technology and tries to commercialize the invention. The industrial entrepreneur acquires the right to commercialize the technology. Roberts and Malone (1996) identify four principal roles in the spin-off process:

- Technology originator; brings the innovation to the point at which the transfer of the technology can begin.
- The entrepreneur; attempts to commercialize the technology into a product or service to be sold in the market.
- The parent organization; is where the technological originator is usually located. May provide assistance in patenting the innovation, technology licensing or other supporting activities. It may also strive to maximize achievement of their goals.
- The venture investor; provides the financial resources to establish the spin-off.

These roles are important because they all participate in the process of USO development. However, in this research, all organizations that support USOs, will be referred to as 'facilitators'. Information on the USO facilitators will be further detailed in paragraph 2.4.1.

In this paragraph, the definition is formed and the involvement of different parties with USOs have been discussed. In the next paragraph, the importance of USOs for their environment, the university and at an individual level will be discussed.

2.1.2 Importance of university spin-offs

USOs exploit a wide variety of different technologies, from software to medical devices and from communication equipment to biotechnology. In some industries, USOs are the dominant type of firms. For example, most biotechnology companies originate from a USO. Spin-offs can also lead to founding companies that generate new technologies, which are then transferred to larger, more established companies. Established firms have a variety of advantages in commercializing university technologies, like market knowledge, relationships with customers, distribution systems and related products. In fact, most university technologies are licensed to existing companies. Some observers have argued that only about 3 percent of all university inventions are right for founding spin-offs (Nelson, 1991, according to Shane, 2004), although the percentage has probably risen in the last decade (Shane, 2004).

USOs can stimulate innovation and regional economic growth (Shane, 2004). USOs can create tangible advantages for its environment such as job creation, investment, tax income and intangible advantages such as economic renewal and entrepreneurial dynamism (Ndonzuau et al., 2002). Shane (2004) acclaims that USOs encourage economic development in at least four ways. Firstly, they generate significant economic value by producing innovative products that satisfy customer wants and needs. Blair and Hitchens (1998, according to Shane 2004) found that USOs produce more new products and services than non-university high technology companies. Secondly, they generate jobs, particularly for highly educated people. Thirdly, they stimulate investment in the development of university technology. Fourthly, they have highly localized economic impact. Most USOs undertake

their activities locally, so they have a significant effect on local economic development.

USOs are not only valuable for their environment, but can obviously be valuable for the university as well. Shane (2004) describes four ways in which the spin-off can be valuable for the university.

They are useful for commercializing university technologies. The technologies could otherwise remain underdeveloped. Spin-offs provide a mechanism to commercialize inventions that are too uncertain for established companies. They ensure involvement of the inventor, which is crucial when technologies are based on tacit knowledge.

They help universities with their major mission. USOs help achieving their primary missions of scholarly research and teaching. Spin-offs can provide financial support for university research. In fact, a reason for an academic to start a spin-off can be to raise funding for research. The spin-off can help to attract and retain faculty because they can be a supplement to their salaries. Spin-offs also facilitate the training of students. Interaction with spin-offs learns faculty members and students about commercial uses of technology, instead of scholarly uses only.

They are disproportionately high performing companies. USOs are less likely to fail compared to the average start-up company and they are more profitable than average technological spin-offs. Researchers found that university spin-offs have extremely high survival rate. For example, from the 92 spin-offs created at the University of Twente from 1984 to 1992, only 16 had failed by 1992 (Kobus 1992, according to Shane 2004).

Spin-offs generate more income for universities than licensing to established companies. Licensing inventions to established companies is only in 20 percent of the time successful (Shane and Katila 2003, according to Shane 2004). Moreover, many established companies change the technology in the process of commercialization and create a new technology without paying the universities. By holding equity in a spin-off, the university is more likely to obtain financial returns.

Next to the environment and the university, USOs are important at individual level. USOs can contribute to the personal goals of the inventor entrepreneur(s). In their research, Prodan & Drnovsek (2010) analyzed the intentions of an academic entrepreneur. USOs can contribute to the fulfillment of entrepreneurial self-efficacy, the desirability of an entrepreneurial career, networking and personal intentions, and socioeconomic status at the university.

To summarize, USOs can be important for generating new technologies and exploiting technologies to the market. They can have a positive impact on innovation and regional economic growth. USOs can be valuable for universities because they are useful for commercializing technologies, helping universities with their major mission, performing disproportionately high and generating more income for universities than licensing to established companies. At individual level they can contribute to the fulfillment of entrepreneurial self-efficacy, desirability of an entrepreneurial career, networking and personal intentions and socioeconomic status at the university.

In this paragraph the importance of USOs has been discussed, in the next paragraph the process of creating a USO will be discussed.

2.1.3 Process of university spin-offs creation

This paragraph focuses on the creation process of a USO. The spin-off creation process takes place before the spin-off starts developing. Shane (2004) describes this process according to the steps in figure 2.1. The first, second and fourth step can be considered as stages in the spin-off creation process and the third and fifth step are decision making moments. All steps will be discussed.

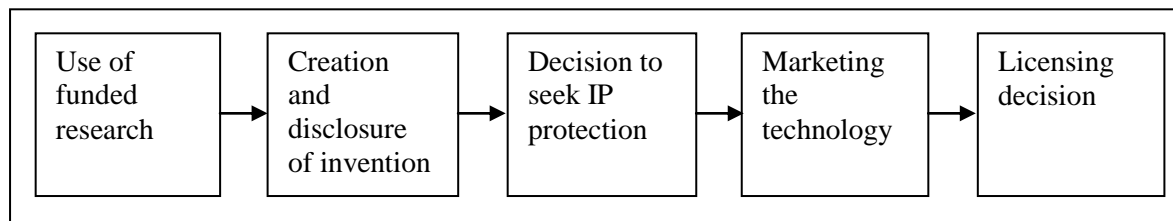


Figure 2.1. The process of university technology development (Shane, 2004)

Use of funded research

In general, the main goal of research at universities is the production of new academic knowledge. Academic research can be very expensive and often uses the funding from companies, foundations and government agencies to obtain human and physical resources. Most of the research funding is used to pursue typical academic goals, like producing knowledge that can be published in academic journals. Sometimes this research leads to new technological knowledge that has the potential to lead to new products and services. A technology is likely to be exploited by a USO if the technology is (Shane 2004):

- 1). Radical. Incremental inventions would better complement a business unit within an existing company, because of their advantage on market experience and market knowledge. Radical technologies are often rejected by established firms because they could negatively affect their existing products or services. Radical technologies undermine existing organizational competencies and established firms often reject radical technology because they see them as not valuable or ineffective.
- 2). Tacit. If a technology is tacit, it is difficult for anyone other than the inventor to see how an invention could be further developed into a technology that can be commercialized.
- 3). Early stage. Shane acclaims that “uncertain value, focus of established companies on existing operations, the lack of expertise in conducting radical product development in established firms, the difficulty of communicating information about early stage technology, the difficulty of capturing value of early stage technology through licensing, and the short time horizons of large, established firms, particularly publicly traded ones” explains why early stage inventions lead to the formation of spin-offs.
- 4). General-purpose. USOs tend to exploit technologies that are general-purpose, which offer multiple markets and are difficult for established companies to identify.

Furthermore, the technology is likely to be exploited by a USO if the technology has:

- 1). Significant customer value. USOs start from scratch and need to assemble the assets needed for the technology. This requires a more valuable opportunity. Established firms can exploit the opportunity with existing assets and can exploit small improvements in customer value.
- 2). Significant technical advance. Far advanced technology is difficult for managers from established companies to understand and hard to license in general.
- 3). Strong IP protection. Starting USO companies have the only competitive advantage of having a strong intellectual property. Spin-offs are more likely to be founded with a large portfolio of patents.

When a potential technology to commercialize has been identified, the next step is the creation and disclosure of the invention.

Creation and disclosure of invention

When a researcher believes that his or her new technology is an invention that can be commercialized, the individual is expected to disclose the discovery to the university technology-licensing office (or a comparable department inside or outside the university).

Before making that decision, two conditions must be met. First, the researcher must believe that the invention is something that is novel, non-obvious and valuable, rather than having produced a research result. Second, depending on the university's policy, the investors must believe that they have to disclose their invention to the university. This is also dependent on the nature of the technology and the nature of intellectual property protection. For example, a biotechnology invention is far more likely to make use of university material than a software invention. A biotechnological invention is thus more likely to make a disclosure to the university than a software invention. When the decision to disclosure is made, the decision to seek IP protection is the next step.

Decision to seek IP protection

The conditions of a patent are met when a technology is novel, non-obvious and valuable. If the inventor wants to seek IP protection, he or she must believe that these conditions are met. Moreover, the technology must be embodied in some form that can be patented. Tacit knowledge that only the inventor knows is difficult to protect through a patent. The next step is to market the technology.

Marketing the technology

If the technology has IP protection, the inventor or technology transfer office will try to market the technology. Licensing to established companies is by far the most used form. Approximately 86 percent of licenses go to companies that already exist (pressman 2002, according to Shane 2004). But it is not always easy to find an established company willing to invest in an often very early stage invention. The uncertainty of these investments is very high. After analyzing the market for the technology, the licensing decision has to be made.

Licensing decision

If a technology has not been licensed to an established company and the inventor believes in its success, the technology can be licensed to a newly established company. This is when a spin-off occurs. As stated above, approximately 86 percent of the licenses are licensed to existing companies, which means that only 14 percent of the licenses are licensed to USO companies. This number might be relatively low due to the fact that most academics try to license a technology to an established company instead of exploiting it through a USO. To promote academic entrepreneurship Prodan & Drnovsek (2010) suggest in their research; entrepreneurial education, introduction of different networking events and actively promoting cooperation between academics and industry.

2.1.4 Summary

In this paragraph, the definition of a USO, the importance of a USO, and the process of USO creation are discussed. A USO company is defined as: a commercial company from which the intellectual property as well as the founder or founders must come from a university or academic institution and at which the technology is transferred directly to the spin-off company. USOs can be important for generating new technologies and exploiting technologies to the market. They can have a positive impact on innovation and regional economic growth and USOs can be valuable for universities because they are useful for commercializing technologies, help universities with their major mission, perform disproportionately high and generate more income for universities than licensing to established companies. USOs can contribute to the fulfillment of entrepreneurial self-efficacy, the desirability of an entrepreneurial career, networking and personal intentions, and socioeconomic status at the university.

The goal of the process that takes place before the decision is made to start a spin-off, is often to produce academic knowledge and licensing technologies to established companies. For an established company the technology can be too uncertain, they do not believe in its value, or the technology is difficult to transfer because only the expert has the knowledge. If the technology is radical, tacit, early stage, general-purpose and has significant customer value, significant technical advantage and strong IP protection, the technology is more likely to be exploited through a USO. A large number of licenses are exploited through established companies instead of USOs. The university can promote academic entrepreneurship through entrepreneurial education, introduction of different networking events and actively promoting cooperation between academic and industry.

2.2 Growth phases and critical junctures

The process of USO formation has been researched by only a few studies (Carayannis et al., 1998, Ndonzuau et al., 2002, Roberts & Malone, 1996, Vohora et al., 2004). Typically, the studies describe the development process of a spin-off with a number of phases (Djokovic and Souitaris, 2006). Three models were selected through a literature scan: the models of Ndonzuau et al. (2002), Vohora et al. (2004) and Clarysse & Morey (2004). The first sub-paragraph introduces the model of Vohora et al. (2004) of growth phases and critical junctures. Sub-paragraph two introduces the stage based model of Ndonzuau et al. (2002). The third sub-paragraph introduces the process of USO development by Clarysse & Moray (2004). The phases and junctures from the first three paragraphs will be analyzed and compared in paragraph four. In sub-paragraph five, the theories derived from a literature scan on the subject will be discussed. The last sub-paragraph will contain the theoretical framework for the phases and critical junctures and will be input for the empirical research.

2.2.1 Model of phases and critical junctures

Vohora et al. (2004) identify five stages of development based upon nine USO companies in the UK and offer an evolutionary perspective on USO development (Djokovic & Souitaris, 2006). The model shows that before a USO can move to the next phase of development, a specific group of activities as well as strategic focus must be accomplished. These ‘obstacles’ are called critical junctures and will be discussed separately after having introduced each phase. In figure 2.2, the phases and critical junctures are displayed in a diagram. The model is based on the stage-based model and resource based view. We will go into the details of the stated phases and junctures.

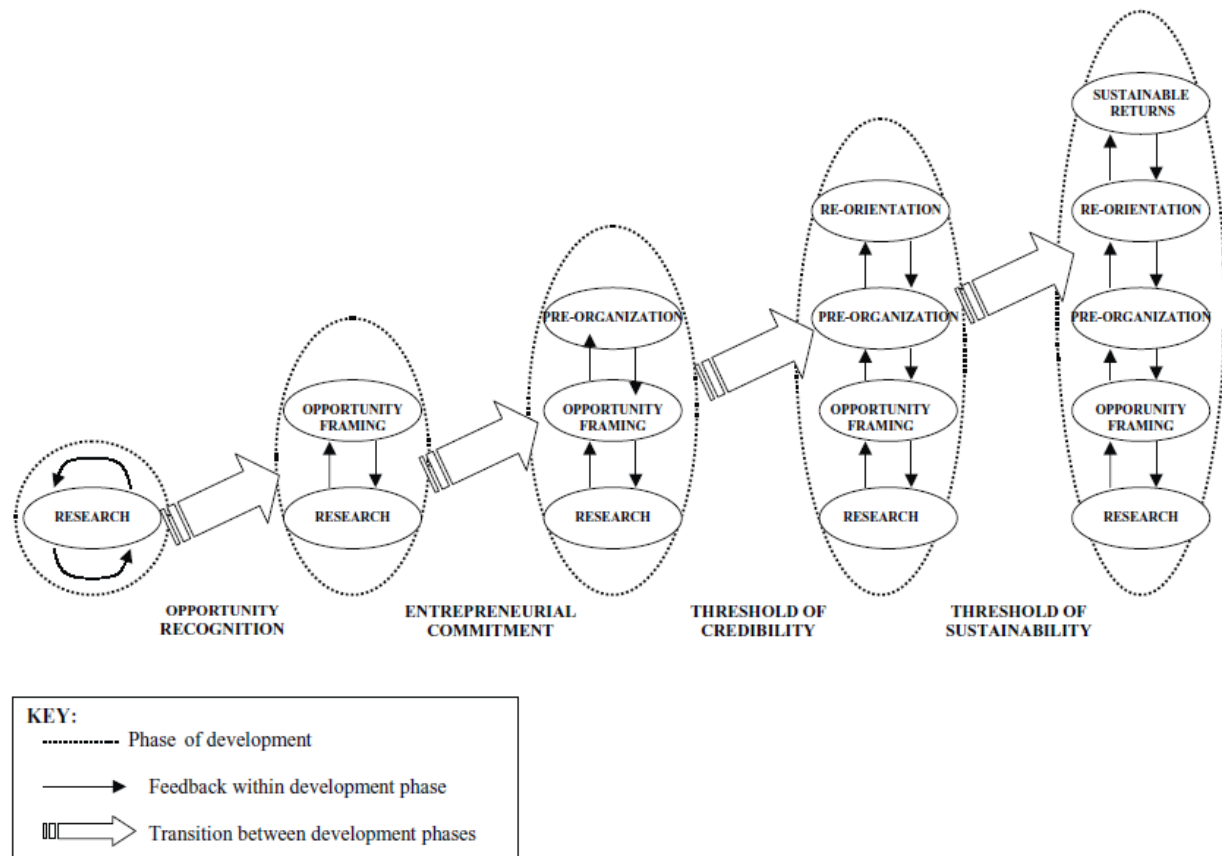


Figure 2.2. The phases and critical junctures in the development of university spin-offs (Vohora et al., 2004)

Research phase

The first phase of the development process is the research phase. As paragraph 2.1.3 suggests, the process that takes place before the decision is made to start a spin-off company, is often aimed at producing academic knowledge and licensing technologies to established companies. The research phase is the period from researching a new technology, to the point that intellectual property is created. This phase can take place over a number of years (Vohora et al. 2004).

Vohora et al. (2004) claim that before the opportunity of commercializing is recognized, the main focus of the academic involved is to perfect the academic research and publication of their work towards a particular scientific community. Academics at the forefront of research in their field are most likely to create valuable knowledge and technological assets. This is consistent with existing literature suggesting that successful scientists in their field are more likely to obtain strong intellectual

property (Shane 2003 according to Vohora et al. 2004). When a potential opportunity of commercialization has been identified, the first critical juncture ‘opportunity recognition’ arises.

Critical juncture: opportunity recognition

When a USO company is at the end of the research phase, the problems that arise from moving to the opportunity framing phase are defined by the critical juncture ‘opportunity recognition’. Opportunity recognition is the solution that satisfies the need of an unfulfilled market (Bhave, 1994). The process leading from opportunity recognition to the creation of a new business is still relatively undiscovered (Delmar and Davidsson 2000, according to Vohora et al. 2004).

The ability to connect the specific knowledge and a commercial opportunity requires a set of skills, aptitudes, insights and circumstances that are neither uniformly nor widely distributed (Venkataraman 1997). The research shows that the conflict at this junctures is that although universities and academics possess significant technological know-how, they have insufficient knowledge of how to serve markets and unrealistic expectations of the profits that could be derived from the technologies they discover. And thus without developing, acquiring or accessing the capability to combine scientific knowledge with a commercially feasible offering that satisfies an unfulfilled market need, academic scientists would not be able to proceed toward commercializing their technology. When a USO is able to link the opportunity to (a) specific market(s), it moves to the next phase, the opportunity framing phase.

Opportunity framing phase

In this phase the academic and involved persons will examine if the recognized opportunity has enough underlying value to proceed with the commercialization. This process consist of evaluating the opportunity and to ensure that there is enough evidence that it actually works and has sufficient promise for application in a commercial environment. If the opportunity can be applied in a commercial environment, the next step is to ‘frame’ it within a commercial opportunity. That is, to identify the markets for the opportunity and what application of the opportunity to develop for those markets. Also how to access the customers with the innovation is critical. After the opportunity framing phase, the critical juncture entrepreneurial commitment has to be overcome.

Critical juncture: entrepreneurial commitment

At the interface of the opportunity framing phase and the pre-organization phase lays the critical juncture entrepreneurial commitment. “Entrepreneurial commitment is necessary for a potential venture to be taken forward from a vision that the academic has created mentally, to the formation of a business that is operational and engaged in business transactions” (Vohora et al. 2004 p. 160).

Entrepreneurial commitments are the acts which bind the venture champion to a certain course of events. In their research, Vohora et al. (2004, p. 163) suggest that “the critical juncture of entrepreneurial commitment arises due to the conflict between the need for a committed venture champion to develop the USO venture and the inability to find an individual with the necessary entrepreneurial capabilities for four key reasons”. The *first reason* is the lack of access to successful entrepreneurial role models for the academic entrepreneur. This causes reluctance to commit and actively exploring the potential of commercializing their scientific discoveries. This reluctance is caused by the fact that they have to go against “accepted conventions held by their peers and reinforced by incentives, and promotion policies set by institutions” (Vohora et al. 2004, p. 163). Scientist can feel uncomfortable commercializing the opportunity by themselves, and the social capital of most academics in general are restricted to networks within academia and do not extend to business and finance. The *second reason* is that USOs suffer from a lack of prior business experience together with a lack of faith in their own abilities to cope in a commercial environment. The academic is

discouraged from making a commitment to pursue the venturing process because if the academic feels unable to frame the opportunity with sufficient clarity, it creates decision uncertainty and decision complexity. This can impede their progress in further exploring how to commercialize their scientific discoveries. “What makes some academics great scientists or engineers clearly does not usually give them the necessary entrepreneurial human capital to start and grow a business” (Vohora et al. 2004, p. 163). The *third reason* is an insight relating to the lack of self-awareness of personal limitations and sometimes a lack of humility on the part of some academics. The majority of the respondents in the research of Vohora et al. (2004) found difficulties in delegating and sharing responsibilities when it came to the commercialization of their intellectual property. This is due to the fact that academics have many years of scientific training, but no or little training in business and entrepreneurship. The *fourth reason* is that a USO can find it extremely challenging to identify, access and acquire the services of a surrogate entrepreneur. This is a result of limited social capital, offering insufficient rewards and incentives to acquire a suitable surrogate due to the lack of resources and the inability to relinquish control of their company to anybody else. When the opportunity is framed within its commercial potential and the company has found, internally or externally, a committed venture champion, the USO moves to the next phase of development.

Pre-organization phase

After framing the opportunity, the management of the USO can develop and start to implement strategic plans during the pre-organization phase. In the research of Vohora et al. (2004) all cases in this phase were taking decisions on what existing resources and capabilities to develop, what resources and knowledge to acquire now and in the future, as well as when and where to access these resources and knowledge. The decisions made in this phase are found to have major and unforeseeable impact upon the entire future success of the USO. The path that the firm will take will be directed. Mistakes made in this phase can be disadvantageous for the success in the future and affects their ability to achieve strategic objectives in later development phases. Greater time to market, lost revenue and lack of venture capital investment are examples of how important these decisions are. These issues require entrepreneurial experience, human capital and access to networks of expertise at a premium. The pre-organization phase has the steepest learning curve for the academic entrepreneur, particularly if they have little or no commercial experience or knowledge of how their target industry operates and few existing relationships with business people, surrogate entrepreneurs, business angels and venture capitalist. When the USO is at the end of the pre-organization phase, it will have to acquire the required resources to start-up the company. At this stage, the critical juncture of credibility occurs.

Critical juncture: credibility

The critical juncture credibility occurs when a USO company is in the pre-organization phase and wants to move to the re-orientation phase. The juncture is the ability of the entrepreneur to gain access to and acquire an initial stock of resources required for the business to begin to function. “The lack of credibility constrains the entrepreneur’s ability to access and acquire key resource: seed finance and human capital to form the entrepreneurial team” (Vohora et al. 2004, p. 164). This creates the problem that the entrepreneurial team identifies the required resources, but has to wait until the required financial resources are available. Unresolved resources weakness, deficient social capital and inadequate entrepreneurial capabilities from the opportunity framing and pre-organization phase are important factors at this juncture. Financial investors want proof of market, proof of concepts and the entrepreneur credentials. The difficulty for the entrepreneurs in this matter is that apart from intangible technological assets in the form of know-how and intellectual property, there is often very little else to demonstrate besides their own published scientific research. Also the connection with the university can be a problem at this stage. As long as their USO company remains embedded within university

departments and failed to project a distinctive corporate identity, customers, suppliers and certain investors will not value the products and services they offer. The path dependency of USOs may present specific challenges opposed to new high-tech ventures in general. Financial investors and customers may be suspicious of the influence of the non-commercial cultures from the university. Certain ties to the university may be perceived to be a liability. When the USO has acquired the necessary financial resources, it will move the next phase of development, the re-orientation phase.

Re-orientation phase

After the pre-organization phase, the USO has sufficient resources and credibility to start-up the business. The USO is now trying to generate returns by offering something of value to the customers. In the re-orientation phase, the entrepreneurial teams are facing the challenges of continuously identifying, acquiring and integrating resources and then subsequently re-configuring them (Teece et al. 1997). Start-up companies with poor endowment of capital and inexperienced management are to a larger extent re-configuring. Information gained from interactions with customers, competitors, suppliers as well as potential investors causes a great deal of change. For example, if results in a certain category of customers are disappointing, the strategy will be realigned to target a new category of customers. The success of progressing from this phase to the next depends to a large extent on the preparatory work done during the previous phases. Before moving to the next phase of sustainable returns, the company has to overcome the critical juncture of sustainable returns.

Critical juncture: sustainable returns

The critical junctures sustainable returns lies at the interface of the re-orientation phase and sustainable returns phase. After exploiting its technological assets commercially, the USO faces the challenge of creating sustainable return. Sustainable returns can be revenues from customers for services or products sold and payments from collaborative agreements of investment from existing or new investors. At this point, the entrepreneurial team should be able to re-configure existing resources, capabilities and social capital with new information, knowledge and resources. The existing resource weaknesses, inadequate capabilities and social liabilities should be re-configured into resource strengths, distinct capabilities and social capital that will enable the USO to generate returns. If this is met, the team is able to create value from the appropriate resources, capabilities and social capital. The “resource weaknesses, inadequate capabilities and social liabilities inherited from decisions and commitments made in early development phases may now be too difficult to resolve” (Vohora et al. 2004, p 167). If the company has succeeded to overcome all the critical junctures, it moves to the sustainable returns phase.

Sustainable returns phase

After the re-orientation phase the USO moves to the sustainable returns phase. If the USO arrives in this phase, it has addressed many of the uncertainties. Typically in this phase, the company moves from the university campus to a commercial environment. Although it has its own commercial identity and self-sufficiency, it will almost certainly retain close links with the university.

2.2.2 Model of academic spin-off creation

Ndonzuau et al. (2002) identify four stages in the development process of USOs. The four stages identified are from a public and academic authorities point of view. This is done by benchmarking international spin-off support programmes. In figure 2.3, the four staged model is presented. The four stages of the model are not wholly independent from each other, decisions made in an earlier stage can have an impact on the later stages. Ndonzuau et al. identify “obstacles, impediments, hindrances and

other sources of resistance” that need to be overcome in each phase. These are called ‘issues’ in their research. In this research, these ‘issues’ are called hereafter ‘critical junctures’.

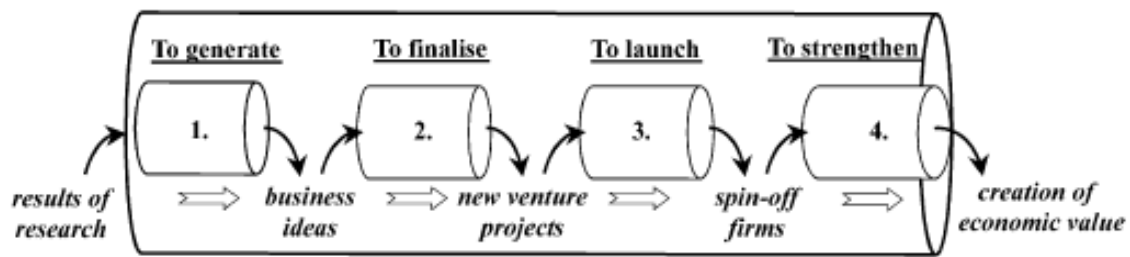


Figure 2.3. The academic spin-off creation process (Ndonzuau et al. 2002)

Stage 1: generating business ideas

In this stage the business ideas are generated. This can be difficult because of the academic culture and the problem of identifying business ideas.

Academic culture

The academic culture can have negative influences on generating business ideas because of the ‘publish or perish’ mentality, the relationship of researchers to money, and the disinterested nature of academic research. As stated by the research of Vohora et al. (2004), researchers are publishing-oriented. This can have negative effects on the economic value of a technology. When a technology is published, it cannot be protected through legal protection such as a patent. In the academic culture, researchers consider money as a means of scientific progress. In the business sphere however, other liabilities such as financial results and project delays have to be taken into account. The disinterested nature of academic research as pointed out in paragraph 2.1.3. is also an important factor of why the academic culture can be problematic in creating business ideas.

Identification of business ideas

Another very important factor in the first stage is the identification and assessment of ideas. A technology has to be identified as a potential business idea. The university should have a good policy toward identifying ideas. Ndonzuau et al. (2002, p. 284) describes this policy; “it requires sensitive contacts, the development of mutual trust, and the organization of an efficient internal diffusion of information”. After an idea has been identified, it should be assessed on its technological aspects, commercial and personal aspects and the most suitable way to exploit them commercially. “Technological evaluation requires the ability to assess the extent to which research results are stable and/or sufficiently developed to lead to industrial exploitation by identifying their possible applications, assessing their technical feasibility, and, in some circumstances, suggesting further research and development” (Ndonzuau et al. 2002, p. 284). This can be done by internal partners (i.e. professors) or external partners (i.e. consulting firms). After the technological evaluation, the market potential must be assessed. Ndonzuau et al. (2002, p. 284) explains this aspect by asking the following questions: “What are the different applications of a given technology? Which are the most promising? Who are the key players in those markets? How high are the barriers to entry? Is the potential good enough to build up a viable company?” When these questions can be answered the next stage of finalizing new venture projects comes in place.

Stage 2: finalizing new venture projects

After stage 1, ideas are generally ill-structured with many grey areas to be clarified, while their potential to make money is not yet precisely known. In the second stage, the idea must be transformed into a business project. This process, which may require major investments, consist of the protection and the development of the idea.

Protection of ideas

First, it must be clear who the owner of the idea is. This is often far from clear because of: “multiplicity of funding sources, the diversity of conventions established between funding organizations and teams of researchers, the collaboration between different research centers (public or private), the various status of people carrying out research activities (professors, contractual researchers, doctoral students, and so forth), and, finally, the intangible character of most results. All these elements contribute to complicating the task of protecting intellectual rights”(Ndonzuau et al. 2002, p. 285). This requires an in-depth analysis to determine who the owner of the idea is.

The next step is to efficiently protect an idea. High technological level and barriers of imitation can protect an idea naturally for a considerable period of time. Most academic results do not have high barriers, so they must be protected through artificial protection such as patents and copyrights. This requires specialists who understand how to formulate a patent. The protection of intellectual right can be costly, therefore a cost-benefit analysis must be conducted on the usefulness of such legal protection.

The development of business ideas

At this stage, the decision must be made on how to best exploit the idea. If the decision is made to exploit the idea through a spin-off, a transformation of the idea into a business project is required. This involves a technical and commercial development and the arrangement of financing.

“The purpose of technological development is to verify the possibilities of industrial exploitation”(Ndonzuau et al. 2002, p. 285). This is done by conducting a prototype which can determine whether production can be extended to a larger industrial scale and also to demonstrate to potential customers and partners what the technology can achieve. This requires material issues like the availability of technical facilities that may be necessary to build up a prototype and non-material issues like the time (several months or years) of development.

Next to the technological development, the commercial development is to determine whether the idea is a business opportunity and in which way this opportunity will be exploited. Ndonzuau et al. (2002, p. 285/286) describes why a good business plan can be important: “First, it helps to design a coherent strategy and to estimate more accurately key elements such as investments, turnover, operating costs, or treasury forecasts. Second, it gives concrete form to a selling document for bankers and investors by giving them a structured and coherent image of the ways in which the results are intended to be exploited”.

Problematic in the technological and commercial development process is to finance this stage. Legal protection is often supported through the university, but for technological and commercial development, it is difficult to find funding. Public funding is dedicated to fundamental research, and very few private financial bankers invest in such early stage idea, in an unpredictable and instable high-tech market, conducted by researchers with often low entrepreneurial capabilities. This is called the ‘financing gap’ and is undoubtedly the key problem to overcome in order to finalize these projects (Reitan, 1997). And the end of this stage, a new venture project should be ready. That is when the process moves to the next phase.

Stage 3: launching spin-off firms

“The third stage deals with the creation of a new firm to exploit an opportunity managed by a professional team and supported by available resources”(Ndonzuau et al. 2002, p.286). At this stage, the process of commercialization takes place, moving from specific academic contingencies towards business considerations. This brings two important problems: the availability of resources and the relationship that should be established between the spin-off company and the university. Dependent on their policy toward spin-offs, some universities can help overcome these problems to find solutions for these issues such as raising venture capital funding.

Access to resources

Both tangible and intangible resources are needed to realize entrepreneurial projects. The management of creating a spin-off is very different compared to the research activities academics normally perform at the universities. They will have competitive pressure and they will have to be surrounded by competent people to avoid mistakes. The main reason of failure is often not the poor business idea but the poor quality of the management (Timmons 1994, according to Ndonzuau et al. 2002). The development of a business requires management expertise and good social networks (Mustar 1997, according to Ndonzuau et al. 2002). The problems that arise from this are how to identify key people and how to involve these people in the spin-off company.

Relationship with university of origin

Eventually, all USOs will leave their academic environment, but most of the USOs retain some relationship with their original university. This can be through an institutional level such as equity shares (financial resources), patent technology ownership by university (intangible resources) and access to university facilities (material resources). But it can also be through a personal relationship between the university and the researchers. These relationships, both institutional and personal, can lead to conflicts of interests. This could be through incidentally benefit from effective research infrastructure accessed at a lower cost than available in the market, or universities that unintentionally subsidize some activities of their spin-offs, because of the complexity between some researchers.

For a USO, this stage is the last stage of the development process. From the universities and public authorities point of view however, the economic value of a USO is important and Ndonzuau et al. (2002) consider this as the last stage of spin-off creation.

Stage 4: strengthen the creation of economic value

The last phase includes the importance of the USO for its environment. In their research, Ndonzuau et al. (2002) state that the valorization by spin-offs is not the final stage. They claim that not only this process is important, but that the purpose must be enlarged to the creation of economic value by USOs. USOs can have tangible and intangible influences on their environment, as discussed in paragraph 2.1.2. This stage on the creation of economic value from a USO is from a public perspective and does not consider the development process of a USO itself. Thus, this stage will not be taken into account by comparing the models of Vohora et al. (2004), Ndonzuau et al. (2002) and Clarysse & Moray (2004) in paragraph 2.2.5.

2.2.3 Model of team formation process

The research of Clarysse & Moray (2004) focuses on the team formation process in the development process of a USO. They closely followed the team development process of a USO in Belgium for a period of 20 months, from 1999 until 2001. In figure 2.4 identified phases are displayed. Each phase will be explained in more detail in this paragraph.

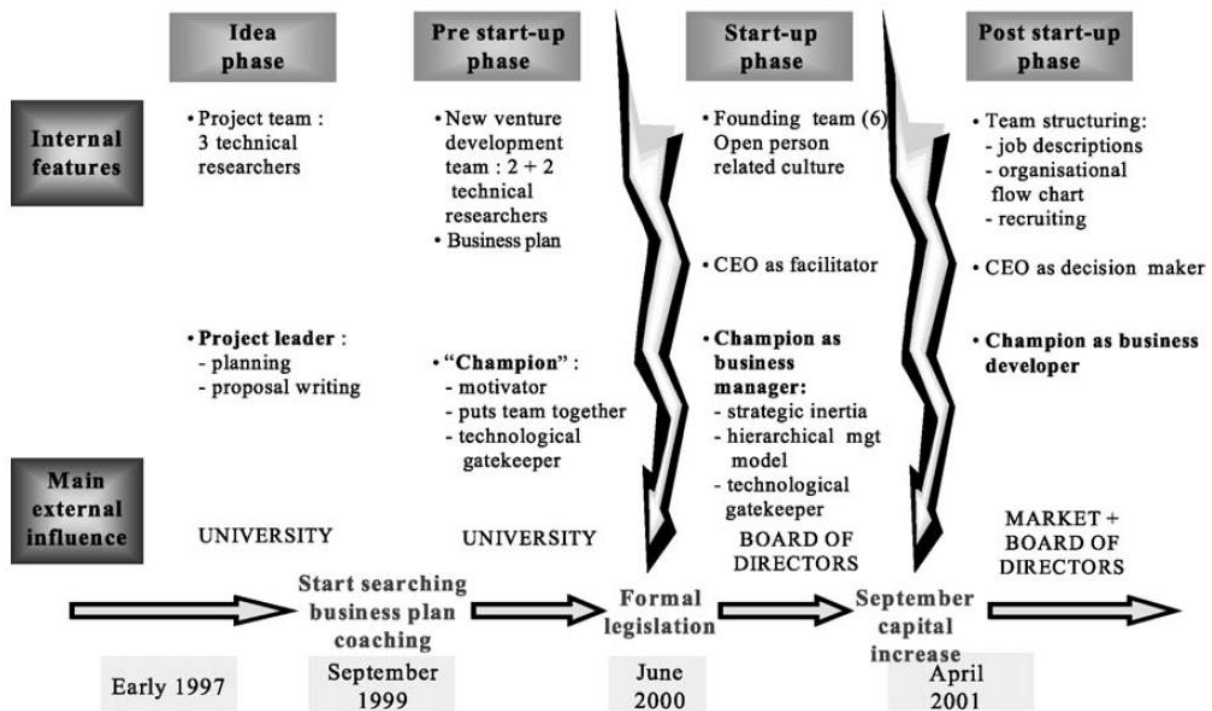


Figure 2.4. The team formation process (Clarysse et al. 2004)

The project phase: a project team at the university

In the project or idea phase, a project team for exploiting the technology is formed. The project team of technical researchers has a project leader which is responsible for the planning and proposal writing of the project. The project phase could take a few years of research and when the business plan writing starts, the project team moves gradually into the pre-start-up phase.

The pre-start-up phase: championing the business idea into a new venture

In this phase the business opportunity needs to be further validated, the business plan is developed and the start capital will be negotiated. The team members are not organized hierarchically and they have a high degree of control over their work. The entrepreneurial team is formed, mainly of technical entrepreneurs at first, attracting engineers with industrial experience during the pre-start-up phase. In this phase, it is important that there is a project leader. This leader usually puts him/herself automatically in the role of steering and motivating the other team members. This leader is called the ‘champion’ and is critical in the development process. “Without champions, product innovations, and corporate venturing are unlikely to occur” (Clarysse & Moray 2004, p. 74). The role of the champion will be further discussed in the following phases. When the company is formally legislated, it will move to the next phase, the start-up phase.

The start-up phase: the champion as business manager and inducer of strategic inertia

With the formal legislation of the company, the champion automatically becomes business manager. The business manager “arranges the physical infrastructure and related operational matters, makes sure internal agreements are made and held by all team members, and manages – in co-operation with others – the development of a certain communication structure” (Clarysse & Morey 2004, p. 69). The other team members will find their place in the new company.

While the champion is critical in the project phase and the pre-start-up phase, the champion as business manager can slow down strategic decision making by “sticking far too long to the original,

commercially nonviable business idea” (Clarysse & Moray 2004, p 71). The business manager is likely to lack managerial (strategic and commercial) competencies. The company is predicted to stagnate or decline unless the founder is replaced or supplemented by professional management. Thus, in the start-up phase it is likely that an internal reorganization of the company evolves.

The post-start-up phase: technological evolution as trigger for strategic focus and professionalizing the organization of the team

If the champion is found to lack managerial skills, a possibility could be to hire an outside CEO. But, finding an experienced outside CEO for a starting high-tech company it is often extremely difficult. It might be more efficient to hire a ‘coach’, so that the entrepreneurial team develops the skills and capacities to run its operations by itself. “A professional manager might only be needed once the revenues are coming and breakeven is realized” (Clarysse & Moray 2004, p. 56).

In conclusion, the research of Clarysse & Moray (2004) describes the team formation process and the development process of a USO. They found that with a minimum amount of coaching, inexperienced entrepreneurial teams are able to acquire the necessary skills in a relatively short period. After the learning phase, as the company grows, external shocks such as capital increase can be a reason to formally restructure the company.

2.2.4 Growth phases

In this paragraph, the models of Vohora et al. (2004), Ndonzuau et al. (2002) and Clarysse & Moray (2004) will be compared. Research question 1.2 will be answered in this paragraph.

Vohora et al. (2004) used a case-based research method to investigate the development of the USO process. With data gathered from a qualitative research at nine USOs, emerged with literature (resource-based view and stage-based models), they formed a detailed model for the USO development process. They have identified five phases in the development process that a USO must pass through to succeed. The model shows that a USO has to pass through the previous phase in order to progress to the next phase, but that the process could be non-linear in which earlier decisions and activities may need to be revised. The model identifies four critical junctures between the phases that a USO has to overcome in order to progress to the next phase. The USO is challenged to acquire the appropriate resources and capabilities required to overcome a critical juncture. While the model of Vohora et al. (2004) is conducted by researching the development process at the USOs, the model of Ndonzuau et al. (2002) is conducted by researching the development process from the standpoints of both public and academic authorities. International spin-off support programmes have been benchmarked for the research. Based on this, a model consisting of four stages is composed. The research focuses on how academic research can be transformed into economic value by the creation of USOs. Not only does the article contribute to how policymakers and university authorities could improve their policy toward USOs, it points out the phases and critical junctures that USOs face in their development process. Three of the four stages explain how USOs develop and what critical junctures they have to overcome. The fourth stage is only of importance for the public and academic authorities, and will not be taken into account in this comparison. Thus, from the model of Ndonzuau et al. (2002), the first three stages will be used for comparison in this paragraph. The research of Clarysse & Moray (2004) focuses on the team formation process in the development process of a USO. It describes how a team of entrepreneurs is formed, how the team copes with crisis situations and how both the team and team members learn from these crises. The model of Clarysse & Moray (2004) consists of four phases in the development process of a USO and its entrepreneurial team. An interesting conclusion is that the ‘shocks’ in the development process co-evolve with the ‘shocks’ in the team formation process.

Comparing phases

To compare the three models, the key characteristics and activities of each phase have been identified. In appendix 1, the key characteristics and activities of the phases are shown for each model. From these tables, figure 2.5 has been derived. Although it is not always precisely clear when the next phase starts, comparing the models gives a good insight of the timeline of these models.

1	research	opportunity framing	pre-organization	re-orientation	sustainable returns
2	generating business ideas	finalize new venture projects		launch spin-off	
3	idea phase	pre-start-up phase	start-up phase	post-start-up phase	

1 = Vohora et al. (2004)

2 = Ndonzuau et al. (2002)

3 = Clarysse & Morey (2004)

Figure 2.5. Comparison of the growth phases

Row 1 represents the phases according to Vohora et al. (2004), row 2 Ndonzuau et al. (2002) and row 3 Clarysse et al. (2004). The first phase starts at the same moment for all the models. In this phase, a potential opportunity for commercialization from academic research is identified. The first phase of Ndonzuau et al. (2002) and Clarysse (2004) continues when in the model of Vohora et al. (2004) the second phase, the opportunity phase, already starts. The opportunity framing overlaps partly with the first phase of Ndonzuau et al. (2002) and Clarysse et al. (2004), through business proposal writing and partly in the second phase through investigating ideas more in depth and through transferring them into business projects in the case of Ndonzuau et al. (2002) and business plan writing in the case of Clarysse et al. (2004). In the second phase of Ndonzuau et al. (2002) and the second phase of Clarysse et al. (2004) the business project is finished at the end of the phase. IP protection, developing prototypes, attract finance and forming the entrepreneurial team are important examples of what a USO has to cope with. In the model of Vohora et al. (2004), these activities take place in phase three. At the end of phase three of the research of Vohora et al. (2004) and at the end phase two of the model from Ndonzuau et al. (2002) and Clarysse et al. (2004) the business is ready to start up. In the next phase, all models focus on the start-up and re-configuration of the company to make the company profitable. This could imply changes in the strategy and the entrepreneurial team. While the model of Ndonzuau et al. (2002) ends after phase three, the models of Vohora et al. (2004) and Clarysse et al. (2004) respectively have a sustainable returns phase and a post-start-up phase in which sustainable returns are achieved and possibly a new management team is created.

The major difference between the phases in the models, before the company is ready to start-up, is: a USO in the model of Vohora et al. (2004) has passed through three phases and the models of Ndonzuau et al. (2002) and Clarysse et al. (2004) has passed through two phases. This is due to the fact that Vohora et al. (2004) consider the opportunity framing as a separate phase. For the theoretical framework, the basic structure of Vohora et al. (2004) will be used, and the model will be complemented by the models of Ndonzuau et al. (2002) and Clarysse et al. (2004). In table 2.1 of paragraph 2.5, the theoretical framework is presented. Now that the phases are compared, the related critical junctures that the models identify are discussed.

2.2.5 Critical junctures

The critical junctures will be discussed through the models presented. The four critical junctures from the model of Vohora et al. (2004) will be leading in this paragraph because they provide a complete set of junctures in the development process of a USO. The four critical junctures from Vohora et al. will be completed by the models of Ndonzuau et al. (2002) and Clarysse et al. (2002) and underpinned by the available literature.

Before the development process of a USO starts, the identification and exploitation of business ideas is important. Ndonzuau et al. (2002) claim that the policy of the university towards the identification of business ideas is key in overcoming the identification problem. “It requires sensitive contacts, the development of mutual trust, and the organization of an efficient internal diffusion of information” Ndonzuau et al. (2002, p. 284). After identification of the opportunity, only 14 percent is exploited through a USO. This number might be relatively low due to the fact that most academics try to license a technology to an established company instead of exploiting it through a USO. In their research, Prodan & Drnovsek (2010) analyzed the intentions of an academic entrepreneur. They identify entrepreneurial self-efficacy, networking and personal intentions, and socioeconomic status at the university as the key factors of entrepreneurial intentions of an academic. To promote academic entrepreneurship, universities could provide entrepreneurial education, introduce different networking

events, actively promote cooperation between academics and industry (Prodan & Drnovsek 2010), help starters in obtaining access to resources and developing their social capital, and set clear and supportive rules and procedures that regulate the university spin-off process (Van Burg et al. 2008). Thus, the university's perception towards entrepreneurship is of major importance at this critical juncture.

The critical junctures from the model of Vohora et al. (2004) can easily be identified between each phase. The figure of the phases combined with the critical junctures are shown in figure 2.6. The junctures are opportunity recognition (the ability to link the opportunity to the market(s)), entrepreneurial commitment (to find a venture champion with entrepreneurial skills), credibility (gain access to financial resources to start-up the business) and sustainability (challenge of creating sustainable returns). From the research of Ndonzuau et al. (2002), the identification of business ideas in an academic environment can be seen as a critical juncture before the spin-off development process starts. The spin-off creation process of Shane (2004) described in paragraph 2.1.3 explains this juncture in detail, pointing out that universities and academics often try to license the technology to established companies instead of exploiting the technology through a USO. The model of Ndonzuau et al. (2002) identifies the critical juncture credibility, but at an earlier stage. According to Ndonzuau et al. (2002), funding is needed for the technological and commercial development process, while Vohora et al. (2004) identify this juncture at the end of the pre-organization phase, when funding is necessary for the resources and capabilities to start-up the company. At a later stage, Ndonzuau et al. (2002) do recognize the availability of resources to start-up the company as a juncture that has to be overcome. The research of Clarysse et al. (2004) identified two critical junctures in the team formation process. The venture champion is very important as the leader and motivator of the team at the early stages of the process, but can slow the process down further in the development process because of a lack of managerial skills. The second critical juncture is the professionalization of the team. Hiring an outside CEO is difficult and often not realizable, thus the team can lack the skills to manage a company.

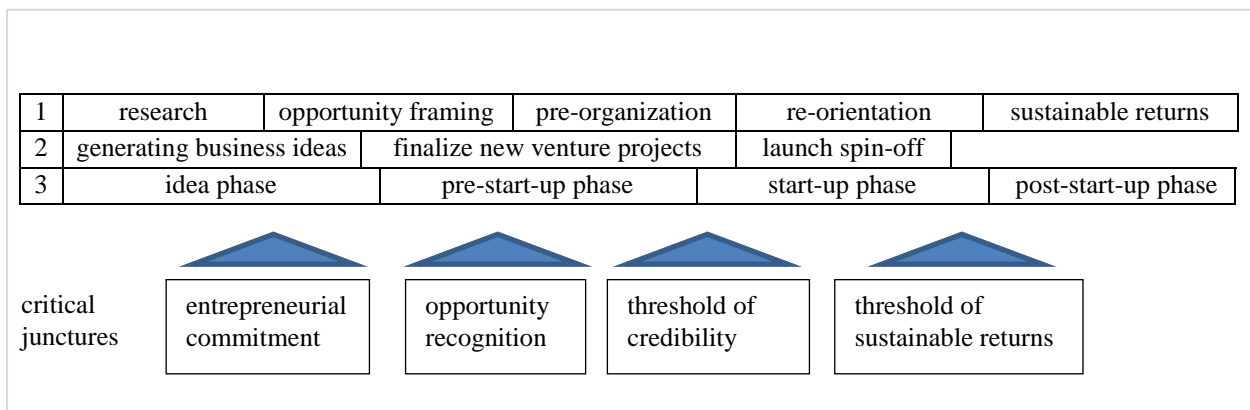


Figure 2.6. Growth stages and critical junctures

During the development process, four critical junctures have to be overcome. These junctures will be explained in the remainder of this paragraph.

1. Opportunity recognition

As the names suggest, the theory of market opportunity identification is closely related to the critical juncture opportunity recognition. Market opportunity identification can be very important for the success of a starting company. By identifying multiple markets, entrepreneurs might be able to select

the most favorable market condition (Danneels, 2007). Identification of multiple market opportunities appears to be fairly uncommon among starting entrepreneurs, due to limited prior knowledge of markets in which a technological competence may be valued (Gruber, 2008). The choice of which market to enter is one of the most profound organizational decisions entrepreneurs are faced with, because the nature of the market has strong effects on a new firm's identity, the capabilities and assets it needs to build, and its organizational structure (Boeker, 1989). Gruber (2008) identifies three insights that explain the importance of market opportunity identification in the early stages:

- Serial entrepreneurs have learned through prior start-up experience to generate a "choice set" of alternative market opportunities before deciding which one to pursue in their new firm creation.
- Entrepreneurs who identify a "choice set" of market opportunities prior to first entry derive performance benefits by doing so.
- The positive relationship between the number of market opportunities identified prior to first entry and new firm performance is nonlinear and subject to decreasing marginal return.

From their research, Vohora et al. (2004, p. 160) identify "the ability to synthesize scientific knowledge with an understanding of markets that is enhanced significantly by higher levels of social capital in the form of partnerships, linkages and other network interactions" as the way to overcome the critical juncture of opportunity recognition.

2. Entrepreneurial commitment

Vohora et al. (2004) identified four reasons for the inability to find an individual with the necessary entrepreneurial capabilities; the lack of access to successful entrepreneurial role models for the entrepreneur, the lack of prior business experience together with a lack of faith in their own abilities to cope in a commercial environment, the lack of self-awareness of personal limitations, and the difficulty to acquire the services of a surrogate/industrial entrepreneur. If these issues cannot be overcome, Vohora et al. (2004) claim that a committed entrepreneur is likely to remain elusive, leading to deficiencies and weaknesses in the later phases.

3. Threshold of credibility

Problematic in the technological and commercial development process is to finance this stage. Legal protection is often supported through the university, but for technological and commercial development, it is difficult to find funding. Public funding is dedicated to fundamental research, and very few private financial bankers invest in such early stage idea, in an unpredictable and instable high-tech market, conducted by researchers with often low entrepreneurial capabilities. This is called the 'financing gap' and is undoubtedly the key problem to overcome in order to finalize these projects (Reitan, 1997). In figure 2.7, the financing gap or "equity gap" is displayed.

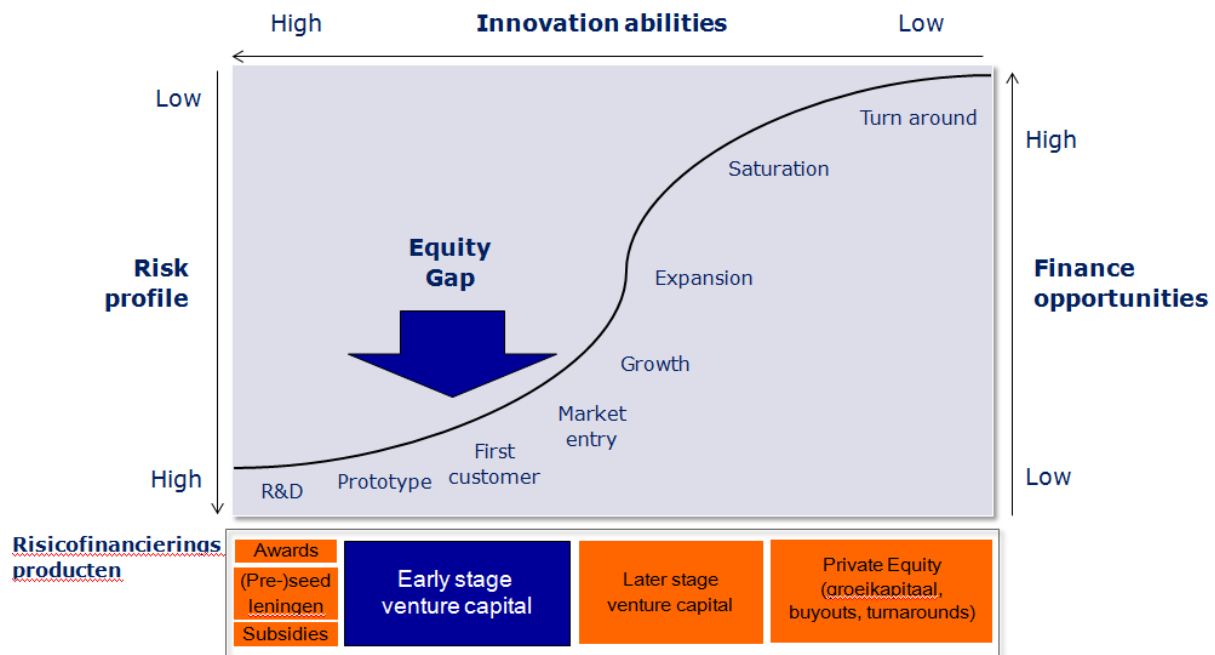


Figure 2.7. “The equity gap” (Rabobank, 2010)

Unresolved resources weakness, deficient social capital and inadequate entrepreneurial capabilities from the opportunity framing and pre-organization phase are important factors at this juncture. Financial investors want proof of market, proof of concepts and the entrepreneur credentials. The difficulty for the entrepreneurs in this matter is that apart from intangible technological assets in the form of know-how and intellectual property, there is often very little else to demonstrate beside their own published scientific research (Vohora et al. 2004).

4. Sustainable returns

When a company is able to exploit its technological assets commercially, the challenge that a USO faces is to create sustainable returns. The entrepreneurial team should be able to re-configure existing resources, capabilities and social capital with new information, knowledge and resources. The existing resource weaknesses, inadequate capabilities and social liabilities should be re-configured into resource strengths, distinct capabilities and social capital that will enable the USO to generate returns. If the team is capable of doing that, the company can create value. At this stage, resource weakness, inadequate capabilities and social liabilities from decisions made earlier in the development process may now be too difficult to overcome (Vohora et al. 2004). At this stage, the team will likely be professionalized. Clarysse & Moray (2004) identify the problem in expenses of hiring an outside CEO. They suggest therefore hiring a ‘coach’ along the development process, so that the entrepreneurial team develops itself. During this process the venture champion is likely to become the CEO.

These junctures will be the input for the theoretic framework on critical junctures. In paragraph 2.5, table 2.4 the critical junctures are summarized. In the next paragraph, the factors to overcome these junctures will be listed.

2.3 Overcoming the critical junctures

In this paragraph the factors that help USOs to overcome their critical junctures will be explained. The resource based view (intangible and tangible factors) and the social capital theory are taken into account. In the on-going Ph.D.-project of Hanieh Khodaei, human capital, social capital and financial capital are identified as main concepts of USOs in overcoming the critical junctures. These concepts were also identified during the discussion on the models of Vohora et al. (2004), Ndonzuau et al. (2002) and Clarysse (2004), summarized in table 2.4, and will be discussed shortly in the following sub-paragraphs. Due to time constraints, we systematically refer to Khodaei (2011) for a more detailed explanation.

2.3.1 Human capital

Human capital involves the stock of knowledge and skills that exist within individuals (Becker, 1964 according to Wright et al. 2007). It can be developed overtime and transferred between individuals, which differentiates human capital from other individual characteristics including personality traits, which have been found to have less impact on entrepreneurial outcomes. Many articles have shared the assumption that employees with more human capital, in the form of education and experience, are more productive than comparable employees in high technology firms (Wright et al. 2007).

Following Khodaei (2011), human capital can be stated to be of significant importance for academic spin-offs at individual level and at team level.

At individual level of members in the management team:

- Prior domain specific research experience. The domain specific research experience of members of the management team relates to the number of years of research experience in a specific field (Khodaei, 2011).
- Entrepreneurial experience. Individuals with start-up experience are beneficial to academic spin-off growth (Scholten, 2006) and evaluate more market opportunities (Gruber et al., 2008). And pre-ownership is positively related to the venture's performance if the business was connected to the experience gained in the entrepreneur's previous firm (Chandler, 1996).
- Industry experience. Industry experience can be important at individual level because they can adapt easier to the habits of that specific industry (Chandler, 1996).

At team level, members of the management team as a group:

Composition and diversity of the members of the management team as a group. A diverse management team can complement each other, which can result in more effective decision-making (Scholten, 2006). Three types of diversity, which are reflections of prior knowledge, can be distinguished:

- Tenure diversity. Tenure diversity is the diversity of moments that team members enter the spin-off. Because some members join the team at a later moment, they are not constrained by previous thoughts or experiences and bring new views and perspectives to the discussion on strategic actions (Khodaei, 2011).
- Function diversity. Functional diversity means that team members span more and different functions. Diversity of functions makes the execution of the various tasks more effective (Khodaei, 2011).
- Industry diversity. Industry diversity are the differences in the industry experiences that team members have gained before working in the spin-off. This can result in different opinions and beliefs of how to act, to compete and to approach business partners.

A much more detailed explanation of the above mentioned issues of human capital can be found in the on-going Ph.D.-project of Hanieh Khodaei. A summary of the items can be found in paragraph 2.5 the theoretical framework.

2.3.2 Social capital

“Social capital exists where people have an advantage because of their location in a social structure” (Burt, 2004). Literature differentiates between bridging and bonding ties. In the entrepreneurship literature, bridging ties are the most prominent, because of its relevance to the formation of new ventures (De Carolis et al., 2009). Following the research of Khodaei (2011), bridging ties and bonding ties can be of influence for the USOs. Bridging ties with industry can stimulate USOs and increase the company’s awareness to new and commercial opportunities. So, bridging ties stimulate academic spin-offs early growth (Scholten, 2006). Bonding ties with university and facilitators can be beneficial in the early stages and these ties can give the USO access to the network of the university and facilitators. Furthermore, the university can be important as a source of scientific capabilities (Khodaei, 2011). Therefore, social capital can stimulate the following factors:

Bridging ties:

- Industry network
 - o Potential clients/customers
 - o Potential markets
- Commercial knowledge

Bonding ties:

- Academic network
 - o Scientific capabilities
 - o Network of university/facilitator

Here again, it must be stated that a more detailed explanation of social capital, bridging and bonding ties, can be found in the on-going Ph.D.-project of Hanieh Khodaei.

2.3.3 Financial capital

The ability to attract financial capital is critical in the development process of a USO. All the models detailed in this research stretched the importance this ability. Especially between the pre-organization and the re-orientation phase, the model of Vohora et al. (2004) shows that attracting financial resources can be problematic. Also in the model of Ndonzuau et al. (2002) attracting financial resources is critical in the technological and commercial development process. Clarysse et al. (2004) recognized the importance of financial resources when forming an entrepreneurial and managerial team during the development process.

There are several options for USO to attract finance. According to Wright et al. (2006), the most important sources of finance for USO companies are:

- Bank debt
- Founder’s own savings or capital
- Licensing deals, business angels
- University challenge fund money
- Joint ventures between the university and an outside firm
- University’s own funds
- Government grant
- Venture capital

The difficulty for the USO companies is to convince the investors to invest in their company. Important in this matter is on what factors do the investors select the USO companies to invest in. Wright et al. (2006) investigated the view of venture capitalists on factors leading to rejection of investment proposals:

- Size of potential market for applications of the technology
- Stage of development of the product/service
- Availability of a prototype/test data to demonstrate proof of concept
- Difficulty in identifying key decision makers
- Lack formalised university technology transfer procedures
- Requirement for service development to support customers who will use the product/service
- Concerns over co-investing with public sector funds
- Concerns over co-investing with universities
- Joint ownership of the intellectual property rights with universities

Looking at these factors, clear communication with investing companies/organizations and a well-established agreement with the university/parent organization on ownership and intellectual property rights are important.

Other resources to lower the need of financial resources can also be important in the development process. Resource that can be valuable to high-tech USOs are accommodation, office space, lab access and access to equipment. In paragraph 2.4, the role of the facilitators with regard to these items and financial capital will be discussed.

2.4 Facilitators

That the factors for overcoming the critical junctures are discussed in the previous paragraphs, this paragraph will focus on the supportive organizations which can provide or stimulate these factors. Firstly the regional clusters will be explained shortly and secondly the facilitators will be explained.

Regional clusters

The Dutch ministry of Economische zaken, Landbouw en Innovatie (EL&I) indicates clusters as important areas to stimulate innovation and entrepreneurship. The coalition in the Netherlands is positive about the innovativeness of the clusters like Food Valley in the Gelderse Vallei and Brainport around Eindhoven (Wubben & Batterink, 2011). Regional clusters can be defined as a group of companies and institutes in a specific field, clustered in a geographical area through common and complementary elements (Porter 2000, according to Wubben & Batterink 2011). Within these clusters, USO companies are important for the valorization of knowledge and the innovativeness of the region. These companies are supported by organizations such as the university, incubators and other organization focused facilitating USOs in their way to become successful and be of importance for the region.

The supportive companies providing facilities are in this research referred to as ‘facilitators’. These organizations will be discussed in the remainder of the paragraph.

Facilitators

In this research the term ‘facilitator’ is used for all the organizations that support USO companies during the development process. A university has often a technology transfer office or incubator to support the USO companies in the very early stages and it is widely believed that these organizations contribute to the development of new USOs (Mian, 1997). Other public organizations and private organization outside the university can also support USOs during their development process. They will also be of interest in this research.

The university plays an important role in spin-off creation process and the early stages of an USO and will be researched on their policy. Universities need to address five major areas to provide an environment capable of supporting academic entrepreneurs (Reitan, 1995):

1. A policy statement from the university on all technology transfer issues
2. Fostering a supportive attitude in administration and colleagues
3. Business training for academics
4. Flexible contract and concern for intellectual property fights
5. Provision of seed capital funding

In assessing the spin-off programs from the universities, these five areas can be used to give an overview of the policy of the university towards USOs.

The universities in e.g. the regions of Brainport Eindhoven, Food Valley and Delft all have organizations within the university that stimulate the USOs in the development process. Van Burg (2010) identified the supportive activities that these organizations should have. In table 2.1, these activities are shown.

1. Screen technologies and ideas for new ventures, and subsequently provide spin-offs with advice and coaching from skilled people	<ul style="list-style-type: none"> - Develop programs targeted to the emergence of entrepreneurial ideas within the faculty and among students - Set goals for spin-off creation and develop (weak versus strong) criteria for screening ideas and plans accordingly - Create start-up teams with the right mix of entrepreneurial skills and technological knowledge - Support academic entrepreneurs in the start-up process - Coach the start-up team, giving them time and freedom to learn
2. Develop clear rules and procedures governing the exploitation of university-assigned technology	<ul style="list-style-type: none"> - Allow exclusive licensing to entrepreneurs - Allocate a lower share of royalties to inventors - Permit spin-offs to use university resources - Develop clear procedures governing exploiting university-assigned technology - Make disclosure of inventions by faculty mandatory
3. Provide spin-offs, throughout their development, with sufficient access to different sources of capital	<ul style="list-style-type: none"> - Create university funds to support students and faculty in the orientation (pre-seed) stage - Create ways to obtain significant amounts of industry funding - Facilitate access to subsidies and other governmental grants - Permit equity investments in spin-offs
4. Create a network of investors, managers and advisors around spinoffs	<ul style="list-style-type: none"> - Create networks for the spin-off to integrate in industry and to acquire access to resources - Create networks with financiers (e.g., venture capitalists, business angels and banks) - Build long-term partnerships with other key agents to support spin-offs - Cultivate the prestige of the university to gain access to external resources for the spin-off
5. Provide spin-offs with support services, but avoid too much embeddedness of these services in the academic environment	<ul style="list-style-type: none"> - Provide licensing offices with skilled staff and abundant resources - Establish physical support infrastructures (e.g., incubators and science parks), but avoid too much embeddedness in the academic environment - Create a decentralized support infrastructure to secure a sufficient level of autonomy
6. Shape a university culture and reward system that reinforces rather than discourages entrepreneurial behavior	<ul style="list-style-type: none"> - Provide faculty with entrepreneurial programs - Develop a clear career-reward structure that stimulates entrepreneurial activities - Create an appropriate mix of incentives targeted to the research group and to the individual researcher(s) - Present successful academic entrepreneurs as role models - Be flexible in dealing with entrepreneurship matters (no 'one-size-fits-all' solution)

Table 2.1. Support activities of organization within the university (source: Van Burg, 2010)

Chan and Lu (2005) did not only identify supporting activities for organizations within the university, but also other organizations that can provide support to USO companies. In table 2.2, these activities are shown.

Pooling resources	Organizing staff training and development activities, marketing events, exhibitions, press conference
Sharing resources	Sharing laboratory facilities, office equipment, testing equipment, administrative support (e.g. meeting room, library, reception area)
Consulting/ counselling services	Provision of legal, accounting, business, technical advices at low cost (or free-of-charge)
Public image	Image of the Science Park/University/Government
Networking	Access to clients/suppliers/subcontractors, partnership opportunity with other technology firms within the incubator, knowledge sharing/ dissemination
Clustering	Development of a pool of skill labour, externalities from logistics arrangement, externalities from supporting network (e.g. emergence of complementary industry)
Geographic proximity	Access to market, research centre, universities
Costing	Rental subsidies, subsidies on telecom/computer network access, other subsidies related to cost reduction
Funding	Access to venture capital (VC) funding, banking facilities, other funding sources

Tabel 2.2 . Supporting activities of organizations to USOs (source: Chan and Lu 2005).

From the outcomes in tables 2.1. and 2.2 the research of Khodaei (2011), the main supporting activities are identified which can stimulate USO companies in their development process. Also with some complementary advice from a facilitator in the region of Food Valley, the following supporting activities are identified:

Finance

- Loan: provide a loan to the USO or make a connection to financial investors
- Subsidies: provide or introduce them to subsidies
- Venture capital: provide or introduce to a venture capitalist

People

- Recruit / train founders for the entrepreneurial / management team
- Recruit / train employees for the entrepreneurial / management team

Information

- Provide scientific knowledge or make a connection to scientific knowledge
- Provide commercial / industrial knowledge or make a connection

Accommodation

- Provide or make a connection to office space
- Provide or make a connection to equipment
- Provide or make a connection to lab access

Clients

- Provide contacts with potential customers through their network
- Provide references to potential markets through their network

These supporting activities will be used for the case studies, which is described in paragraph 3.2.1.

In this paragraph all the factors that can help USOs in overcoming their critical junctures were discussed. Human capital, social capital and financial capital stimulate USOs in overcoming their critical junctures. Facilitators can play a role in overcoming the critical junctures by providing finance, people, information, accommodation and clients. Before moving on to the methodology, the next paragraph will provide concluding remarks on the growth stages, critical junctures and factors in overcoming the critical junctures.

2.5 Concluding remarks

The models of Vohora et al. (2004), Ndonzuau et al. (2002) and Clarysse (2004) are discussed. This paragraph summarizes the models into a theoretical framework that forms the basis for the interviews questions.

2.5.1 Growth phases

The structure of five phases from Vohora et al. (2004) is used, complemented by the models of Ndonzuau et al. (2002) and Clarysse (2004). In table 2.3 each phase is explained shortly and the main activities are listed. The table summarizes the models discussed in paragraph 2.2.

<i>Phase</i>	<i>Description</i>	<i>Activities</i>
Research	The main focus of the academics is to run academic research and publish their work, until the business opportunity is recognized ^{1a,3a,b} . The project team of technical researchers is formed ^{2a} and the intellectual property is created ^{1a} .	<ul style="list-style-type: none"> - Recognition of opportunity^{1a,3a,b} - Project team is formed^{2a} - Intellectual property created^{1a} - Business proposal writing^{2a, 3b}
Opportunity framing	The academic and involved persons will examine if the opportunity has enough underlying value to proceed with the commercialization. The opportunity will be framed in a commercial environment by identifying the potential markets, the applications for those markets, and how to access the customers ^{1a,b, 3a,b} .	<ul style="list-style-type: none"> - Interaction with facilitators and scientists^{1a} - Examine the opportunity on commercial value^{1a, 3b} - Identification of markets^{1a, 3b} - Analysing applications for the markets and^{1a}, - how to access the customers^{1b, 3b} - Interaction with customers, potential investors and industry^{1b, 3b} - Increase networks^{1a,b}
Pre-organization	The entrepreneurial team is formed ^{2b} . The team can develop and start to implement strategic plans. Decisions will be taken on what existing resources and capabilities to develop, what resources and knowledge to acquire now and in the future, and when and where to access these resources and knowledge ^{1b,c} . This requires entrepreneurial experience, human capital and access to networks of expertise at a premium ^{1c} .	<ul style="list-style-type: none"> - Entrepreneurial team is formed^{2b} - Develop and start implementing strategic plans^{1b, 3c} - Take decisions on resources and knowledge to acquire now and in the future^{1b, 3c} - Find out how to access the resources and knowledge^{1b, 3c} - Legal protection^{3c} - Prototype^{3c}
Re-orientation	The USO has sufficient resources and credibility to start-up the business and is trying to generate returns by offering something of value to the customers. In this phase, the entrepreneurial team faces the challenge of identifying, acquiring and integrating resources and then subsequently re-configuring them. The success of progress in this phase is to a large extent	<ul style="list-style-type: none"> - Start-up the company^{1c, 2c, 3d} - Information gaining from customers, competitors and suppliers^{1c} - Re-configure resources, for example^{1c,d}: <ul style="list-style-type: none"> o Target new customers^{1d} o Changing the management team^{2c}

	dependently upon the preparatory work done during the previous phases ^{1c,d} .	
Sustainability	The USO has addressed many uncertainties. Typically, the company moves from the university campus to a commercial environment. It will almost certainly retain close links with the university, although it has its own commercial identity and self-sufficiency ^{1e} . In this phase, the management team will be professionalized gradually ^{2c} .	<ul style="list-style-type: none"> - Leaving the university's campus^{1e} - Gradually professionalizing the management team^{2d} - Orientation on new markets / 2 or 3 product lines^{1e} - High turnover^{1e} - New geographic territories^{1e}
¹ Vohora et al. (2004), ² Clarysse et al. (2004), ³ Ndonzuau et al. (2002),	^{1a} p. 151 ^{2a} p. 64 ^{3a} p. 283	^{1b} p. 156 ^{2b} p. 65 ^{3b} p. 284
	^{1c} p. 157 ^{2c} p. 69 ^{3c} p. 285	^{1d} p. 158 ^{2d} p. 73 ^{3d} p. 286
		^{1e} p. 159

Table 2.3. Theoretical framework: growth stages

2.5.2. Critical junctures

For the critical junctures, the structure of Vohora et al. (2004) is used, complemented by the models of Ndonzuau et al. (2002) and Clarysse (2004). The framework is displayed in table 2.4. The table summarizes the critical junctures discussed in paragraph 2.2 and factors in overcoming the barriers from paragraph 2.3.

Critical juncture	Description	How to overcome
1. Opportunity recognition	<p>It is the ability to synthesize scientific knowledge with an understanding of markets that is enhanced significantly by higher levels of social capital in the form of partnerships, linkages and other network interactions^{1a, 3a}.</p> <ul style="list-style-type: none"> - Lack of prior knowledge about how markets and industries operate^{1e} - Inability to understand how technical discovery can be applied^{1e} - Lack of encouragement to think commercially and behave entrepreneurially^{1e} 	<p><i>Social capital</i></p> <ul style="list-style-type: none"> - Partnerships^{1a, 3a} - Linkages^{1a, 3a} - Network interactions^{1a, 3a} <p><i>Human capital</i></p> <ul style="list-style-type: none"> - Prior business experience^{1a}
2. Entrepreneurial commitment	<p>Uncertainties related to apply a technology in a specific market niche or to move forward the company beyond the concept stage require the full-time and total commitment of the inventor. In this critical juncture the firm has to find out the venture champion, with the necessary entrepreneurial capabilities who can make a solid commitment to developing the company into an established^{1b, 2a}.</p> <ul style="list-style-type: none"> - Lack of self-awareness over personal limitations^{1e} - Inability to accept risks, and tolerate 	<p><i>Social capital</i></p> <ul style="list-style-type: none"> - Deep network with financiers, surrogate entrepreneurs and industry^{1b,c} <p><i>Human capital</i></p> <ul style="list-style-type: none"> - Prior entrepreneurial experience^{1b} - Commercial expertise^{1b} - Surrogate entrepreneurs^{1b} - Entrepreneurial

	<p>uncertainty^{1e}</p> <ul style="list-style-type: none"> - Little prior business management experience^{1e} - Inability to obtain and leverage social capital through networks^{1e} 	<p>capabilities^{1b}</p> <p><i>Financial capital</i></p> <ul style="list-style-type: none"> - Pre-seed finance^{1b}
3. Threshold of credibility	<p>To gain access to and acquire an initial stock of resources, which are required for the business to begin to function^{1b, 3b}. The lack of credibility constrains the entrepreneur's ability to access and acquire key resources: seed finance and human capital to form the entrepreneurial team^{1b}.</p> <ul style="list-style-type: none"> - Inability to attract finance from investors^{1e, 3b} - Inability to secure quality human resources to form a well-balanced managerial and scientific team^{1e, 2b} - Inability to generate or show a clear route to revenues and profitability in order to attract financial resources^{1e} - Inability to achieve proof of concept and evolve the technology to a state of market readiness^{1e} - Lack of depth and breadth in the technology portfolio to provide sufficient long-term options for commercialization^{1e, 3b} 	<p><i>Financial capital</i></p> <ul style="list-style-type: none"> - Seed finance^{1b} - Venture capital^{1b} <p><i>Social capital</i></p> <ul style="list-style-type: none"> - Network with suppliers and venture capitalists^{1b} - Collaborative agreements with existing firms^{1b} - Access to surrogate entrepreneurs^{1b, 2b} <p><i>Human capital</i></p> <ul style="list-style-type: none"> - Prior industry experience^{1b}
4. Threshold of sustainability	<p>The entrepreneurial team should be able to re-configure existing resources, capabilities and social capital with new information, knowledge and resources. The existing resource weaknesses, inadequate capabilities and social liabilities should be re-configured into resource strengths, distinct capabilities and social capital that will enable the USO to generate returns.</p> <ul style="list-style-type: none"> - Inability to manage growth through the identification, acquisition and integration of resources and capabilities^{1e, 2b} - Inability to recognize opportunities and threats and make strategic decisions under pervasive uncertainty^{1e} - Inability to gain traction and build momentum in the market through generating sufficient sales and capturing market share^{1e} - Inability to employ resources and develop capabilities to acquire speed to market^{1e} - Inability to attract and secure next round finance from existing and new investors^{1e} 	<p><i>Human capital</i></p> <ul style="list-style-type: none"> - Entrepreneurial capabilities^{1d}
<p>¹Vohora et al. (2004) ^{1a} p. 160 ^{1b} p. 164 ^{1c} p. 171 ^{1d} p. 167 ^{1e} p. 169</p> <p>² Clarysse et al. (2004) ^{2a} p. 65 ^{2b} p. 71 ^{2c} p. 74</p> <p>³ Ndonzuau et al. (2002) ^{3a} p. 284 ^{3b} p. 286</p>		

Table 2.4 Theoretical framework: critical junctures

3. Methodology

This chapter discusses the method for data-gathering that has been chosen and the data sources that were selected and realized. Also the operationalization, data collection and method of analysis are discussed in this chapter. First, the research methods are discussed, second, the data sources are motivated, third, the operationalization is discussed, fourth the data collection is discussed and finally the method of analysis is discussed.

3.1 Research methods

Desk research

This research method is used by investigating existing literature to gain insight in existing theories in the field of interest (Verschuren en Doorewaard, 2003). Scientific publications that are published by other scientists are used. The literature study of chapter 2 is the outcome of the desk research. An advantage of desk research is the possibility to collect a large amount of data in a relatively short time span. A disadvantage is that the data might be collected for a different purpose (Verschuren and Doorewaard, 2003). The three models researched at the literature study focus specifically on the process of USO development. The model of Vohora et al. (2004) focuses on the junctures in the life-cycle process from a USO's point of view, the model of Clarysse et al. focuses on the managerial aspects of a USO in the development process from a USO's point of view and the model of Ndonzuau et al. (2002) focuses on the development process of a USO from the point of view of a university.

Case studies

Qualitative research can be used to get a rich understanding of a certain process (De Vaus, 2002). It enables the possibility to achieve depth, elaboration, complexity and a sound foundation with a minimum of uncertainties (Verschuren and Doorewaard, 2003). Qualitative research in the form of case studies enables the researcher to gain a profound insight into several objects or process (Verschuren and Doorewaard, 2003). Explorative research is useful because empirical evidence on the development process of USOs is limited. Through this explorative research, the phases, critical junctures and factors for overcoming the critical junctures for the selected regions will be detailed. According to De Vaus (2002), a well-designed case study will avoid examining just some of the elements of the case, the elements will be examined holistic. This creates a whole picture of the development process of USOs by taking information from many perspectives into account. The consequence of a case study is that only a small number of cases will be selected and examined (De Vaus, 2002).

3.2 Data sources

3.2.1 Selection of facilitators

For the research, the regions of Brainport Eindhoven, Food Valley and Delft are selected because of their high-tech orientation and the presence of a high-tech university. Moreover, the selection is based upon contacts present in the research team with the universities and facilitators in these regions. For the purpose of the research, it is crucial that the representatives of the facilitators that will be interviewed have an extensive view on the development process of USOs. Through the contacts, the

persons were identified as far as possible on forehand. Using snowball sampling, other key persons were identified.

A facilitator should provide at least one, and, preferably several of the following support activities to USOs (derived from paragraph 2.4):

- Finance
- People
- Networks
- IP-support
- Coaching
- Knowledge
- Clients
- Accommodation
- Reputation/endorsement

In paragraph 2.1.1, the following definition of a USO is formulated: a commercial company from which the intellectual property as well as the founder or founders must come from a university or academic institution and at which the technology is transferred directly from the parent organization to the spin-off company. In practice, facilitators do not always make a clear distinction between high-tech spin-offs from universities/academic institutes, research institutes and research institutes from established companies or a combination. Facilitators often provide support for all of them. To avoid this grey area, at the beginning of the interview, we asked to keep in mind only spin-off companies from academic institutes and research institutes when answering the interview questions.

The regions of Brainport Eindhoven, Food Valley and Delft can be seen as individual cases. On forehand, in the ideal situation, the following persons were selected to be interviewed in each case:

- Representative from supportive organizations (3)
- Intellectual property manager from the university (1)
- Representative from a venture capitalist (1)

Representatives from supportive organizations can be all organizations that support the spin-off companies with a least one of the above mentioned support activities. In each case, the three most important organizations are selected on the basis of the contacts with spin-off companies and the scope of activities that they provide for them. One intellectual property manager from the university is selected to know the university's policy towards patents and spin-off companies. And a venture capitalist is selected on the basis of the financial support they provide for the USO companies and the selection criteria they have towards these companies. For the three cases, this will bring a total of 18 interviews. Next to the facilitators, in the ideal situation, an interview with a scientific (serial) entrepreneur was planned. In the next sub-paragraph, the realized interviews are listed.

3.2.3 Interviews with facilitators

In total, 17 interviews are realized with facilitators. From these 17 facilitators:

- 12 support the USO in various ways;
- 3 focus explicitly on IP management;
- 2 mainly provide venture capital to the companies.

In figure 3.1, an overview of the interviewed facilitators is given. In Food Valley, an interview with 5 facilitators was conducted, including 1 private facilitator, of which the managing director is a scientific serial entrepreneur. And an interview with a venture capitalist and the IP manager of Wageningen UR

was held. In the region of Brainport Eindhoven, interviews were conducted at 5 facilitators, 1 venture capitalist and 1 IP manager from TU Eindhoven. In the region Delft, an interview with 2 facilitators, 1 IP manager of TU Delft and a venture capitalist (with overlapping regions Food Valley and Delft) was conducted.

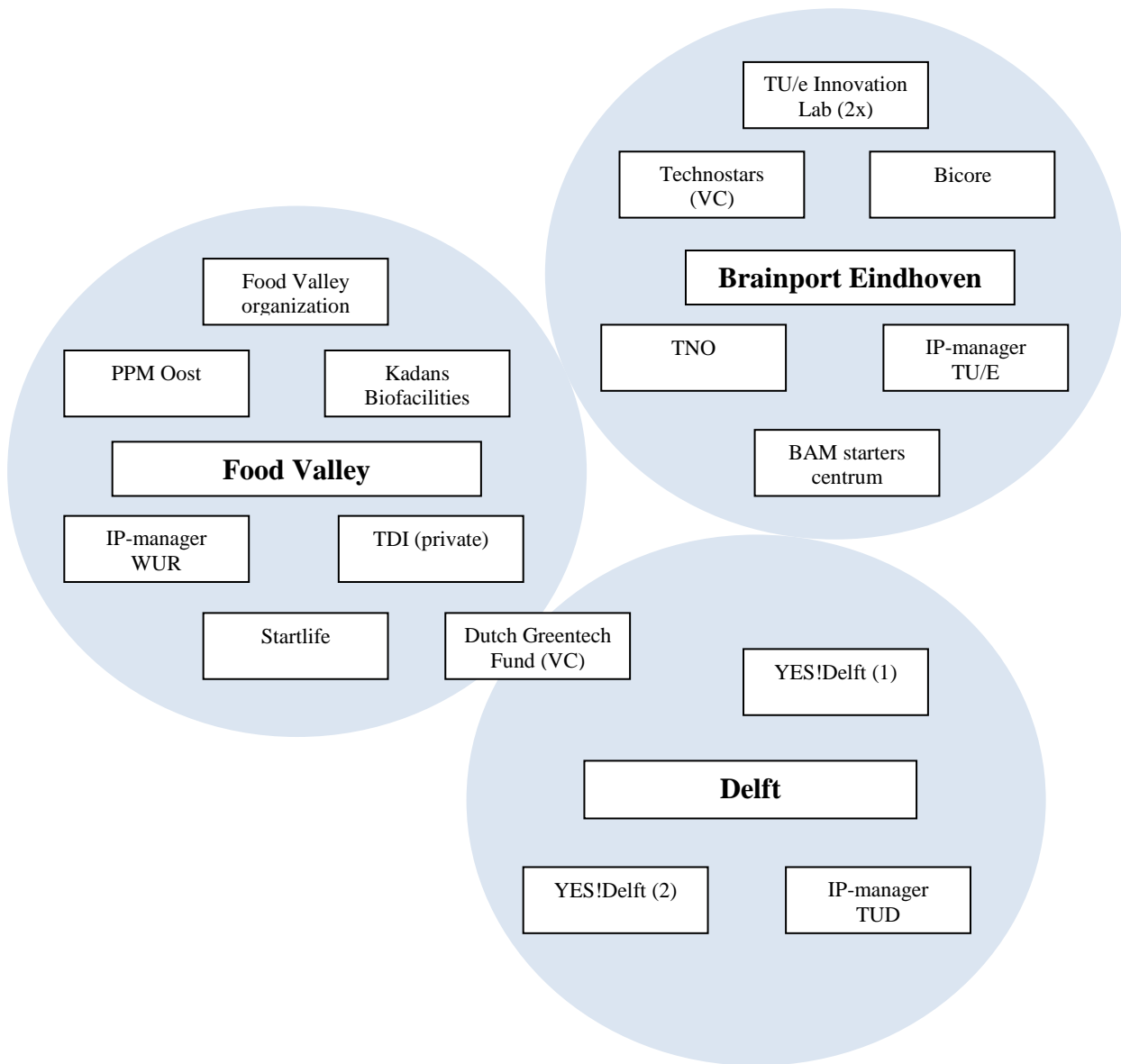


Figure 3.1. Interviewed facilitators in selected regions

The ideal situation of a minimum of 3 supportive facilitators in Delft was not reached, because only 2 interviews were conducted. The ideal situation of the IP manager was in every region 1, which was reached. For the venture capitalists, 1 venture capitalist is active in both Food Valley and Delft and consisted of one interview, covering both regions. The other venture capitalist is active in Brainport Eindhoven. A total overview with information on facilitators and interviewed persons can be found in appendix 6.

3.2.3 Selection of companies

The main part of the data-gathering consists of interviews with the facilitators. Complementary to this are the interviews with USO companies. During the interviews with facilitators, they were asked to name three successful spin-off companies. We asked them to name successful spin-offs, because we want to know what factors made them successful. In each case, three companies that are mentioned the most, or by the most prominent facilitators, are selected for an interview. These companies have to satisfy four conditions:

- Be a new company
- Come from a university / research institute
- Exploit academic research results
- Have a for-profit mission

At the beginning of the interview, these conditions are presented to the facilitators. Furthermore, the facilitator was asked to answer the questions while considering these companies as far as possible. On forehand, in the ideal situation, nine interviews USO companies were to be conducted. In the next sub-paragraph the interviewed companies are listed.

3.2.4 Interviews with companies

Complementary, in total 5 USOs companies are interviewed. As mentioned above, the ideal situation was 9 USO companies, but due to the lack of availability of the founding fathers during the holiday period and the time limitation of the researchers, this number is brought back to 5.

These companies are:

Food Valley

- Nsure (providing maturity tests in agri-business)
- Phycom (technology development in food and feed, specialized in algae)
- Learning Valley (providing interactive rich media, ICT)

Brainport Eindhoven

- Nemo Healthcare (technology in monitoring pregnancy, healthcare)

Delft

- Epyon (fast charging batteries)

Note: Phycom is not a spin-off from Wageningen UR, but founded by an academic and is supported by two facilitators in the Food Valley region.

3.3 Operationalization

The following research questions will be answered from the results case study: 2.1. How do USOs develop overtime (phases)? 2.2. What critical junctures do USOs face during the development process? 2.3. What factors help USOs to overcome the critical junctures?

In table 3.1 the an overview of the connection of research questions, concepts, results from literature study, main sources and interview questions are listed. In appendix 2, the interview guideline with facilitators is presented.

Research question	Concept	Categories literature study	Main sources	Interview questions
2.1	Growth stages (table 2.3)	<ul style="list-style-type: none"> - Idea phase - Opportunity framing phase - Pre-organization phase - Re-orientation phase - Sustainable returns phase 	Vohora et al. (2004) Ndonzuau et al. (2002) Clarysse et al. (2004) Kazanjian (1988)	2, 2a, 4b, 5a, 6a, 7, 9, 12
2.2	Critical junctures (table 2.4)	<ul style="list-style-type: none"> - Opportunity recognition - Commitment - Credibility - Sustainable returns 	Vohora et al. (2004) Ndonzuau et al. (2002) Clarysse et al. (2004) Kazanjian (1988)	4, 4a,b, 7, 7a, 8, 8a
2.3	Overcoming critical junctures (table 2.4)	<ul style="list-style-type: none"> - Human capital - Social capital - Financial capital 	Vohora et al. (2004) Khodaei (2011) Chandler (1996) Van Burg (2010)	1, 5, 5a, 6, 6a, 7a, 8, 8a,b,c,d, 9, 11, 12

Table 3.2. Operationalization

3.4 Data collection

The interview is semi-structured to make sure that all the topics that need to be researched are discussed. Semi-structured interview allow some flexibility to discuss topics in more depth and discuss topics or items not included in the interview. The interview consists of a combination of open-ended questions and closed questions. Questions on growth stages and critical junctures start with an open-ended question to gather a broad picture of the phenomenon. However, questions prompts are used to steer the answer in a certain direction, improving the ability to compare the answers from different interviews. The interviews will be performed by a Master student together with a Ph.D. student.

To improve the internal validity, the method of triangulation is used by interviewing different kind of facilitators. The viewpoints of respondents of universities, public facilitators, a private facilitator/scientific serial entrepreneur and venture capitalists are taken into account. Next to the triangulation, the view of facilitators on the development process of USOs is likely to be more objective than the view of the USO companies on their own development process. Furthermore, these organizations have often several years of experience with USO companies, have of a number of USO companies in their portfolio and have a close relationship with these companies. Next to the facilitators, five USO companies are researched, which also contributes to the internal validity of the research. “By developing a full, well-rounded causal account, case studies can achieve high internal validity” (De Vaus, 2001 p. 234).

Although a high level of internal validity may be reached, this research cannot be generalized to a greater population. Case studies have been widely criticized as lacking external validity (De Vaus, 2001).

The interviews are all conducted face-to-face, with the exception of two interviews which were conducted by telephone because of a lack of the respondent’s time and availability. Two interviews, one of facilitators and one of IP-managers are answered by the same person because of his knowledge and experience on both of the interviews. Overlapping questions were not asked twice.

In preparation for the interview, information about the organization was gathered through for example the website of the organization.

3.5 Method of analysis

The interviews with the facilitators are recorded and transcribed afterwards. For the phases, critical junctures and factors overcoming the critical junctures, a coding list is made according to the literature in order to analyze the data. The coding list is detailed and expanded during the process of analyzing the transcripts. The program of Atlas.ti (Atlas.ti, 2011) is used for coding. This created the possibility of analyzing and detailing the networks of the identified codes. The coding is performed by two people separately and discussed to come to a final version, increasing the trustworthiness.

4. Results

This chapter will present the research results of the case study. As explained in paragraph 3.2, 17 facilitators and 5 USO companies are researched through a semi-structured interview. In paragraph 4.1 the results on the growth stages will be presented, in paragraph 4.2 the critical junctures and in paragraph 4.3 results on factors in overcoming critical junctures will be presented.

The results will be discussed question by question. An overview of the corresponding interviews, questions and items discussed in this chapter is shown in table 4.1. The interview guidelines are attached in appendices 2-5.

	Item:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Facilitators (appendix 2)		Q. 2	Q. 2a		Q. 4	Q. 4a	Q. 7a		Q. 8	Q. 5	Q. 5a	Q. 6, 6a		Q. 1	Q. 11	Q. 12	Q. 13	
Venture Capitalists (appendix 3)													Q. 1- 6					
IP managers (appendix 4)																		Q. 1- 4
USOs (appendix 5)				Q. 1				Q. 2										

Table 4.1. Questions from interview guidelines (appendix 2-5) discussed in result items

4.1. Growth stages

This paragraph presents the results on the growth stages in order to answer research question 2.1. The first two questions are asked at the facilitators. The first question concerns an open question, while the second question relates to the growth stage model from the theoretical framework. The third question in this paragraph is asked at the USO companies in order to discover the time line of the major activities and what activities they have accomplished so far. The results from each region will be taken into account and this will result in a new growth stage model for high-tech USO companies presented in paragraph 5.4.

Item 1

At this item, we asked the facilitators through an open question to describe the process of commercialization in the course of time and the major activities that ideal spin-offs must run until they become well established (question 2, appendix 2). This question is asked to learn the major activities USOs have to accomplish during their development process in order to become successful. The question was answered by 13 respondents. In order to be able to discuss the most important activities, only the 8 activities that were mentioned at least 4 times will be detailed. The activities will be explained in chronological order, based on the interpretation of the researcher on the general order in which respondents named these activities during the interview. An overview of all the activities identified is shown in figure 4.1. Activities mentioned less than 4 times are not discussed in this paragraph. However, they will be considered when deriving an enhanced stage model in paragraph 5.1.

9 respondents identify the 'Business idea' as the starting point of the development process. Respondent 15 describes the very beginning of the USO development process as follows: *"There is an invention. They showed that it should work if they would make it, or they have a mathematic calculation that this should work ... That's where it starts"*.

5 respondents mention 'Identify potential market' as a major activity. Respondent 14 explains by raising the questions: *"Which markets do you see for this product, what is the value for that market, how can you communicate to that market..."* Respondent 13 argues that identifying potential markets should be done before the decision on IP: *"...before you do this you should first do a market research to see if there is some demand for this product and if there are certain market developments"*.

9 respondents identify 'Start product development / prototype' as a major activity. Respondent 17 takes it even a step further, and identifies prototyping as the first phase. In his opinion, at this stage, most founders are not entrepreneurs, but prototype builders. *"They spend all the time getting finance to build a prototype or build their first product ... So that is not really entrepreneurial behavior, but just prototype building"*. Respondent 15 states the next about the costs of prototyping: *"To come to a prototype, depending on the complexity of the machine or the technology, from a few hundred thousand to a few million"*.

6 respondents identify 'Developing a business plan' as a major activity. According to the respondents, the business plan is mostly needed to attract finance from investors. Respondent 6 on this matter: *"With only an idea you can't go to the bank. So, the better the business plan is, the more chance the starter has to find money"*. Respondent 15 recognizes the importance of the process USO companies go through when writing a business plan: *"... going to the process of writing a business plan means going to the process of answering the implicit questions that have to be answered explicitly. ... Also those tough questions about competition, about industry trends, about entry barriers, about legislations, about pricing strategies, whatever"*.

7 respondents identify 'Attracting finance' as a major activity. Respondent 15 has a very clear view on moments of funding during the development process. The first moment of attracting finance is the pre-seed funding which is usually provided by 'family, friends and fools' and the facilitators. The second moment of funding is the seed funding, which involves informal investors. The third moment of funding is early stage finance, which involves venture capitalists. The fourth moment of funding is growth stage finance, which involves either venture capitalists or partners. Financial capital will be further detailed with the results from the venture capitalists at item 12.

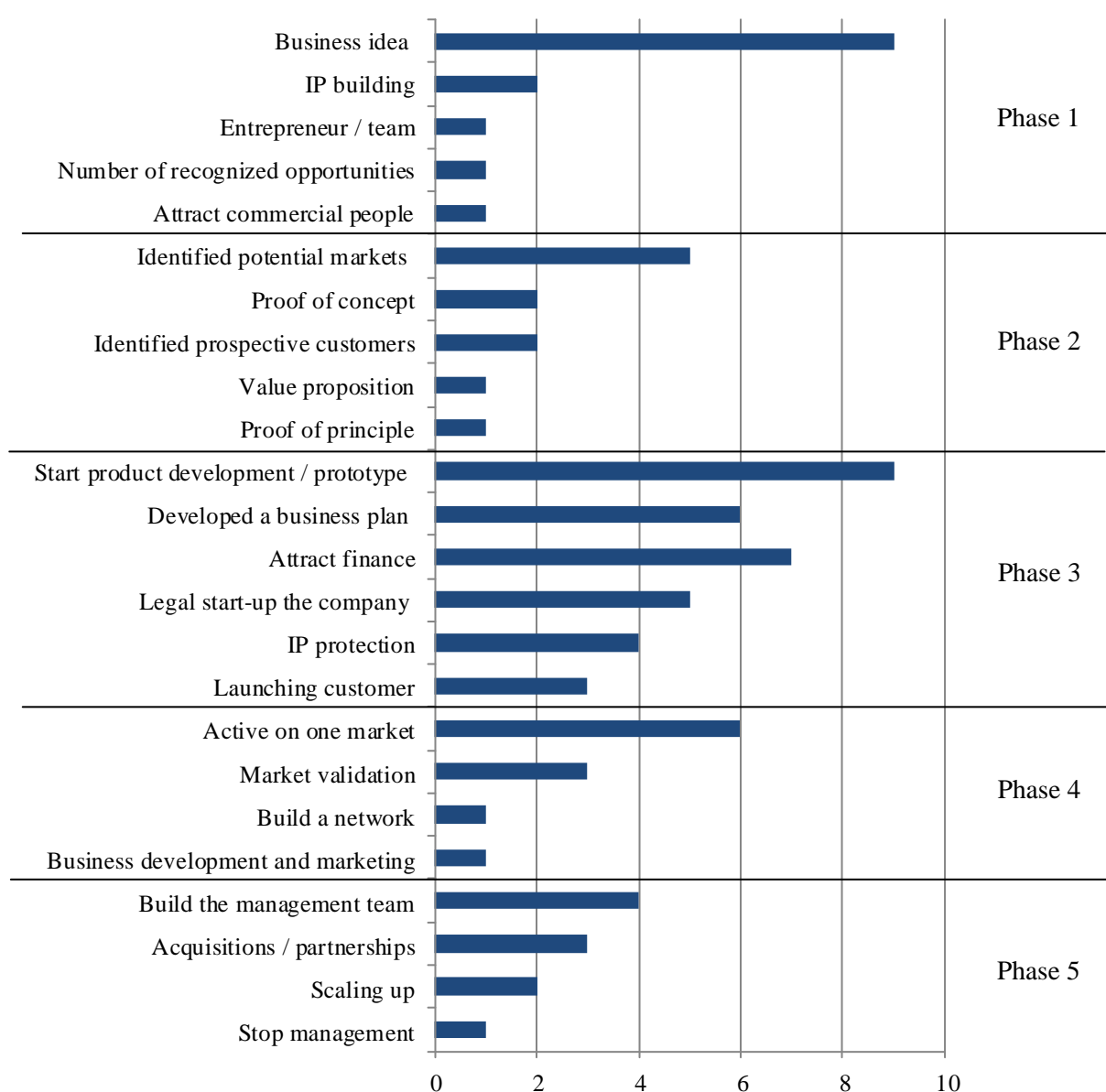
5 respondents identify 'The legal start-up of the company' as a major activity in the development process. They don't consider it as difficult, just necessary. Respondent 2 illustrates the process: *"You have to go to the chamber of commerce and register, then you are an established company. Based on the legal form of entity, you are choosing, this is almost for free. For a limited company it cost 18.000 Euros. Basically this is the only thing to establish a company"*.

4 respondents identify 'Intellectual property protection' as a major activity. Respondent 13 states about the moment of IP protection: *"From the research you come to a point where you say, we should investigate if it is possible to get IP on the idea"*. The number of respondents that identify IP protection as a major activity is relatively low. This can be a result of the fact that the respondents do not always think protection is necessary or wise. During the interview, respondent 9 explains: *"Other people may read the literature and see the patent, and they are sooner than you are"*. Other

respondents also argue during the interview that the companies do not have sufficient means in the early stages to fight against larger companies if they make use of their patent.

6 respondents mention ‘Active on one market’ as a major activity in phase 4. The commercialization phase is also by the facilitators recognized as the phase that the USO is active on a first market.

4 respondents identify ‘Building the management team’ as a major activity in stage 5. Now that the company is getting larger, the management team needs specialized members in the team, such as a CEO, a CFO or a CTO.



4.1. Major activities of USOs in each stage, based on number of times mentioned by facilitators

Item 2

At item 2 we asked for the view of the facilitator on the phases and results in each phase, derived from the theoretical framework (question 2a, appendix 2). This question was asked to validate these stages and, if necessary, adjust the model to the situation of the USO's in the selected regions, taking also the results from question 1 into account. As mentioned, from all the items on growth stages an enhanced model will be derived in paragraph 5.1. Because of that, all comments on the growth stage model are presented at this question. This question is answered by 16 respondents.

General

2 respondents argue that this model should be non-sequential.

1 respondent argues that the organization phase should be renamed into 'development phase'.

1 respondent argues that this kind of model is not possible, because of the high variety of the USO companies. He states: *"So every time there is a new one I think, ok, I'm still surprised that there is another color than all the colors I've seen so far"*. In this respect, 1 respondent argues that this model is just one of the possible models.

11 respondents agree with the model and stages as presented.

The comments and suggestions from the respondents for the results of each phase are next to be.

Phase 1:

3 respondents mention that the 'decision on IP protection' should be added to stage 1.

3 respondents mention that potential market and potential customers should be in stage 1 and that stages 1 and 2 are interlinked to each other. Respondent 8 states: *"As long as you haven't been in touch with your customers, you can hardly say anything about it in your business plan. It is good to have market survey, and that you think you can achieve something in that market with your product. But talking to customers, they are the one who are going to tell you whether or not you can enter the market"*.

2 respondents mention that it is still too early for a project team in stage 1.

1 respondent would like to add finance with 'government support or guarantee' in this stage.

Phase 2:

1 respondent would like to rename this phase to 'concept phase'.

1 respondent argues that the first general business plan should be ready in phase 2.

1 respondent recognizes the potential customers, but takes it a step further, and wants to receive feedback from customers in stage 2.

1 respondent marks that 'potential partnerships' should be in this stage.

Phase 3:

3 respondents mention that a prototype should be ready at the end of phase 2.

1 respondent argues that the result should not be the IP protection, but the outcome of the decision whether or not protect the IP.

1 respondent argues that 'funding for prototyping' should be added.

1 respondent would like to rename this phase to 'seed phase'.

1 respondent argues that a prototype should be tested with launching customers at this stage.

Phase 4:

1 respondent argues that the start of the company could be already earlier to test the product.

1 respondent mentions that performing contract research can be necessary to attract money.

1 respondent would like to add ‘build a formal organization’ to this phase.

Phase 5:

1 respondent argues that the USO should leave the incubator at this stage, not necessarily the campus.

1 respondent argues that hiring a management team is too expensive.

Item 3

The question from this item (question 1 appendix 5) is asked exclusively at 5 successful USO companies, as listed in paragraph 3.2.4. At this question we presented the respondents the 5 phases and 26 results in each phase, and asked at each result if they completed this result and when they completed this result. These results were modified to the view of the facilitators and presented to the USOs to verify the growth stage model at the companies. The achieved activities of each company are presented in table 4.2.

Phase	Result	Company					
		1	2	3	4	5	
Phase 1	1. We identified initial business ideas	X	X	X	X	X	5
	2. We identified our intellectual property	X	X			X	2
	3. We organised the project team	X	X		X	X	4
	4. We protected our intellectual property	X	X			X	2
Phase 2	5. We recognized the market opportunities	X	X	X	X	X	5
	6. We identified applications for our patents	X	X			X	2
	7. We identified potential markets	X	X		X	X	4
	8. We identified a variety of prospective customers	X	X	X	X	X	5
	9. We identified a business model	X	X		X	X	4
	10. We contacted potential investors	X	X		X	X	4
Phase 3	11. We received seed funding	X	X			X	2
	12. We developed a business plan	X	X	X	X	X	5
	13. We tested our prototype	X	X	X	X	X	3
	14. We got venture capital	X	X	X		X	4
	15. We developed our innovation product/service	X	X	X	X	X	5
Phase 4	16. We organise the management team	X	X	X	X	X	4
	17. We brought our product / service to the market	X	X	X	X	X	4
	18. We adapted our product / service	X	X	X	X	X	4
	19. We received reputation on the market	X	X	X	X	X	4
	20. Establishment of competence signals with respect to other market participants	X	X		X	X	4
Phase 5	21. We received some revenue	X	X	X		X	3
	22. We have clear plans to leave the university's campus / incubator / business centre	X	X	X		X	3
	23. We changed the management team with functional specialists	X	X			X	2
	24. We have seen a large increase in our turnover / profits	X	X			X	2
	25. We are expanding our orientation on new markets or with more product lines	X	X			X	2
	26. We are exploring new geographic territories	X	X		X	X	3
Total		20	18	11	16	26	

Table 4.2. Achieved activities in each growth phase, answered by 5 successful USO companies

Company 1 and 5 are already in phase 5, companies 2, 3 and 4 are at the end of phase 4. Notably in phase 1 is that 3 out of 5 successful companies did not identify and protect their intellectual property. These companies also did not need seed funding in the second phase. Although company 3 is almost at stage 5, it did not recognize several activities in the first 4 phases. This can be due to the fact that this company is in ICT, a very dynamic industry, which might enable them to move faster and skip some of the results.

The time line and achieved activities of each company is graphically presented in figures 4.2 on the next page. The y-axis represents the activities 1 to 26 as presented in table 4.1. The x-axis represents the time in months from the moment they identified the first business idea.

Some companies are able to move faster, or are able to accomplish more activities in a short period. That can clearly be seen from figure of company 3, compared to the other 4 figures. These differences are most likely due to the fact that these companies are active in different fields/markets. Company 4 is very fast in achieving the activities. This is most likely because they had a partnership with a private facilitator early on. The companies 1, 2 and 5 show a nice linear pattern. Overall it can be concluded from these patterns that the successful companies do follow the phases identified relatively well.

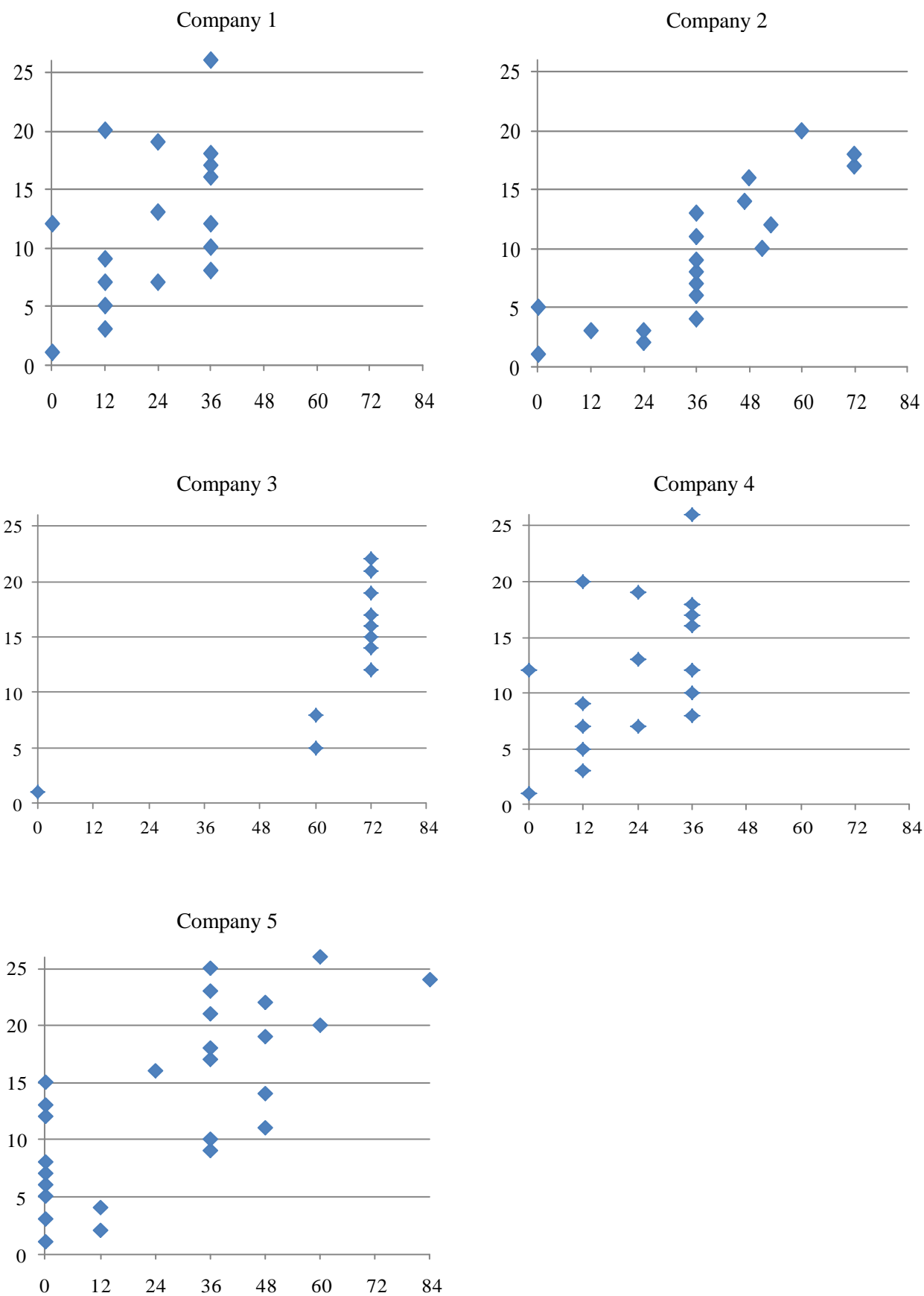


Figure 4.2. Achieved activities (y-axis, 1-26) in time span (x-axis, months) for each company

4.2 Critical junctures

This paragraph presents the results of the questions asked on critical junctures, in order to answer research question 2.2. Questions 3,4 and 5 are asked at facilitators. Question 3 is an open question on the main critical junctures, question 4 identifies the importance of the critical junctures from the theoretical framework during each stage of development and question 5 is a question on explicit examples of failed USOs and the critical junctures they were not able to overcome. Question 6 is asked at the 5 successful companies, investigation the critical junctures they experienced during their development process.

Item 4

At this item, we asked the facilitator through an open question to describe the main critical junctures that USOs go through in their development process (question 4 in the interview). This question is asked to learn the main critical junctures that USOs face. 15 respondents answered this question. In order to be able to discuss the most important critical junctures in detail, critical junctures mentioned at least 3 times will be discussed. An overview of all the critical junctures mentioned by the respondents is presented in figure 4.3.

12 respondents argue that the ‘Inability to attract finance from investors’ is a major barrier in the development process. Respondent 1 recognizes this as a problem especially from the last few years: *“Ten years ago you had a lot of venture capital in the Netherlands, and they were exited of anything that came along and it was quite easy to get funding. But they have not been able to make good returns on early stage companies, so they have really shifted towards later stage or even mature companies”*. Respondent 4 marks that underestimation of time to go through the phases as a cause of this problem: *“Most of the people who start their spin-off are thinking too easy about all the phases that they have to go through. Being a result of this, is that the financial part of the process is always difficult. Because if you take three to four times more time, you need three to four times more money to get to the phase where you want to be, compared to what your initial thoughts were”*. Respondent 12 (venture capitalist) and respondent 15 argue that the multiplier effect of the investors is a problem, which means that companies must be able to show that their company has a lot of potential, to make up for the high risk of these companies. Respondent 12 illustrates this with an example: *“If you look from an investor’s point of view, out of our 10 investments, only 2 are (well, hope to be) successful. If you have 100 euro invested in 10 companies, 2 companies were you invested in 20 euro’s in together, should make up for loss in the others. So it takes a couple of years as well. So you want to have a return on investment, otherwise you could better put your money on the bank. And so every investment should have the potential to earn back a multiple of five. So if I put 10 euro in one company, there should be a look-out to getting 50 to 100 euro back when everything goes right”*. Furthermore, the ‘Inability to attract finance from investors’ is often mentioned for the whole USO development process instead for a specific activity or phase.

9 respondents identify the ‘Lack of entrepreneurial capabilities’ of the founder as a main barrier in the development process. According to the respondents, most academics are too scientific and lack entrepreneurial capabilities. Respondent 5 argues that not all scientist are entrepreneurs: *“The first thing that came to my mind with identifying the problems, ... is the person that wants to start the company, is he really an entrepreneur ... you have a scientist that has an idea, has the knowledge. But not every scientist is an entrepreneur”*. Respondent 9 illustrates why most scientist are not entrepreneurial: *“... the biggest barrier for a scientist is inside. Wanted to know and get to the bottom of things, which costs a lot of money and time”*. Respondent 7: *“Maybe there are some scientists that*

are entrepreneurial, but hardly ever they are entrepreneurs. So you really need a good team to start the spin-off and be the management of the spin-off”. Respondent 7 takes it even a step further and argues that you cannot make entrepreneurs out of scientists: “to me that’s rubbish”.

4 respondents argue that the ‘Inability to form a well-balanced start-up team’ is a major critical juncture. Financially it is difficult to attract qualified people in the early stages and also finding the right people is a problem. Respondent 1 argues: “You need very qualified people that know their functional area, but are also entrepreneurial. That is not an easy combination. You can hire an operative manager from Philips that has done it for 20 year professionally, but once he turns into a start-up it is too slow for him, or the environment is not working for him. It is a difficult combination of entrepreneurship and experience professional expertise”. Respondent 13 argues that it is especially difficult to attract a good CEO. The difficulty to form a well balance team is explained by respondent 13: ... To have not only good technical guys, but to have a good CEO or a good commercial guy who has experience in the market. And it should be someone with experience ... preferably more than 10 years of experience in a business environment”.

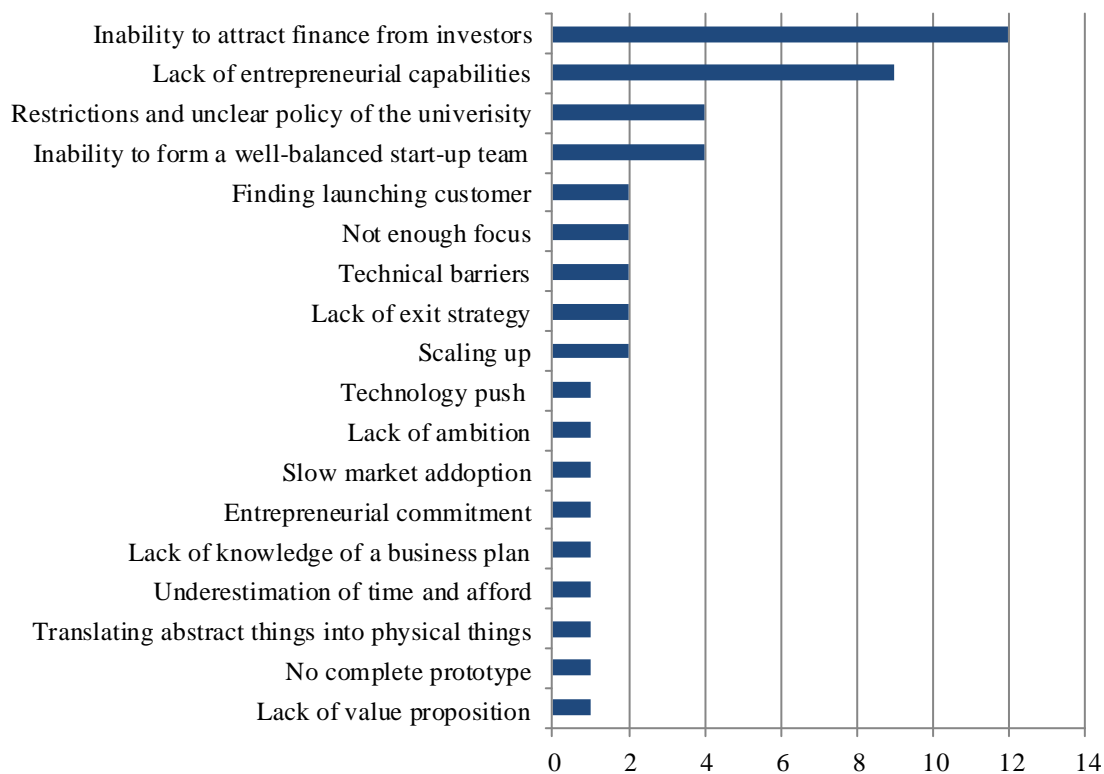


Figure 4.3. Main critical junctures of USOs according to facilitators

4 respondents argue that ‘Restrictions and unclear policy of the university’ is a critical juncture for USOs. Respondent 3 explains: “... does the university allow you to set-up your own company with technology which is in fact owned by the university. ... You have access to nice technology, protected by a patent, but the patent is owned by the university. The IP, as you are an employee of the university, it means it is not your knowhow, it belongs to the university. Respondent 17 argues that the short term policy of the university is the problem: “... sometimes the university is not focused on global impact but on short term returns. Because they are monitored on the fact that they get some IP income. So they prefer to have very fast, within a few years, IP returns and that is not always in the best interest of the company. Respondent 5 argues that if there is an unclear policy, different expectation can even

come to a conflict: “... what is the link or what is the status of the newly started company with the parent organization, the university or the institutes. That is something you have to define at a very early stage, and that is frequently forgotten ... And it is not infrequent, that when the expectation levels are different, the parent organization and the new company, part in a fight”.

Item 5

At this item, (question 4a, appendix 2) the respondent was asked to indicate the importance of the critical junctures from the theoretical framework (paragraph 2.5.2) in each of the identified phases of development (paragraph 2.5.1) from 1 (= not important) to 7 (= critical). 12 respondents answered this question. In figure 4.4, the results from this question are presented.

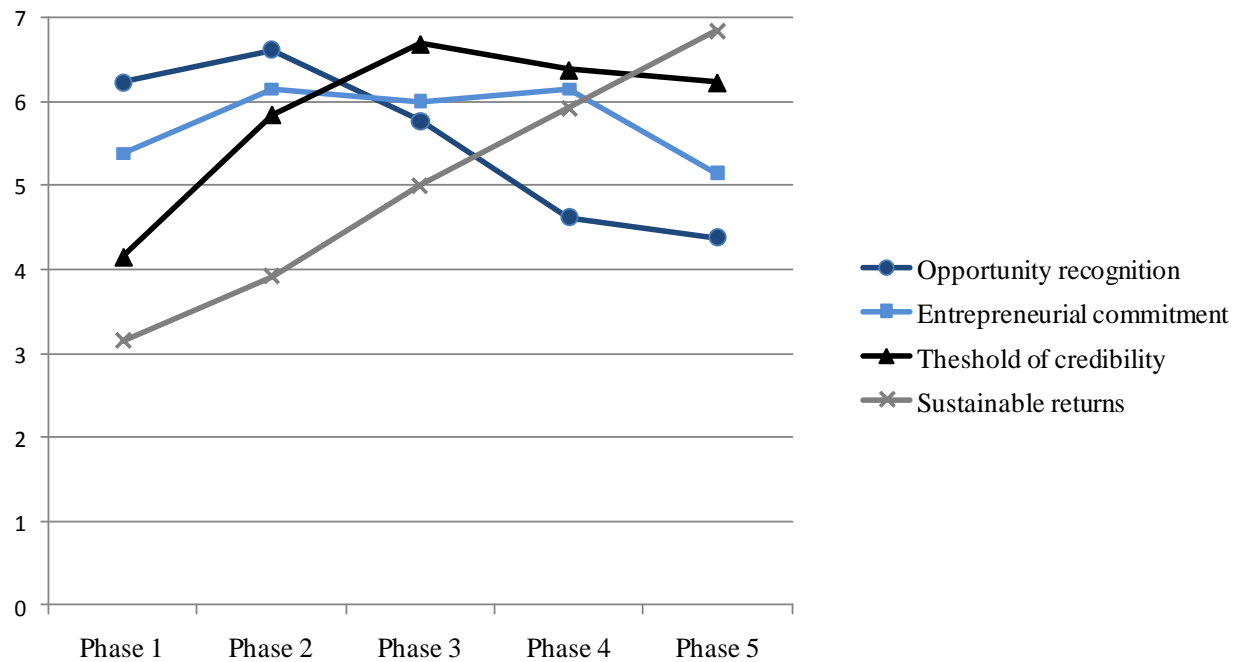


Figure 4.4. Importance of critical junctures for USOs in each phase (1 = not important, 7 = critical) according to facilitators

Opportunity recognition

According to the literature, ‘opportunity recognition’ arises between phase 1 and 2 (paragraph 2.2.5). Figure 4.4 shows that the respondents indicate the opportunity recognition as very important in the first two phases, confirming that this critical juncture occurs in the first 2 phases. The phases 3, 4, and 5 indicate lower values to opportunity recognition, thus lower importance, although the level remains relatively high. This can be a result of respondents identifying other market opportunities for products/services complementary to the initial idea during the other stages of development.

Entrepreneurial commitment

Paragraph 2.2.5 explained that ‘entrepreneurial commitment’ is the critical juncture between phase 2 and 3 according to the theoretical framework. When looking at figure 4.4, the line shows that entrepreneurial commitment remains important throughout the development process. In phase 5, the importance is relatively lower compared to the other phases. The results on entrepreneurial commitment indicate that it is most important in phase 2, in line with the expectation. In phase 3, where also a high value was expected, the importance according to the respondents decreases slightly. In phase 4 the importance increases again slightly when the USO starts commercializing their businesses.

Threshold of credibility

The critical juncture ‘threshold of credibility’ arises when a USO moves from phase 3 to phase 4 according to the literature. Figure 4.4 shows that the juncture is less important in phase 1, becomes more important in phase 2 and respondents indicate that it is almost critical in phase 3, which is consistent with the expectation. In the phases 4 and 5 the importance of this juncture decreases compared to phase 3, but remains very high.

Sustainable returns

According to the literature, the critical juncture sustainable returns arises when moving from phase 4 to phase 5. Looking at the results in figure 4.4, this is confirmed by the respondents through low values at phase 1 and 2 and increasing values during the development process. The respondents recognize that this juncture is very important in the last 2 phases, from very important in phase 4 to critical in phase 5.

Item 6

At this item we asked the respondents to describe the main critical junctures. At this question (question 7a, appendix 2) we asked explicitly to name 3 failed spin-offs, and we let the respondent explain which barriers these spin-offs experienced that made them fail. We asked for explicit examples to increase the objectivity of the results and to learn what exact critical junctures causes the USO to fail. This question was answered by 10 respondents.

Figure 4.5 presents an overview of the critical junctures. In case of 4 failed USO companies, the ‘Inability to attract finance from investors’ was the prime problem, 3 companies failed because of the ‘lack of market validation’, and at each of the following problems, 2 USOs did not overcome the critical junctures of: ‘technical issues’, ‘university’s policy’, ‘lack of entrepreneurial capabilities’ and ‘lack of acquisitions / partnerships’. Critical junctures named only once, as reason of failure are listed in figure 4.5. In paragraph 5.2 of the analysis, the critical junctures at this question will be compared to the critical junctures identified from the theoretical framework and from question 3 of this paragraph.

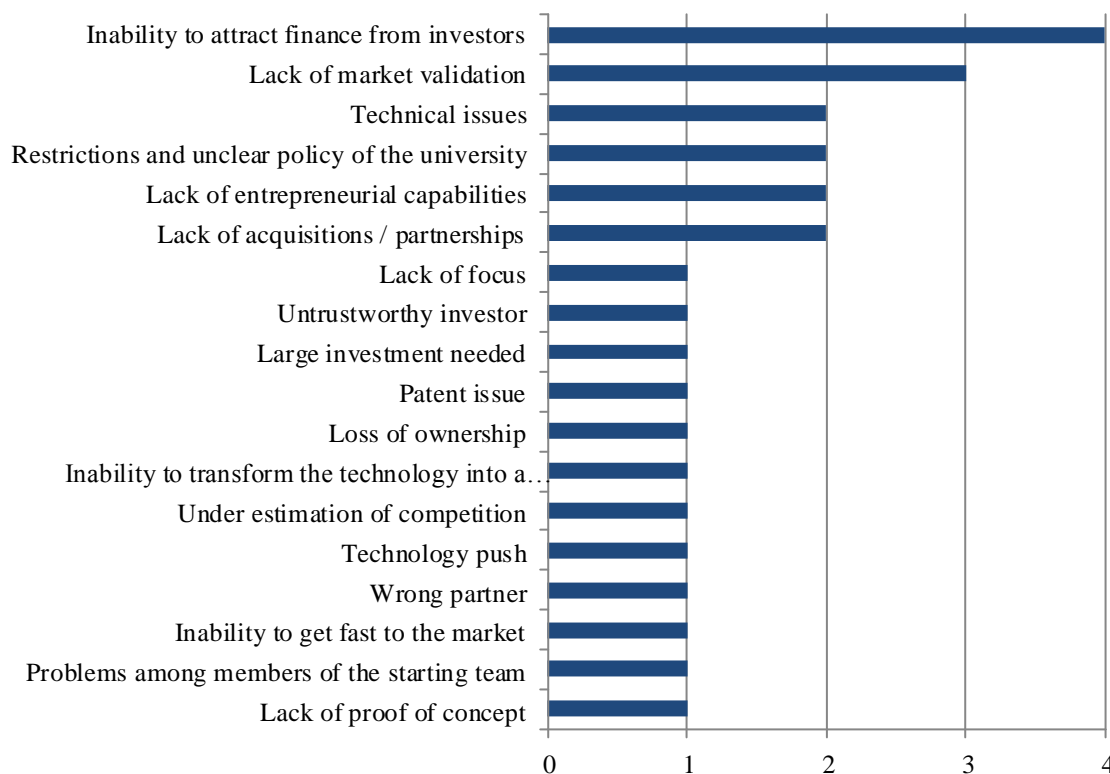


Figure 4.5. Critical junctures that caused a USO to fail according to facilitators by number of times mentioned

Item 7

At this item (question 2, appendix 5), the 5 USO companies were asked to rank per stage how much they agreed with in experiencing the critical junctures from 1 (= completely disagree), to 7 (= completely agree). They ranked the following statements:

Opportunity recognition

1. Inability to translate our initial idea into a business opportunity.
2. We had great difficulty translating scientific knowledge into market opportunities.
3. We had difficulty articulating our value proposition.

Entrepreneurial commitment

4. Inability to run the business and explore the commercial potential of the business opportunity.
5. We were missing essential entrepreneurial capabilities in the management team.
6. We had difficulty putting a solid commitment of some management team members to develop the company.

Credibility

7. Inability to gain access and acquire different resources and developing existing resources for business to begin function.
8. We had difficulty convincing investors.
9. We took a long time to form a well-balanced management team.
10. We had troubles defining sufficient long-term options for commercialization.

Sustainable returns

11. Inability to reach a level of sustainable returns in our company.
12. We had difficulty establishing a stable position in product/market segments.
13. We had difficulty making strategic decisions under pervasive uncertainty.

In figure 4.6, the results are presented. The first 10 statements are assessed from 1 to 7 by all 5 successful USO companies. The statements 11, 12 and 13, representing the critical juncture sustainable returns, are assessed by 2 companies because the other 3 companies did not reach that phase so far (as shown in table 4.1). The 5 successful companies experienced the critical junctures opportunity recognition, entrepreneurial commitment and credibility relatively low, with values between 2 and 3. At entrepreneurial commitment, the statement ‘We were missing essential entrepreneurial capabilities in the management team’ is valued higher compared to the other statements at entrepreneurial commitment. The 2 companies responding to the statements on sustainable returns assessed the statements considerably higher than the others, while they have reached phase 5 according to question 3.

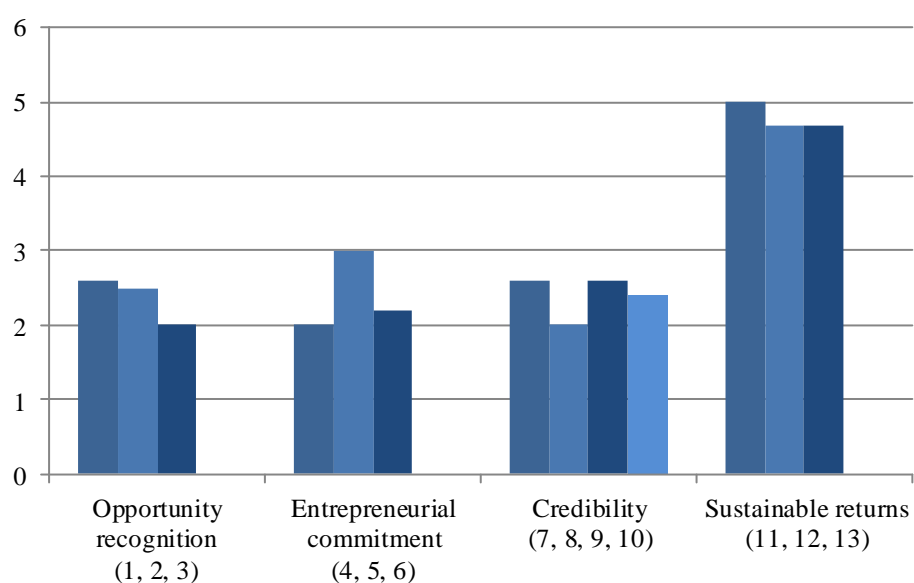


Figure 4.6. Critical juncture experienced by 5 successful USO companies

4.3 Overcoming critical junctures

This paragraph presents the results on factors that can help USOs in overcoming the critical junctures in order to answer research question 2.3.

4.3.1 Factors for success

Item 8

At this question, we asked the facilitator to name 3 successful companies, and why these companies are successful according to them (question 8, appendix 2). We asked this question to learn what factors lead a company to its success. In table 4.7, an overview of the mentioned factors is presented. Factors named 3 times or more will be discussed. This question was answered by 11 respondents.

4 respondents mention the ‘Heterogeneous management team’ as a success factor for the identified successful companies. Respondent 9 on this factor: “... *What is part of the critical success, is multidisciplinary. Various kinds of backgrounds. So you can look at many angles of a problem and come to better solutions and convert them into things that work*”. Respondents mention the mix of entrepreneurial people, commercial people and technical people as the ideal composition of the management team.

3 respondents argue that ‘Strategic investors’ are important for success. Strategic investors (also referred to as ‘smart money’), bring not only financial resources to the company, but they can bring other advantages such as a network, knowledge and experience. Respondent 7 states the next about why a strategic investor was important for a specific successful company: *“That was the one that we could hook up with an informal investor that invested in the company but had a huge network as well”*. Respondent 17 argues that the importance of strategic investors or Smart money is often underestimated by USO companies: *“... people do not understand in the beginning of their company how important that it is not only to have money but also smart money”*.

3 respondents mention the presence of ‘Entrepreneurial capabilities’ in the management team as factor of success. They mentioned the presence of entrepreneurial capabilities in the team as important factor, especially in the early stages of the development process.

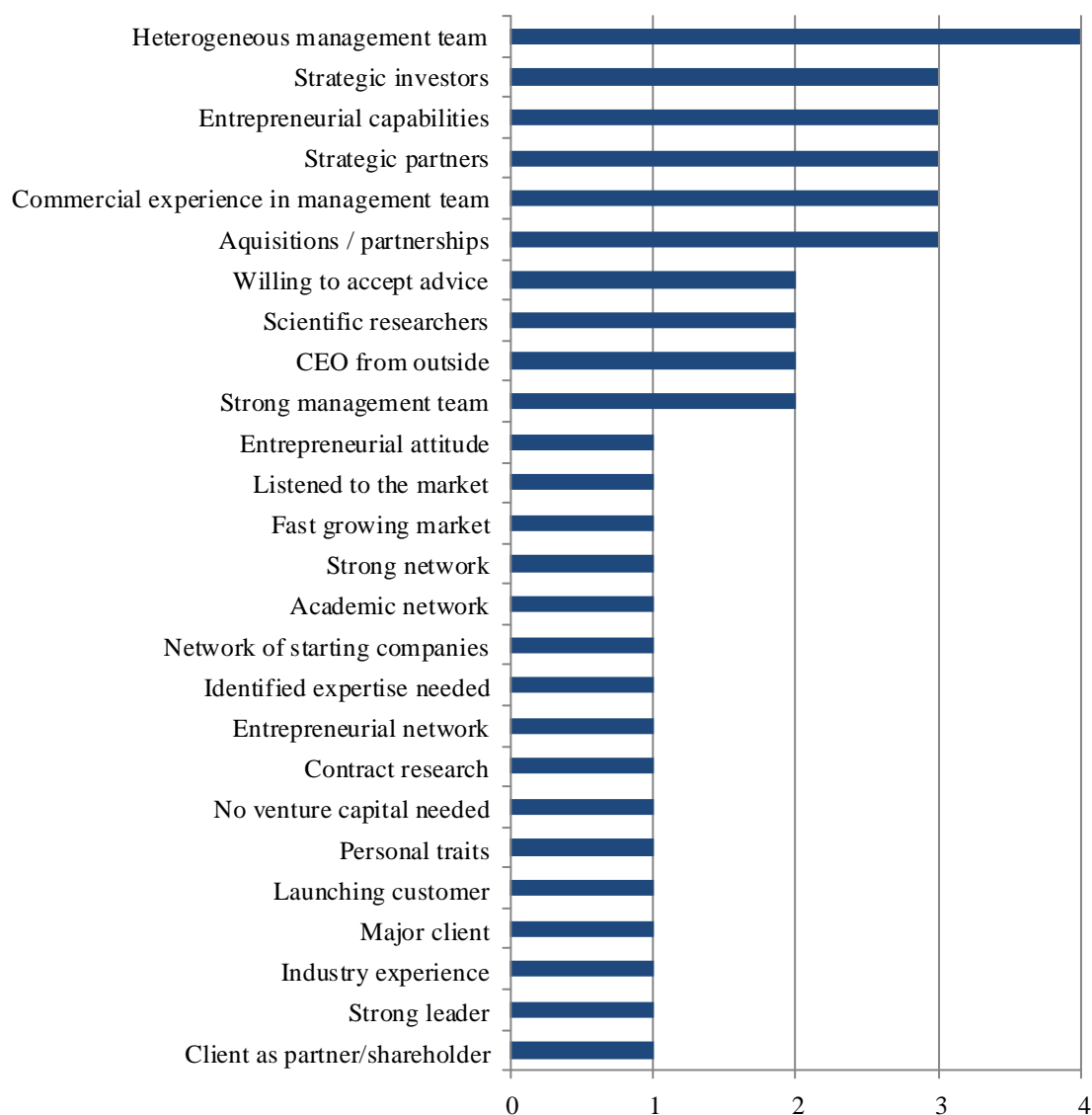


Figure 4.7. Factors for success

3 respondents argue that having ‘Strategic partners’ is important for the success of the USO company. The difference with ‘Strategic investors’ is that ‘Strategic partners’ are directly involved and have the same mission as the USO. At one company, the strategic partner was a larger company and it became their major client and at another company a private facilitator became shareholder, bringing all the experiences and knowledge they have in the company.

3 respondents mention that having ‘Commercial experience in the management team’ is important for the success of the USO company. When contacts with the industry are made, the team needs commercial experience to deal in the right way with partners.

3 respondent mentioned having ‘Acquisitions / partnerships’ as a major factor of success. These facilitators explain that an acquisition / partnership is a way of becoming successful. Selling the USO to a bigger company means a larger change for the technology to become a success because of the resources of that company. And for the entrepreneurs an acquisition / partnership is financially attractive.

4.3.2. Human capital

Item 9

At this item, we asked the facilitators to name the human factors that are critical for the success of academic spin-offs (question 5, appendix 2). We stated this question to learn what education and experience the team of a USO should have in their team. In figure 4.8, an overview is presented. This question was answered by 11 respondents. It brings us 5 factors.

8 respondents argue that ‘Commercial experience in management team’ is an important human factor. The respondents recognize this throughout all the stages. Respondent 1 on this matter: “... *commercial thinking is very important in almost every stage, so if you don’t have commercial people in the team and it is driven by technical people only with no experience then there is a higher risk of failure*”.

6 respondents mentioned ‘Qualified scientific researchers’ as an important human factor. Most USOs are high-tech, which requires qualified scientists. Respondent 1 argues: “... *you need very creative and highly qualified scientific researchers, who are able to solve issues that nobody has solved before*”.

5 respondents mentioned that it should be a ‘Well-balanced management team’. The team should consist of people with different knowledge and experiences. Respondent 14: “*I think what you need in a team is a good mix of characters, a good mix of knowledge*”.

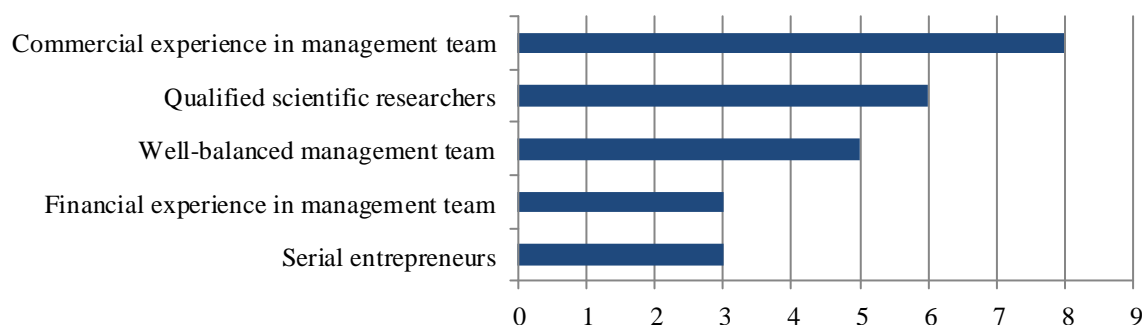


Figure 4.8. Experiences of member of the management team

3 respondents argue that there should be ‘Financial experience in management team’. Especially in the later stages, this becomes important according to the respondents. Then the team needs to have someone who is focused at the financial well-being of the company.

3 respondents mention ‘Serial entrepreneurs’ as important experience in the management team. Respondent 1 explains that they can be very important, but also hard to find: “...*they are much better qualified as first time entrepreneurs. It is very hard to find those people, especially here. If you go to Silicon Valley they are all over the place, here it is more difficult*”.

Item 10

At this item, we asked the facilitator what experiences and education the members of the management team should have during the development process (question 5a, appendix 2). We asked this question to understand the specific experiences and education of members needed for the management team. Due to the lack of time during the interview, in some cases the experiences of the members in general was asked, not specified for the stages. Thus, the results in this question will answer the experiences for the whole development process. All 3 answers mentioned at least 3 times will be discussed. From the others, the most notable answers will be discussed. 10 respondents answered this question.

3 respondents mention that ‘Entrepreneurial capabilities’ are important for the members of the management team. Respondent 3 argues that this is critical: “*Without education in business and administration you will see that they will remain researcher, and although they do have some entrepreneurial spirit, they never are successful in establishing a viable company*”.

3 respondents argue that ‘Personal traits’ are important. Respondent 2 about this : “... *for me the cognitive dimensions and the personality profile combined with the traits and competences is the most important*”.

3 respondents mention that the persons should be ‘Enthusiastic.’ Respondent 1 on this matter: “... *drive and enthusiasm, because the scientific things and other things you can get from other persons as well. Does the person convince the other people that they should do business with him*”.

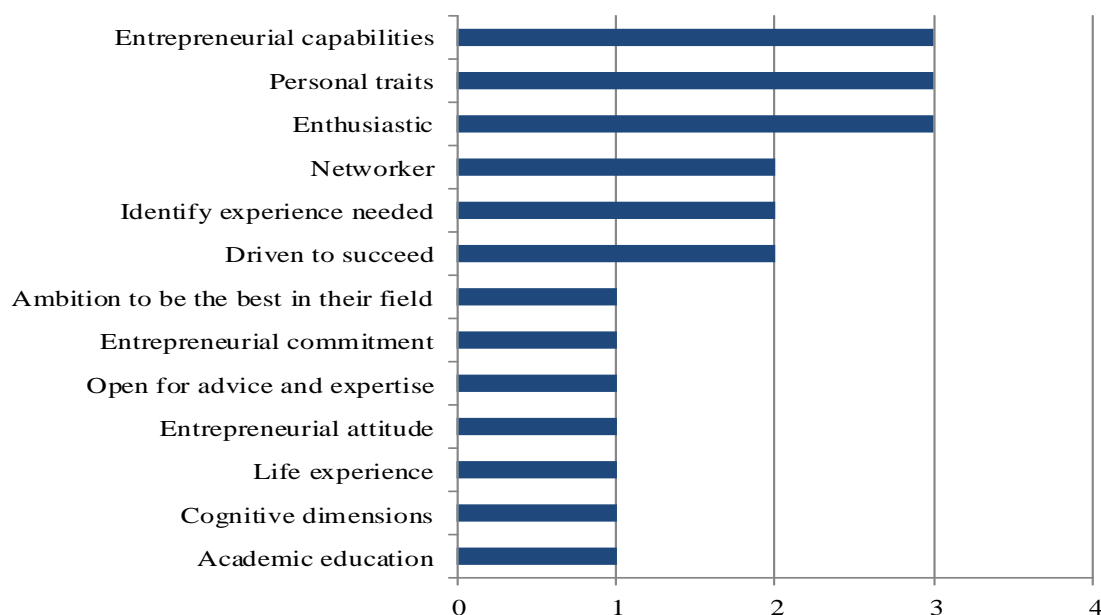


Figure 4.9. Experiences of members of the management team

4.3.3 Social capital

Item 11

At this item, we asked the facilitator to describe what network the USOs should have and what partners they should have a strong connection with (question 6 and 6a, appendix 2). We asked this question to learn what networks and partners are important for the USO companies. This question was answered by 8 persons. The result is graphically presented in figure 4.10.

5 respondents mention ‘Industry network’ as important network for USO companies. Respondent 1 on the importance of industry networks: *“Ideally, if you have decided which market you want to enter, or which industry, which you have to do in an early stage, it is very good if you have an industry network, so you now everybody in the industry. Because they are going to help you, give you feedback and meet your future clients”*.

4 respondents mention that the USO should have an ‘Academic network’. Especially in the early stages, connections of the USO with academic institutions are valuable to get access to specific research and knowledge. Respondent 3: *“The most important in your organization is to keep your contacts within the research and the research organization. Because they continue with their own research programs, and that leads to new knowledge and new technologies. So through that way you are always sure that you will be aware of the latest inventions in the university or research institute that was your origin”*.

The respondents detail that there should be a strong connection with strategic partners (2), like a (potential) major clients or a (potential) shareholder and that there should be a strong connection with potential customers (1) or even launching customers (1) to get feedback from the market.

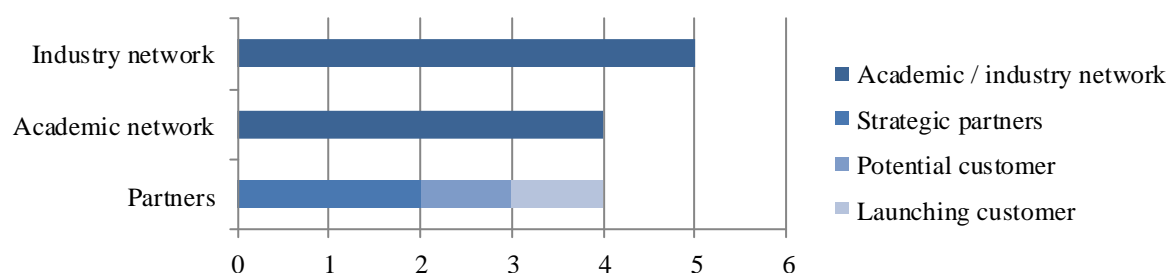


Figure 4.10. Important networks and partners for USO companies

4.3.4 Financial capital

Item 12

The interviews with the venture capitalists (2) will be used to describe the results on financial capital.. In appendix 3, the questions that are asked specifically for the venture capitalists are shown. The results of the interviews with venture capitalists are presented and the main points are summarized.

Venture capitalist Food Valley and Delft

The venture capitalist provides pre-seed money in the early stage, often in cooperation with the pre-seed fund of the university. Most companies in the pre-seed phase need 10.000-100.000 Euros for the concept phase and prototype phase. This money is provided on a personal account, no legal entity is necessary. They also provide money in what they call the seed phase, which are amounts starting from 100.000 Euros to a couple of 100.000 Euros. According to the venture capitalist IP protection and a dedicated management team who has a large share in the company are important reasons to invest. The technology is important, but the management team makes the difference. They receive 100-150 start-up plans every year, and invest in only 5% of them. They take a minority stake in the company, and support the company with their knowledge, including coaching, network and clients. Via contacts with the universities, an objective assessment of the technology is gained, and the IP protection is analyzed by specialized lawyers. They provide a convertible loan which makes it possible for them to convert the loan into shares of the company. As mentioned at the critical junctures, the venture capitalist identifies the potential of the company as the biggest critical juncture. The company should be able to show that they could make large profits, to make up the losses from other companies. The high risk of starting innovative companies is the main reason that the investor wants to see high potential. The venture capitalist has invested in a number of company. From 4 example provided by the venture capitalist, table 4.3 shows that they invest from stage 3 and especially in stage 4.

Finance: Equity	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Company 1				€ 500.000	
Company 2			€ 300.000	€ 1.000.000	
Company 3				€ 400.000	€ 300.000
Company 4			€ 400.000	€ 400.000	

Table 4.3. Amount and moment of investment

Venture capitalist Eindhoven

This venture capitalist works closely together with the incubator of which the university is a shareholder. They are not lending, but always shareholder of the company they invest in. The venture capitalist only invests in high innovative companies. Preferably a company with patents and with a maximum committed management team, also financially. This venture capitalist also mentions that a quick growth ratio is important, so the company should be able to show that they can achieve this quick ratio. Other than the venture capitalist from Food Valley and Delft, this venture capitalist only invests when they have a co-investor with specific knowledge and experience in the same field as the company. The venture capitalist has invested in 1 USO company, at which they provided money in the third and fourth phase.

To summarize, the venture capitalists indicate that the most important reasons for an investment are:

- IP protection
- Dedicated management team owning a large share of the company
- Ability to show a large potential growth of the company

4.1.5 Facilitator's support

Item 13

At this item, we asked to facilitators to describe the support activities that they provide for USO companies (question 1, appendix 2). We asked this question to learn what kind of supporting activities facilitators provide to the USO companies. In table 4.3, the results are shown.

Finance	Finance in general	8
	Shareholding	4
	Total	12
People	Coaching	8
	Enhancing entrepreneurial attitude	2
	Stimulate self-reflection	1
	Create experience in a safe environment	1
	Total	12
Information	Education	4
	Research	1
	Total	5
Accommodation	Accommodation in general	6
	Total	6
Network	Network in general	6
	Clients	4
	Preferred suppliers	1
	Total	11
Reputation / endorsement	Reputation	1
	Total	1

Table 4.3. Support activities facilitators

Facilitators support the USO companies most often through financing. 8 respondents mention finance in general and 4 respondents mention that they take a stake in the company through shareholding. 11 respondents provide support through their networks. 6 respondents through networks in general, 4 specifically mention to link them to clients in their network and 1 to preferred suppliers. 8 respondents mention that they provide support through coaching. 2 facilitators mention that they train the members of the USO to create experience and self-reflection, and 2 work on enhancing entrepreneurial attitude at the USO companies. 4 respondents mention they provide education for the USOs, and 1 also provides research for the USO companies.

Item 14

At this item, we asked the facilitator to rank their contribution to overcome the critical junctures listed in the theoretical framework, from 1 = not important to 7 = critical (question 11, appendix 2). We asked this question to learn the contribution of the facilitators in overcoming the critical junctures. This question was answered by 12 facilitators. In figure 4.11, the results are presented.

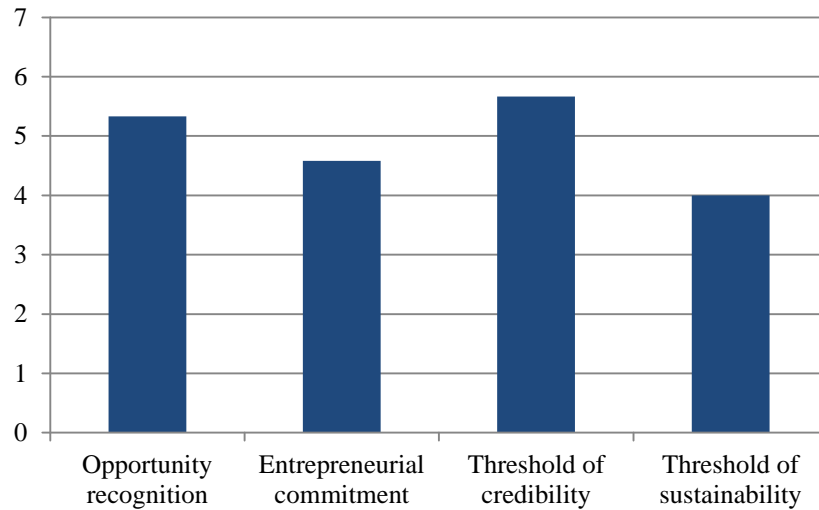


Figure 4.11. Contribution of facilitators in overcoming the critical junctures
(from 1 = not important to 7 = critical)

Facilitators claim that they contribute the most to the critical juncture ‘Threshold of credibility’ and ‘Opportunity recognition’. The contribution of facilitators to ‘Entrepreneurial commitment’ is in comparison somewhat lower and they indicated that they contributed the least to the critical juncture ‘Threshold of sustainability’.

Item 15

At this item, the facilitator was asked to indicate if they had a formal or informal relationship with the 3 identified successful companies (question 12, appendix 2). This question was asked to understand the relationships facilitators have with the USO companies. In figure 4.12 the results are presented.

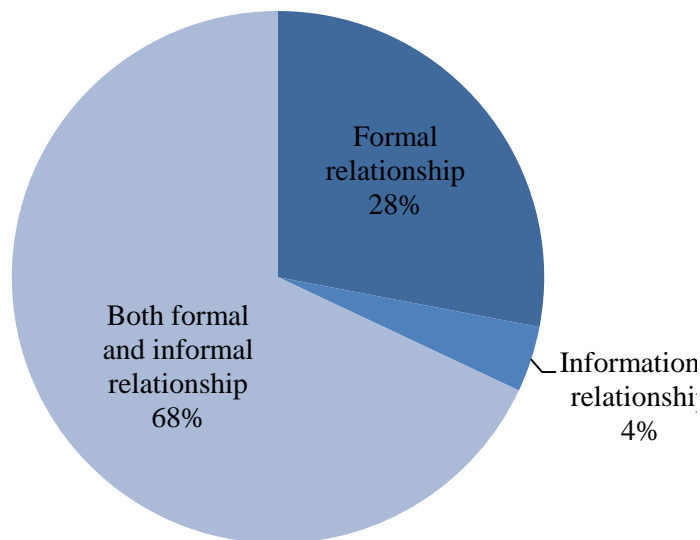


Figure 4.12. Relationship facilitator with USO

In most cases (68%), the relation is based on both formal and informal contracts. In 28% of the time it is based on only formal contracts and in 4 % there is only an informal relationship.

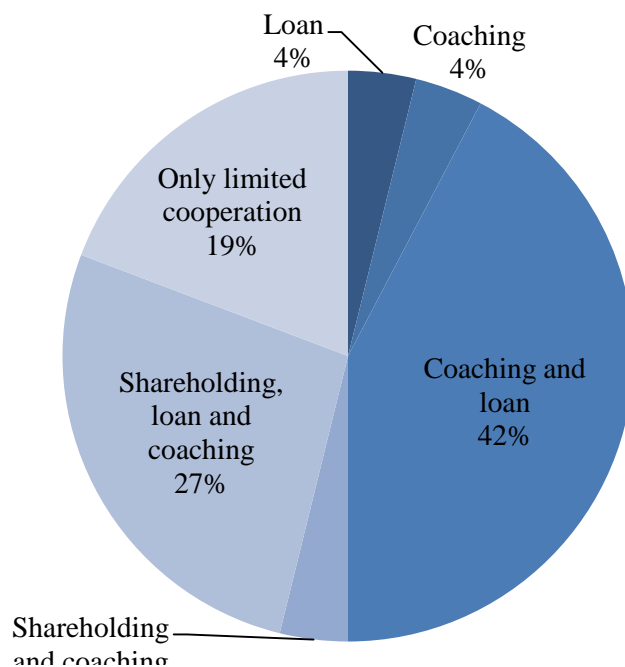


Figure 4.13. Type of relationship with USOs

When looking at the type of relation in figure 4.13, the results show that most of the facilitators have either a relationship with the USO through coaching and loan, or through loan, coaching and shareholding.

Item 16

At this item, we asked the facilitator to rank the support they provided to the 3 successful companies identified (question 13, appendix 2). We asked this question to know which support activities are provided to the USO companies. The respondents filled this question out for a total number of 27 USO companies: 10 in Brainport Eindhoven, 11 in Food Valley and 6 in Delft. The facilitators could rank their support from 1 = not important at all, 2 = not important, 3 = less important, 4 = neutral, 5 = somewhat important, 6 = important, 7 = critical. The results are presented in figure 4.14.

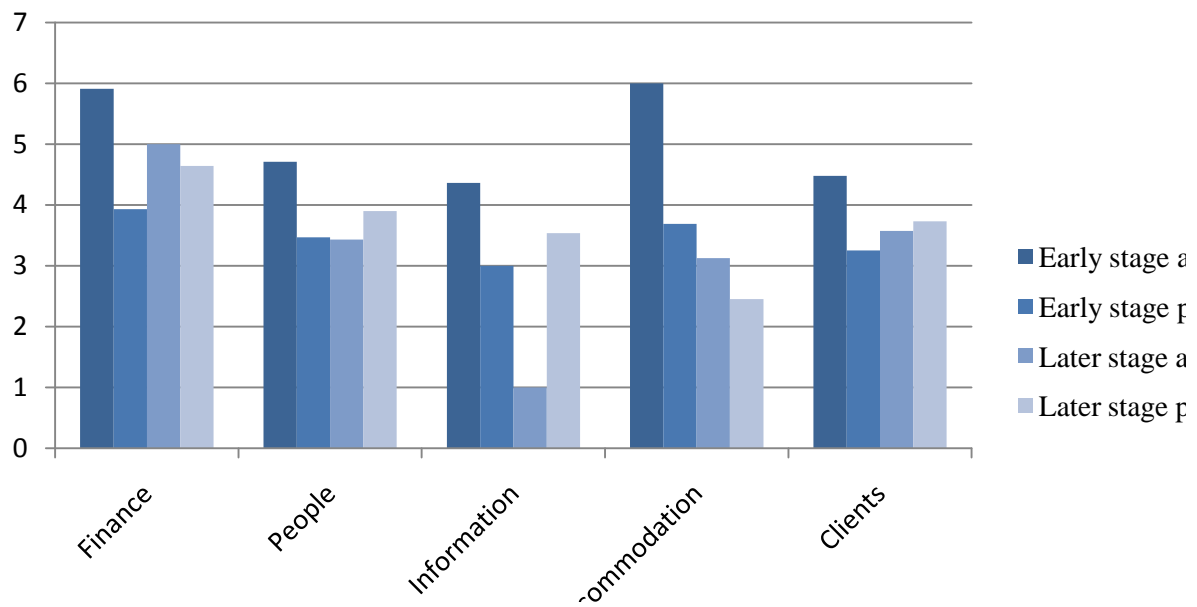


Figure 4.14. Importance of provided support activities for USOs (1 = not important, 7 = critical)

Facilitators highly value their active support to USO companies in the early stage. Especially finance and accommodation is indicated as important for the USO companies. Also the support activities for people, information and clients are valued highly. Passive support in the early stage is valued lower for all activities in the early stage compared to active support, with the highest value on finance and the lowest on information providing. Active support in the later stage is valued high at finance and low at providing information. The active support in means of people, accommodation and clients are valued less important to neutral. Passive support in the later stage is considered somewhat important in finance and neutral to less important for people, information and clients. They indicate that providing accommodation passively is not important to less important.

Item 17

An interview with the intellectual property manager of the university in each region was conducted to understand the policy of the university towards USOs. The questions of the interview can be found in appendix 4. For each university, the main points are summarized in this paragraph.

Wageningen UR

- No official policy for intellectual property, it is delegated to several parts of the university and the institutes
- There are differences between the science groups
 - o Different policy towards patents
 - o Some have a budget to file patents, some don't
 - o Department or scientist has to pay for the patent
- Institutes are more interested in the long term policy, university is more interested to sell and re-invest in research.
- In comparison not that many patents from the university, but quite a lot from the institutes.
- Strict policy in filing patent applications (Is a patent possible? Is it inventive? Can you make money with it? Is there a market? Do you have a network in the market?)
- Half of patent application will be sold or licensed, majority to large companies (start-up companies most of the time scientists from institutes).
- Usually the patents are transferred to a start-up within 2 – 2,5 years

	Patents filed each year	Number of patents	Commercialized annually	Licensed to companies
Wageningen University, institutes and Van Hall Larenstein	20-25	200	Half	Majority
TU Delft	35	190-200	Half	Unknown
TU Eindhoven	Unknown	67	10 spin-offs a years (108 since 1990)	Unknown

Table 4.4. Number of patents of the universities

TU Delft

- All the patents come through the department
- Involvement of senior entrepreneurs to develop a proper strategy for the patent
- Licensing to large companies or a company
- Spin-off companies can have an entrepreneurial contract with the university. Conditions can be negotiated; this is a case by case decision.
- No strict policy in filing patents (*"Because our philosophy is that you need a large portfolio to generate a lot of businesses, so before applying for patents we only look at: has it any chance of being granted technically; and has it any chance of being commercialized"*)
- After applying with existence of a business developer it is decided at the end of one year whether the patent is continued or not.
- 30 months after applying there has been spend about 50.000 Euros.

TU Eindhoven

- Strict policy toward filing a patent (only when there might be a valid business case).
- Inventor(s) / entrepreneur(s) also important in decision.

- Patent filing through American patent lawyer (cheaper).
- After a year decide to commercialize it or not (provisional patent).

Generally for all they universities

- All patents within the university are managed by an intellectual property manager.
- 30 months after filing a patent, it becomes much more expensive
- Inventors are entitled to one-third of the profit of the patent

These points will be used in the analysis in the next chapter and to make recommendations to universities in the conclusion and recommendations. Now that all the items of the results are discussed, the next chapter will analyze the results.

5. Analysis

Chapter 4 showed the results of the data-gathering. In this chapter, the results will be analyzed taking all the items of chapter 4 into account. The growth stages, critical junctures and factors overcoming the critical junctures will be analyzed and compared with literature. The chapter starts with paragraph 5.1 that will answer research question 2.1 on the growth stages. Paragraph 5.2 will answer research question 2.2 on critical junctures and paragraph 5.3 will answer research question 2.3 on overcoming the critical junctures.

5.1 Growth stages

Questions 1 and 2 from the results detailed the growth stages according to the facilitators in the regions Brainport Eindhoven, Food Valley and Delft. Question 3 was asked at the companies for the verification of the phases and results. In table 5.1, the growth stages of the theoretical framework and the newly concluded framework, adjusted to the development process in the regions Brainport Eindhoven, Food Valley and Delft are presented.

From question 3 of the results, it can be concluded that USO companies follow the growth phases relatively well during the development process. Therefore, we keep the order of the concluded phases consistent with the theoretical framework. However, the first two phases are merged into one phase. Reasons for this are that 3 respondents spontaneously mentioned specifically that the stages are interlinked. Respondent 7 on this: *“If there are no customers, there is nobody to sell your product to. And what you can do with your prospective customers is discuss whether or not this is the product, or that is should be modified a little”* Respondent 6: *“If you have a business idea, you should also have an idea about the market of course, the potential market at least”*. Also from the overall impression of the interviews, we noticed that USO companies identify potential markets, potential customers and potential applications for the business idea already when starting with the business plan draft in phase 1. This market driven approach suggest that phases 1 and 2 should not be separated but merged into 1 phase: ‘The business opportunity phase’. Concerning the results of phases 1 and 2 we made a few changes. Question 2 shows that 3 respondents argue that the IP protection decision should already be in phase 1. The results of question 3 show that IP creation as such is not recognized as major activity by USO companies, if they do not file an application for IP protection later on. We propose the result to phase 1 therefore as ‘The decision on IP protection’. Furthermore, the result ‘Pre-seed’ is added to phase 1. USO companies receive pre-seed money from the facilitators at an early stage.

Phase 3 from the theoretical framework becomes phase 2 and its name is changed from ‘Pre-organization phase’ to ‘Organization phase’. In our opinion, the USO is already organizing to get ready for the commercialization process and the term ‘organization’ was used in the interview by the interviewee, which was clear to the respondents. In line with feedback from facilitators, ‘Finalized business plan’ and ‘Seed finance’ are added to this phase. ‘Tested prototype’ is shifted to the beginning of this phase, 3 respondents argue that it should be earlier in this phase.

Phase 4 of the theoretical framework becomes phase 3 in the concluded framework, and changes from ‘Re-orientation phase’ to ‘Commercialization phase’, which indicates that this phase is the start of the commercial activities. ‘Venture capital’ is added conform the interview results, which is needed at the end of the commercialization phase to be able to grow the company at phase 4.

Phase 5 of the theoretical framework becomes phase 4 in the concluded framework. The name ‘Sustainability phase’ is changed to ‘Growth phase’, indicating that the company reaches high growth

in this phase. Sustainability is added as a result of this phase, at the end of the development process of a USO. The item ‘Possible acquisitions and partnerships’ is added to this phase. To be able to reach high growth and be sustainable in the end, the possibility of acquisitions by, and partnerships with larger companies is recognized relatively often by facilitators. From now on, the phases of the concluded growth phase model will be used.

Growth stages from theoretical framework:		Concluded framework	
Initial idea phase	<ul style="list-style-type: none"> - Recognition of opportunity - Project team is formed - Intellectual property created - Business proposal writing 	Business opportunity phase	<ul style="list-style-type: none"> - Business idea - Project team - Business proposal draft - Pre-seed finance - Identified potential markets - Identified prospective customers - Potential investors/partners - Decision on Intellectual property protection - First contact with launching customers
Opportunity recognition phase	<ul style="list-style-type: none"> - Interaction with facilitators and scientists - Examine the opportunity on commercial value - Identification of markets - Analysing applications for the markets and how to access the customers - Interaction with customers, potential investors and industry - Increase networks 	Organization phase	<ul style="list-style-type: none"> - Tested prototype - Finalized business plan - Seed finance - Entrepreneurial team is formed - Identify resources and knowledge to start-up the company
Pre-organization phase	<ul style="list-style-type: none"> - Entrepreneurial team is formed - Develop and start implementing strategic plans - Take decisions on resources and knowledge to acquire now and in the future - Find out how to access the resources and knowledge - Legal protection - Prototype 	Commercialization phase	<ul style="list-style-type: none"> - Start-up the company (commercialization) - Active on a market / first product line - Re-configured to the market needs - Target new customers - Changing the management team - Venture capital
Re-orientation phase	<ul style="list-style-type: none"> - Start-up the company - Information gaining from customers, competitors and suppliers - Re-configure resources, for example: <ul style="list-style-type: none"> o Target new customers o Changing the management team 		

Sustainable returns phase	<ul style="list-style-type: none"> - Leaving the university's campus - Gradually professionalizing the management team - Orientation on new markets / 2 or 3 product lines - High turnover - New geographic territories 	Growth phase	<ul style="list-style-type: none"> - Leaving the incubator / business centre - Management team with functional specialists - Orientation on new markets / 2 or 3 product lines - High turnover - New geographic territories - Possible acquisitions / partnerships - Sustainable returns
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Table 5.1. Growth stages from theoretical framework compared to concluded framework

5.2 Critical junctures

This paragraph discusses the critical junctures identified by facilitators, and compared the junctures to the critical junctures of the theoretical framework.

The facilitators recognized 4 main critical junctures in the development process of USOs:

- Inability to attract finance (12): The last 10 years investors shifted more towards later stage companies to reduce the risk, therefore it is more difficult for early stage companies to attract finance. Technology companies need a lot of money, which is sometimes underestimated by these companies. And because of the high risk at early stage companies, these companies need to be able to show that they have a lot of potential to make up for the loss of investors of other companies that failed.
- Lack of entrepreneurial capabilities (9): USOs are mostly founded by academics. Because of their scientific orientation and background, most academics lack entrepreneurial capabilities.
- Inability to form a well-balanced start-up team (4): Financially it is difficult to attract people needed in the management team and also finding the right people, especially in the early stages, is a juncture that has to be overcome.
- Restrictions and unclear policy of the university (4): Short term policy of the university towards USOs and unclear policy, which can eventually lead to conflicts.

These critical junctures can be categorized to the critical junctures from the theoretical framework. Table 5.2 shows the critical junctures mentioned by facilitators categorized to the critical junctures 'Opportunity recognition', 'Entrepreneurial commitment', 'Threshold of credibility' and 'Threshold of sustainable returns'.

Opportunity recognition	- Translating abstract things into physical things	1
	- Technology push	1
	- Lack of entrepreneurial attitude	1
	Total	3
Entrepreneurial commitment	- Lack of entrepreneurial capabilities	9
	- Entrepreneurial commitment	1
	- Lack of commercial experience	2
	- Lack of focus	2
	- Underestimation of time and afford	1
	Total	15
Credibility threshold	- Inability to attract finance from investors	12
	- Inability to form a well-balanced start-up team	4
	- No complete prototype	1
	- Lack of value proposition	1

	Total	18
Sustainable returns	- Lack of acquisitions / partnerships	2
	- Inability to scale	2
	Total	4

Table 5.2. Critical junctures identified by facilitators categorized by critical juncture from theoretical framework.

When comparing the specific junctures identified spontaneous by facilitators with the broader critical junctures from the theoretical framework, most junctures can be linked to entrepreneurial commitment and credibility; 15 and 18 times respectively. Opportunity recognition and sustainable returns are only identified 3 and 4 times respectively, which is surprisingly low. This shows that the critical junctures entrepreneurial commitment and credibility are the most ‘critical’ junctures to overcome. The juncture ‘Restrictions and unclear policy of the university’ identified by facilitators cannot be categorized to the main critical junctures. Although the USO itself do cannot affect restrictions and unclear policy, it is a juncture according the facilitators, thus it should not be underestimated by the USO companies.

The reason why the facilitators do not mention critical junctures in the sustainable returns phase very often, could be because of the simple fact that not many companies reach to that phase. USO companies face high risk when moving throughout the development process. Moreover, only the best companies reach to the point where they have to overcome the critical juncture of sustainable returns. They were able to overcome all junctures to that point, suggestion that it is a strong company. Thus, the fact that not that many companies reach to the point when they have to overcome the critical juncture sustainable returns, and mostly strong companies reach to this point because they were able to overcome all the other critical junctures, could be why this juncture is not mentioned that often.

The critical juncture of opportunity recognition however, is at the beginning of the development process. From the results there is not much support indicating that this critical juncture is a problem for USO companies in the researched regions.

Looking at the moment in the development process at which stage these critical juncture become a problem, opportunity recognition is, as expected, a problem especially in the first phase from the concluded model. Entrepreneurial commitment was expected to be the most important in stage 1 and 2, but with a decrease in importance in phase 2, it does not show that this is the case for the selected regions. However, entrepreneurial commitment stays relatively important throughout the stages. The threshold of credibility is as expected important in stage 2, but decreases in importance in stage 3. This is notable, because in stage 3 the company starts with its commercial activities. The facilitators could reason that finance is needed in stage 2, to gather all the required resources to start-up in stage 3. The critical juncture sustainable returns is as expected becoming more important as the USO develops, becoming almost critical in phase 4.

The critical junctures entrepreneurial commitment and threshold of credibility are most important as indicated by the facilitators. In stage 1 entrepreneurial commitment is most important and in stage 2 credibility is most important. In stage 3 they are both relatively important. This indicates that USOs need the most support in these stages.

The 5 successful USO companies (as identified by facilitators) experienced the critical junctures opportunity recognition, entrepreneurial commitment and credibility relatively low, as expected. The 2 companies that reached the phase of sustainable returns (growth phase in the concluded model),

however, experienced the critical juncture of sustainable returns surprisingly high. Although the results are based on only 2 companies, the differences with the other critical junctures are large. An explanation for this fact could be that these USO companies are considered to be in phase 4, as indicated at item 3 (phase 5 in the theoretical framework), but in reality they have not reached 'sustainable returns'. The critical juncture 'sustainable returns' is considered to be not only the problem between stage 3 and 4, it is also a problem during stage 4.

5.3 Overcoming critical junctures

In this paragraph, the factors in overcoming the critical junctures will be discussed and compared to the literature. The factors for success; human capital, social capital, financial capital, facilitators' support and the policy of the university will be discussed.

Human capital

The facilitators mention the following human factors for the team of a USO:

- Commercial experience (8)
- Qualified scientific researchers (6)
- Well-balanced managerial team (5)
- Financial experience in management team (3)
- Serial entrepreneurs (3)

Besides the facilitators, commercial experience is also mentioned by a successful USO. The respondent explains how the USO coped with this: *"It became a problem that we lacked commercial experience and the moment that that started to be a problem coincided with the moment that we were running out of initial funding. So we were not able to appoint a commercial manager, a commercial person when it was really needed. That was a little bit difficult. I solved that by looking for new investors and that also allowed us to build a management team"*.

When comparing these results with the literature described in paragraph 2.3.1, the importance of functional diversity becomes clear in the results. The members of the team should have a variance of entrepreneurial, commercial, scientific and financial experience in the management, supported by the fact that facilitators specifically mention a well-balanced managerial team as important. When looking at tenure diversity, the different moments that members enter the team, this is mostly the case at the end of phase 4 and in phase 5, because then functional specialists are needed with commercial, financial and management experience. Some respondents do recognize the fact that the new views of these people can be of positive influence on strategic actions. The results show no specific evidence on industry diversity. Industry experiences could be important, but differences in industry experience have not been mentioned as important for the team.

The respondents mention the following human factors for the members the team:

- Entrepreneurial capabilities (3)
- Personal traits (3)
- Enthusiastic (3)

Looking again at the results from literature in paragraph 2.3.1, facilitators have recognized prior domain specific research experience as important, identified in item 9, through qualified scientific researchers. They have also identified entrepreneurial experiences through serial entrepreneurs at item 9, and entrepreneurial capabilities at item 10. Respondents did not specifically stated industry experiences for specific member of the management team as important, but they did mention commercial experiences and the identified industry network at item 11.

Social capital

The respondents mention the following social factors:

- Industry network (5)
- Academic network (4)

The results show clearly that the respondents recognize both bonding ties (academic network) and bridging ties (industry network) as factors that can stimulate the USO. The USO company should keep the contacts with the research organization to benefit from their knowledge and technology

development. The industry network is becoming more important when the USO develops. However, it has been mentioned by several respondents that close links with the industry can also be beneficial in the first phases, especially with parties with whom there should be a close connection with during the development process. The results show that there should be a strong connection with:

- Strategic partners (2)
- Potential customers (1)
- Launching customers (1)

All these strong connections are in the industry network. Although respondents identify an academic network as important, no strong connections with specific partners in the academic network are identified.

Financial capital

Venture capitalists invest mostly in phase 3, but also in phase 2 and 4 (concluded framework). Important reasons to invest in a company are:

- IP protection
- Dedicated management team owning a large share of the company
- Ability to show that the company has a large growth potential

To increase the chance for USOs to attract finance, they should especially focus on these items. Following the results of the interview, USO companies need pre-seed capital in the 'Business opportunity phase', seed capital in the 'Organization phase' and venture capital in the 'Start-up phase'.

Factors for success

Unrelated to the questions on human capital, social capital and financial capital, the respondents mentioned spontaneously the following factors for success of a specific example of a USO mentioned during the interviews at item 8:

- Heterogeneous management team (4): the mix of entrepreneurial people, commercial people and technical people is the ideal combination.
- Strategic investors (3): if the company is able to get finance from a strategic investor, it can benefit from factors such as: (industry) network, knowledge and experience.
- Entrepreneurial capabilities (3): especially in the early stages a factor for success is the presence of entrepreneurial capabilities in the team.
- Strategic partners (3): the difference with strategic investors is that strategic partners are directly involved and have the same mission of the USO company. Examples are a major client or a private facilitator.
- Commercial experience in the management team (3): commercial experience in the team reduces the chance of failure for the USO.
- Acquisitions / partnerships (3): selling the company to a larger company can be a factor of success in the later stages of the development process. The risk for the technology to be a success is reduced and for the investors it is financially attractive.

Outstanding in these results are the number of companies that became successful through either an strategic investor, a strategic partner or an acquisition / partnership, according to the facilitators. These factors all involve attracting finance and show that other the factors involved can be very beneficial as well to become a successful company.

Facilitators

The results show that the facilitators provide mostly finance, coaching and their network to the USO companies. Education is relatively low, however, all 3 facilitators from the universities in the regions provide education in enhancing and stimulating entrepreneurship. Reputation/endorsement is very low,

only 1 organization specifically stated that they support this. The relationship is for 68% based on both formal and informal contact, 28 % on a formal contract and only 4% on informal contact. This shows that in almost all the cases, a formal contract between the facilitator and USO is established and in most cases this involved also informal contact.

The facilitators highly value their active support to USOs in the early stage, especially finance and accommodation. Looking at the most important critical junctures, entrepreneurial commitment and the threshold of credibility, notably is that they highly value their support on finance and accommodation, which stimulates the credibility, but they do not highly value their support on people, finding employees and training people in the team.

The facilitators rank their support to the critical juncture 'Opportunity recognition' relatively high. They mentioned this critical juncture not very often as a problem for USOs, so their contribution seems to be successful in overcoming this critical juncture, or this critical juncture is not problematic for the USOs in the regions. The facilitators rank their support to 'Entrepreneurial commitment' relatively low, especially in comparison with how often they mentioned this critical juncture as a problem. Thus, the facilitators should provide more support to the USO companies to overcome the critical juncture of 'Entrepreneurial commitment'. The contribution in overcoming the critical juncture 'Threshold of credibility' is valued high. They also mentioned this critical junctures often as a problem. The contribution in overcoming the critical juncture 'Threshold of sustainable returns' is valued not that high. This could be because a lot of USO companies already left the facilitator at this stage.

University's policy

University's policy towards patents and USOs can be important for the success of a USO. All patents within the university are managed by an intellectual property manager. 30 months after filing a patent, it becomes increasingly expensive. The technical University of Delft has a deviating policy towards filing patents. At the technical University of Eindhoven and at the University of Wageningen there is a strict selection process, at the University of Delft that selection process is less important. This is because their philosophy is to generate a lot of patents first to create more possibilities. Within a year the decision of commercialization is made to reduce the costs of patenting.

Also notable is the fact that there is no general policy towards patents and USOs at the University of Wageningen. The different departments have different policies. At item 4, 5 facilitators mention 'Restrictions and unclear policy of the university' as a critical juncture. 4 out of 5 facilitators are active in the region Food Valley. Also the literature suggests that there should be a clear policy.

5.4 Concluding model

From the results in chapter 4 and the analysis of the first 3 paragraphs of this chapter, a concluded growth stage model can be derived. The growth stage model is presented in figure 5.1. In this growth stage model, the factors to overcome the critical junctures are incorporated. These factors are most of the time needed throughout major parts of the process, so they are not assigned to the critical junctures directly but incorporated in the growth stage model.

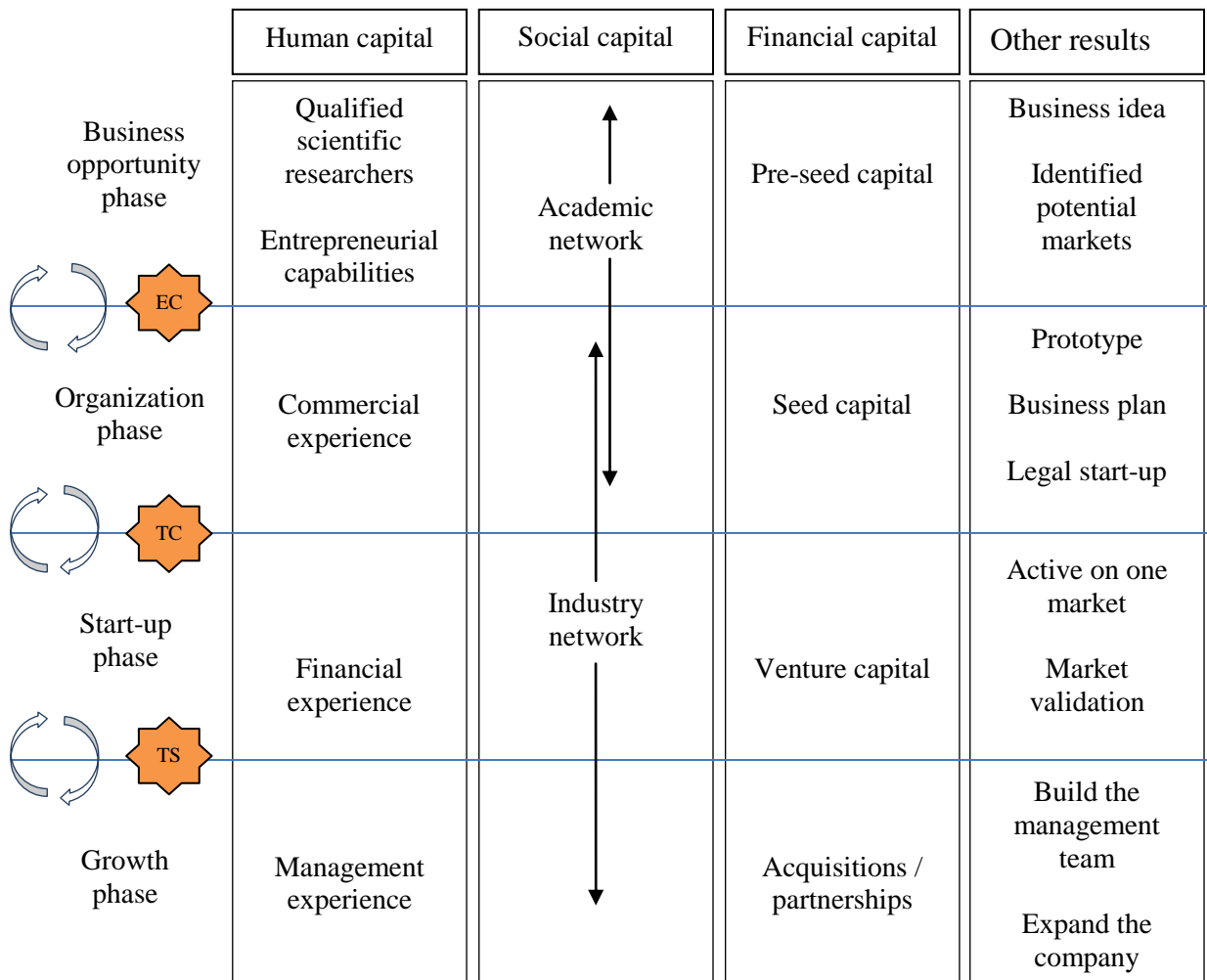


Figure 5.1. Model of growth phases and identified results

The critical junctures ‘Entrepreneurial commitment’ (EC), ‘Threshold of credibility’ (TC) and ‘Threshold of sustainable returns’ (TS) are important as mentioned in paragraph 5.2. The moment that these critical junctures arise was not a clear moment in the development process according to the results. The critical junctures are shown in the model according to the research of Vohora et al. (2004), because that is the moment when it is expected that the juncture is the most ‘critical’. The arrows in the figure on the left side indicate that it is possible that USO goes back to the previous phase. This is for example the case when a chosen market turned out to be not that successful, so a new market has to be found and the plans and product has to be adjusted to that market, falling back from for example phase 2 to phase 1. The arrows at academic network and industry network show that throughout more phase these networks are important. In the early stages the academic network is more important and in the later stages the industry network is more important.

6. Conclusion and recommendations

In this chapter the final conclusion of the research is presented and recommendations for universities, facilitators and university spin-off companies will be made. Paragraph 6.1 will present the conclusion and paragraph 6.2 will present the recommendations.

6.1 Conclusion

Research objective:

To identify growth phases and critical junctures between the different growth phases in the development process of university spin-offs, and to find out what resources and knowledge the university spin-offs used to overcome these critical junctures.

What is a university spin-off and what does the development process of a university spin-off look like?

A university spin-off is a commercial company from which the intellectual property as well as the founder or founders must come from a university or academic institution and at which the technology is transferred directly from the parent organization to the spin-off company (paragraph 2.1.1). The goal of the process that takes place before the decision is made to start a spin-off, is often to produce academic knowledge and licensing technologies to established companies. For an established company the technology can be too uncertain, they do not believe in its value, or the technology is difficult to transfer because only the expert has the knowledge. If the technology is radical, tacit, early stage, general-purpose and has significant customer value, significant technical advantage and strong IP protection, the technology is more likely to be exploited through a USO (paragraph 2.1.3).

What phases and critical junctures in the development process of university spin-offs are distinguished in the literature?

There are five phases identified in the literature. The basic structure from Vohora et al. (2004) is used, complemented by important issues in the models of Ndonzuau et al. (2002) and Clarysse and Morey (2004). The first phase is the research phase in which the main focus of the academics is to run academic research and publish their work, until the business opportunity is recognized. The project team of technical researchers is formed and the intellectual property is created. The second phase is opportunity framing phase, in which the academics and involved persons will examine if the opportunity has enough underlying value to proceed with the commercialization. The opportunity will be framed in a commercial environment by identifying the potential markets, the applications for those markets, and how to access the customers. The third phase is the pre-organization phase, in which the entrepreneurial team is formed. The team can develop and start to implement strategic plans. Decisions will be taken on what existing resources and capabilities to develop, what resources and knowledge to acquire now and in the future, and when and where to access these resources and knowledge. This requires entrepreneurial experience, human capital and access to networks of expertise at a premium. The fourth phase is the re-orientation phase, in which the USO has sufficient resources and credibility to start-up the business and is trying to generate returns by offering something of value to the customers. In this phase, the entrepreneurial team faces the challenge of identifying, acquiring and integrating resources and then subsequently re-configuring them. The success of progress in this phase is to a large extent dependently upon the preparatory work done during the previous phases. The fifth phase is the sustainability phase, in which the USO has addressed many uncertainties. Typically, the company moves from the university campus to a commercial environment. It will almost certainly retain close links with the university, although it has its own commercial identity and self-sufficiency. In this phase, the management team will be professionalized gradually (paragraph 2.2.4).

There are four major critical junctures identified in the literature (identified from the models of Vohora et al., 2004, Ndonzuau et al. 2002 and Clarysse et al, 2004). The first critical juncture is opportunity recognition, which is the ability to synthesize scientific knowledge with an understanding of markets that is enhanced significantly by higher levels of social capital in the form of partnerships, linkages and other network interactions. The second critical juncture is entrepreneurial commitment, which are uncertainties related to apply a technology in a specific market niche or to move forward the company beyond the concept stage, which requires the full-time and total commitment of the inventor. In this critical juncture the firm has to find out the venture champion with the necessary entrepreneurial capabilities, who can make a solid commitment to developing the company into an established. The third critical juncture is the threshold of credibility, which is the problem of gaining access to and acquire an initial stock of resources, which are required for the business to begin to function. The lack of credibility constrains the entrepreneur's ability to access and acquire key resources: seed finance and human capital to form the entrepreneurial team. The fourth critical juncture is the threshold of sustainability, in which the entrepreneurial team should be able to re-configure existing resources, capabilities and social capital with new information, knowledge and resources. The existing resource weaknesses, inadequate capabilities and social liabilities should be re-configured into resource strengths, distinct capabilities and social capital that will enable the USO to generate returns (paragraph 2.2.5).

What methods can be found in the literature that university spin-offs can use to overcome these critical junctures?

Three methods are identified for overcoming the critical junctures. The first is through human capital (paragraph 2.3.1.), which is the stock of knowledge and skills that exist within individuals. Employees with more human capital in the form of education and experience are more productive than comparable employees in high technology firms. The second method is through social capital (paragraph 2.3.2). Bridging ties with the industry can stimulate USOs and increase the company's awareness to new and commercial opportunities. And bonding ties can be beneficial in the early stages providing a network with academics and facilitators. The thirds is financial capital. Technical USOs need a lot financial resources, so the ability to attract finance is critical in the development process of a USO (paragraph 2.3.3). Facilitators can help the USO to overcome the critical junctures by providing support activities (paragraph 2.4).

How do university spin-offs develop overtime (phases)?

In table 6.1, the concluded growth stages model is presented. Phases 1 and 2 of the model of the theoretical framework are merged to 1 phase, the business opportunity phase, as explained in paragraph 5.1. USO follow these phases and activities relatively well.

Phases	Results in each phase
Business opportunity phase	<ul style="list-style-type: none"> - Business idea - Project team - Business proposal draft - Pre-seed finance - Identified potential markets - Identified prospective customers - Potential investors/partners - Decision on Intellectual property protection - First contact with launching customers

Organization phase	<ul style="list-style-type: none"> - Tested prototype - Finalized business plan - Seed finance - Entrepreneurial team is formed - Identify resources and knowledge to start-up the company
Commercialization phase	<ul style="list-style-type: none"> - Start-up the company (commercialization) - Active on a market / first product line - Re-configured to the market needs - Target new customers - Changing the management team - Venture capital
Growth phase	<ul style="list-style-type: none"> - Leaving the incubator / business centre - Management team with functional specialists - Orientation on new markets / 2 or 3 product lines - High turnover - New geographic territories - Possible acquisitions / partnerships - Sustainable returns

Table 6.1. Concluded growth stage model

What critical junctures do university spin-offs face during the development process?

The case study resulted in the next critical junctures (paragraph 5.2). The first is the inability to attract finance. The last 10 years investors shifted more towards later stage companies to reduce the risk, therefore it is more difficult for early stage companies to attract finance. Technology companies need a lot of money, which is sometimes underestimated by these companies. And because of the high risk at early stage companies, these companies need to be able to show that they have a lot of potential to make up for the loss of investors of other companies that failed. Second is lack of entrepreneurial capabilities. USOs are mostly founded by academics. Because of their scientific orientation and background, most academics lack entrepreneurial capabilities. The third is inability to form a well-balanced start-up team. Financially it is difficult to attract people needed in the management team and also finding the right people, especially in the early stages, is a juncture that has to be overcome. The fourth is restrictions and unclear policy of the university. Short term policy of the university towards USOs and unclear policy, which can eventually lead to conflicts.

When the critical junctures are categorized to the junctures identified in the theoretical framework (paragraph 2.5.2), the critical junctures of entrepreneurial commitment and threshold of credibility are the most prominent critical junctures to overcome. The critical juncture of sustainable return was not identified frequently, but due to the fact that this is the last critical juncture in the development process and not many companies reach to this phase, it might be a critical junctures for the companies. Especially when relying on the two successful companies interviewed in this research. Opportunity recognition is not identified frequently and there is no reason to suggest that this critical juncture is a major problem in the development process of USOs in the regions researched.

The moment that critical junctures arise is not a specific moment, but a period of time. The company can be in the next phase, but still struggling with a critical juncture. However, because the results do show that at a specific moment the critical junctures are the most ‘critical’, the critical junctures are placed between the phase (paragraph 5.4), as in Vohora et al. (2004) (paragraph 2.5.2).

What factors help university spin-offs to overcome the critical junctures?

Human factors:

Important human factors for the team of a USO are commercial experience, qualified scientific researchers, well-balanced managerial team, financial experience in management team and serial entrepreneurs. Human factors for the members the team are entrepreneurial capabilities, personal traits and enthusiasm. The members of the team should have a variance of entrepreneurial, commercial, scientific and financial experience in the management. The different moment that people enter the team (tenure diversity) is important to bring new views into the company.

Social factors:

Both bonding ties (academic network) and bridging ties (industry network) can stimulate the USO. The USO company should keep the contacts with the research organization to benefit from their knowledge and technology development. The industry network is becoming more important when the USO develops. However, close links with the industry can also be beneficial in the first phases (paragraph 5.3).

Financial capital:

Venture capitalists invest mostly in phase 3, but also in phase 2 and 4. Important reasons to invest in a company are: IP protection; dedicated management team owning a large share of the company; ability to show that the company has large potential. To increase the chance for USOs to attract finance, they should especially focus on these items (paragraph 5.3).

Facilitators:

Facilitators provide mostly finance, coaching and a network to the USO companies. Education provided at all three universities in the regions to enhance and stimulate entrepreneurship. Reputation/endorsement is only supported by 1 facilitator. The relationship is for 68% based on both formal and informal contact, 28 % on a formal contract and only 4% on informal contact. This shows that in almost all the cases, a formal contract between the facilitator and USO is established and in most cases this involved also informal contact.

The facilitators highly value their active support to USOs in the early stage, especially finance and accommodation. Looking at the most important critical junctures, entrepreneurial commitment and the threshold of credibility, notably is that they highly value their support on finance and accommodation, which stimulates the credibility, but they do not highly value their support on people, finding employees and training people in the team, which should stimulate the entrepreneurial commitment. It has also been found that facilitators rank their support the USO in overcoming the critical juncture of entrepreneurial commitment not very high, but they do see it as a major problem in the development process.

6.2 Recommendations

General recommendations, recommendations for facilitators, university spin-off companies, universities and recommendation for further research made in this paragraph.

General recommendations

Researching the growth phases, critical junctures and factors that help USOs to overcome the critical junctures through the viewpoint of facilitators was very successful. The facilitators have close contact with the companies and have a very clear view on the development process of the USO companies. This approach is definitely recommended to create an objective and holistic view of a development process.

In this research, all the transcripts are coded by the program of Atlas.ti (Atlas.ti, 2011). This resulted in one document with 17 bundled transcripts, which makes it easier to analyze and compare the results. The coding system gives the researcher the advantage of moving directly to the identified codes and linked sentences throughout the whole document, making fast analysis possible. It also directly counts the number of codes and a network of codes can be made. These advantages contributed to the quality of the coding system and the analysis of the data in this research. However, even though the data can be analyzed fast, coding the transcripts, link them to the sentences and networks in the program of Atlas.ti is very time consuming. This resulted in a time delay of the research. Moreover, the possibility of creating a network from the coding system graphically was due to time restriction not added to this research. Thus, using the program of Atlas.ti can contribute to the quality of a qualitative research, but it can cause significant time delays.

Recommendations for facilitators

Entrepreneurial commitment and the threshold of credibility are the most important critical junctures for USO companies in their development process. However, facilitators do not value their support to the critical juncture of entrepreneurial commitment very high. The results show that to improve their support to USO companies, facilitators should focus more on activities supporting entrepreneurial commitment.

Recommendations for university spin-off companies

Important in the first phases are entrepreneurial capabilities, which can be obtained by education, attracting people from outside or cooperation with other organizations. Also commercial experience should not be underestimated in the first phase and becomes more important in the later phases. A solid business plan, IP protection, a large share in the company as management team and showing large potential are the most important factors to improve chance of attracting investors.

Recommendation for universities

A clear policy towards university spin-offs is recommended. An unclear policy can create uncertainties for USO companies and the differences in expectations can even lead to a conflict. A clear policy which is focused on the long term results of USO companies creates the best environment for a USO in its development process.

Recommendations for further research

This research provided a holistic view on the growth phases, critical junctures and factors that help USOs to overcome the critical junctures from the viewpoints of a large number of facilitators. However, it is recommended to verify the results from this research with the facilitators in the region of Twente, to strengthen the representativeness. To validate the growth phase, most prominent critical

junctures and factors that help USO to overcome the critical juncture, a survey on these items with a large number of USO is recommended.

7. Discussion

Value of the research

This research provides valuable information about the development process of USOs. A literature study is completed, comparing the growth stages and critical junctures present in literature. Furthermore, the factors that help USOs in overcoming the critical junctures are described. Interviews with 17 facilitators and 5 USO companies form the basis of the case study. This case study provides valuable information for USOs in the regions of Brainport Eindhoven, Food Valley and Delft. The holistic description of the growth stages, critical junctures and factors in overcoming the critical junctures provides results that are of interest for facilitators who are active in supporting USO companies, universities that want to stimulate USO companies, and the USO companies when they are in the development process. This research provides a starting point for a survey on a large number of USO companies in the Netherlands.

Limitations

In the region Delft, only two facilitators were interviewed. This can have an influence on the results because the region of Delft is less represented in the case study. Moreover, the research is conducted in the regions of Brainport Eindhoven, Food Valley and Delft, in which three technical universities are present. The University of Twente is also considered as a technical university. Allowing us to create a solid case study within the time restriction, three regions were researched. The three regions were selected on contacts with the university within these regions. As mentioned in the recommendations, a verification with the results in the region of Twente can contribute to the representativeness of the results.

The USO companies researched are mainly high-tech, which means that the results cannot be generalized to other USO companies. Technical companies can have other growth phases and may face other difficulties than other USO companies. Qualitative research cannot be generalized to a much larger population in general. But given the fact that three high-tech regions in the Netherlands are researched and relatively a large number within these regions are researched, the representativeness of the results are relatively high for high-tech USOs in the Netherlands.

Although the research provides an objective view on the development process of USOs by facilitators, only 5 companies are used for the verification of the results. Given this small number, this research can be seen as input for a survey on the development process with a large number of USO companies.

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Appendices

Appendix 1: Comparison of growth stage models

Vohora et al. (2004)	Ndonzuau et al. (2002)	Clarysse & Moray (2004)
Research phase <ul style="list-style-type: none"> - Producing academic knowledge - Potential opportunity recognized - Intellectual property is created 	Generating business ideas <ul style="list-style-type: none"> - Producing academic knowledge - Identification of business ideas - Commercial and technological evaluation - Business proposals 	Idea phase <ul style="list-style-type: none"> - Project team is formed - Business proposal writing - Start of business project writing
Opportunity framing phase <ul style="list-style-type: none"> - Examine commercial value - Frame commercial opportunity - Identify markets and customer access 	Finalize new venture projects <ul style="list-style-type: none"> - Investigating ideas in more depth - Ideas transferred to business projects - IP protection - Verify possible industrial exploitation - Conducting a prototype in which way the opportunity is exploited - Critical juncture financing - Venture project ready at end of phase 	Pre-start-up phase <ul style="list-style-type: none"> - Business plan is developed - Start capital negotiated - No hierarchical organization - High degree of control on their work - Entrepreneurial team is formed - Champion identified - Phase ends if company is formalised
Pre-organization phase <ul style="list-style-type: none"> - IP protection created at this phase - Decision what resources and knowledge to acquire now and in the future. - When and where access resources and knowledge - Important decisions are made for next phases 	Launch spin-off firms <ul style="list-style-type: none"> - Creation of a new firm - Identification of key people in the company - Academics leave their academic environment - Maintaining relationship with university 	Start-up phase <ul style="list-style-type: none"> - Formal legislation of the company - Internal reorganization of the company likely
Re-orientation phase <ul style="list-style-type: none"> - Start-up of the company - Offering value to customers, generating returns. - Re-configuring - Possible new strategy 		Post-start-up phase <ul style="list-style-type: none"> - Hire people from outside - Hire a coach to develop skills and capacities of the team
Sustainable returns phase <ul style="list-style-type: none"> - USO has addressed many uncertainties at this stage - Typically moving off university campus - Almost certainly remains close links with university. 		

Appendix 2: Interview guideline facilitators

A. Role of facilitators

Introduction

Literature provides information on the importance of spin-off facilitators during their development process through the variety of support that they provide. First, we would like to learn about your role in the academic spin-off growth. We visited your website and we think that you have an important role in academic spin-offs growth.

1. What is your role in helping academic spin-offs in developing process? What kinds of support do you provide for them?

B. Academic spin-off development process / growth stage

We would like to discuss the development process and growth stages from the initial business idea to an established company.

2. Would you please describe the process of commercialization (the process of bringing new knowledge to the market) in the course of time and major activities that ideal spin-off must run until they become well established?

- a. We found the following stages in the literature (table 1). What is your view on these stages? What are the most important results in each stage? Do you confirm the names of the stages?

Table 1. Academic growth stages

Stage	Name	Results
Stage 1	Initial idea	<ul style="list-style-type: none"> Business idea Project team Intellectual property creation Business proposal draft
Stage 2	Opportunity framing	<ul style="list-style-type: none"> Number of recognized opportunities Potential markets Identified prospective customers Potential investors
Stage 3	Organization	<ul style="list-style-type: none"> Resources and knowledge to start-up the company Seed funding Legal protection/IP protection Tested prototype
Stage 4	Commercialization	<ul style="list-style-type: none"> Start-up the company (commercialization) Active on a market / first product line
Stage 5	Sustainable returns	<ul style="list-style-type: none"> Leaving the university's campus / incubator / business centre Management team with functional specialists Orientation on new markets / 2 or 3 product lines High turnover New geographic territories

C. Academic spin-off barriers

Literature suggests that there are specific problems academic spin-offs face during their development process. We call these problems barriers. To continue their growth academic spin-offs must overcome their barriers.

4. Can you describe the main barriers that spin-offs encounter as they are going from one stage to the other?

a. We found these barriers in literature (table 3). In general, which of these barriers are the most important ones in the development process of academic spin-offs (3-5 items)?

b. Please indicate how important the barriers are to each stage (1=not important; 7=critical)

Table 3. Barriers

Barriers		Please assess (1=not important; 7=critical).				
		Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Opportunity recognition	<ul style="list-style-type: none"> Lack of prior knowledge on markets and industries Inability to think commercially 					
Commitment	<ul style="list-style-type: none"> Lack of entrepreneurial capabilities Inability to make use of network contacts to get things done 					
Credibility	<ul style="list-style-type: none"> Inability to attract finance from investors Inability to form a well-balanced managerial and scientific team Inability to provide sufficient long-term options for commercialization 					
Sustainable return	<ul style="list-style-type: none"> Inability to establish a stable position in product/market segments Inability to make strategic decisions under pervasive uncertainty 					

D. Human and social factors

Based on the literature on the academic spin-off, there are several social and human factors that a management team experience and networks that can help academic spin-offs to foster their growth and overcome their growth barriers.

5. What human factors are critical for the success of academic spin-offs? (Question prompt: for example education, experience)

a. What kind of experiences is more important for members of academic spin-offs management teams for each stage? (Question prompt: for example experience in start-up, research and industry)

6. What social factors are critical for the success of academic spin-offs?
(Question prompt: for example the type of network partners, and number of partners)

a. With what partners should spin-off have strong connection and in what stage? (Question prompt: Research institute/industry/public authorities)

E. Cases

7. Please name 3 failed academic spin-offs. Looking back at table 3, which stage did they reach?

a. What barriers did they experience?

8. Please name 3 successful academic spin-offs. What criteria do you apply to call them successful academic spin-offs? Looking back at table 3, in what stage are they?

a. What barriers did they have? How did they overcome the barriers during their development process?

b. Please specify their management teams/ directors for each company? (Question prompt: Number of people, experience, and education)

c. What was the experience of different directors for each company? (Question prompt: for example entrepreneurial experience, research, industry)

d. Can you detail their network? (Question prompt: for example the network partners and strength of relationships, please name 3-4 main type of partners)

F. Facilitator's support

We will now distinguish between earlier and later growth stages. Earlier stage comprises of stage 1, 2 and 3, before the business is launched. Later stage comprises of stage 4 and 5, after the business has been launched. We also define support as active support, meaning support provided directly by you, and passive support, meaning support that you provide by referencing the academic spin-offs to the information without your involvement.

9. Please assess your support activities for the stated 3 successful spin-offs in the different stages (table 4) (Blank=not applicable; 1=not important; 7=critical).

Table 4. Facilitator's support

Support activities		Please assess (Blank=not applicable, 1=not important; 7=critical).					
		Company 1:		Company 2:		Company 3:	
		Early stage	Later stage	Early stage	Later stage	Early stage	Later stage
Finance Loan Subsidies VC	Provide or be involved in a connection to: money, loan, subsidy						
	Make reference						
People Founders employee	Training / recruiting / or be involved in a connection to the right people						
	Make reference						
Information Scientific knowledge Commercial/industrial	Provide them information or be involved by an introduction or connection						
	Make reference						
Accommodation Space Equipment Labs access	Provide them facilities or be involved in a connection						
	Make reference						
Clients Customers Potential market	Help them to enter to market by finding them clients						
	Make reference						

10. Look again at table 2 (below), in which activities do you participate?
With 2 markers, yellow and green, check your interventions actively or passively (Green for active support and yellow for passive support).

Table 2. Absorbing and developing external knowledge

	Acquisition	Assimilation	Transformation	Exploitation
Activities	Identify, acquire, monitor, search and collect external knowledge	Analyse, comprehend, interpret, understand and adapt external knowledge	Develop, refine and change external knowledge	Refine, extend, leverage, use and implement external knowledge

11. Look again at tables 3 (below), please assess your contribution in navigating these barriers?

Table 3. Barriers

Barriers		Please assess (1=no contribution; =critical contribution)
Opportunity recognition	<ul style="list-style-type: none"> • Lack of prior knowledge on markets and industries • Inability to think commercially 	
Commitment	<ul style="list-style-type: none"> • Lack of entrepreneurial capabilities • Inability to make use of network contacts to get things done 	
Credibility	<ul style="list-style-type: none"> • Inability to attract finance from investors • Inability to form a well-balanced managerial and scientific team • Inability to provide sufficient long-term options for commercialization 	
Sustainable return	<ul style="list-style-type: none"> • Inability to establish a stable position in product/market segments • Inability to make strategic decisions under pervasive uncertainty 	

12. We define formal relation when there is a legal contract with the company. Please indicate the frequency of your meetings and indicate if the relation is formal or informal? (Leave blank=not applicable, 1= less than a year, 2= every year, 3= every 6 months, 4 = every quarter, 5= every month, 6= every two weeks and 7= weekly).

Table 5. Strength of connection

Type of relation	Please assess (Blank=not applicable; 1=rarely; 7=often).					
	Company 1:		Company 2:		Company 3:	
	Early stage	Later stage	Early stage	Later stage	Early stage	Later
Cooperation	F:	F:	F:	F:	F:	F:
	I:	I:	I:	I:	I:	I:
Coaching	F:	F:	F:	F:	F:	F:
	I:	I:	I:	I:	I:	I:
Loan	F:	F:	F:	F:	F:	F:
	I:	I:	I:	I:	I:	I:
Shareholding	F:	F:	F:	F:	F:	F:
	I:	I:	I:	I:	I:	I:

13. How do you think the 3 successful academic spin-offs will evaluate the importance of your support in the different stages (table 6) (1=not important; 7=critical)?

Table 6. Facilitator's support

Support activities		Please assess (1=not important; 7=critical).					
		Company 1:		Company 2:		Company 3:	
		Early stage	Later stage	Early stage	Later stage	Early stage	Later stage
Finance Loan Subsidies VC	Provide or be involved in a connection to: money, loan, subsidy						
	Make reference						
People Founders Employee	Training / recruiting / or be involved in a connection to the right people						
	Make reference						
Information Scientific knowledge Commercial/industrial	Provide them information or be involved by an introduction or connection						
	Make reference						
Accommodation Space Equipment Labs access	Provide them facilities or be involved in a connection						
	Make reference						
Clients Customers Potential market	Help them to enter to market by finding them clients						
	Make reference						

This is the end of the interview. Thank you for your time and cooperation.

Do you know more persons that could be important for the research that we should interview? Do you have any suggestion to improve the interview?

Appendix 3: Complementary questions venture capitalists

Role of venture capitalist

Introduction

Literature provides information on the importance of venture capitalists during their development process. First, we would like to learn about your role in the academic spin-off growth. We visited your website and we think that you have an important role in academic spin-offs growth.

- 1 What are the different new venture categories that your organization invests in? (question prompt: academic spin-offs, corporate spin-offs, start-ups, etc.)
- 2 What is your role in helping academic spin-offs in the developing process? What kinds of support do you provide for them?
- 3 What are the conditions for lending (giving credits) to spin-offs? Have they changed over the last few years? If so, how so?
- 4 What kinds of products/services does the venture capital currently offer to academic spin-off clients? Will this portfolio of products/services change over the next few years?
- 5 What kinds of loans does the VC offer academic spin-off clients?
- 6 Does the VC face any challenges in serving this particular customer base – i.e. academic spin-off clients?

Appendix 4: Complementary questions intellectual property managers

Introduction

Literature provides information on the importance of spin-off facilitators during their development process through the variety of support that they provide. First, we would like to learn about your role in the academic spin-off growth. We visited your website and we think that you have an important role in academic spin-offs growth.

1. What is your role in helping academic spin-offs in developing process? What kinds of support do you provide for them?

2. Could you please describe your intellectual property policies towards knowledge valorization? (Question prompt: disclosing inventions/discoveries, protecting intellectual property, ownership rights)

3

How many patents, trademarks or other intellectual property do you own or have been listed on as an inventor?	Patents	
	Trademarks	
	Other	

4

How many of the intellectual properties you own or have been listed on have been commercialized?	Patents	
	Trademarks	
	Other	

Appendix 5: Interview guideline university spin-off companies

(selection of questions on importance for this research)

Academic spin-off development process and growth

Introduction

We would like to discuss with you the development process and growth of your company and several important issues during the development and growth.

1. Would you please describe in course of time several important issues during the start-up process? (Q prompt: Think about how you identified your business opportunity, how you knew how to protect your IP, how to organize your management team, obtained initial funding, found your first customer, bringing your product to market etc.).

--

Based on literature we identified 5 issues which are considered important. Please select the achievements that you achieved and indicate when you reach to significant improvements on these issues?

Issue	Achievements	Year/ month
Initial idea	We identified initial business ideas <input type="checkbox"/> We identified our intellectual property <input type="checkbox"/> We organised the project team <input type="checkbox"/> We protected our intellectual property <input type="checkbox"/>	
Opportunity framing	We recognized the market opportunities <input type="checkbox"/> We identified applications for our patents <input type="checkbox"/> We identified potential markets <input type="checkbox"/> We identified a variety of prospective customers <input type="checkbox"/> We identified a business model <input type="checkbox"/> We contacted potential investors <input type="checkbox"/> We received seed funding <input type="checkbox"/>	
Organization	We developed a business plan <input type="checkbox"/> We tested our prototype <input type="checkbox"/> We got venture capital <input type="checkbox"/> We developed our innovation product/service <input type="checkbox"/> We organise the management team <input type="checkbox"/>	
Commercialization	We brought our product / service to the market <input type="checkbox"/> We adapted our product / service <input type="checkbox"/> We received reputation on the market <input type="checkbox"/> Establishment of competence signals with respect to other market participants <input type="checkbox"/> We received some revenue <input type="checkbox"/>	
Sustainable returns	We have clear plans to leave the university's campus / incubator / business centre <input type="checkbox"/> We changed the management team with functional specialists <input type="checkbox"/> We have seen a large increase in our turnover / profits <input type="checkbox"/> We are expanding our orientation on new markets or with more product lines <input type="checkbox"/> We are exploring new geographic territories <input type="checkbox"/>	

Academic spin-off barriers

Introduction

Literature suggests that there are specific problems academic spin-offs face during their development process. We call these problems barriers.

2. Please indicate to what extent do you agree or disagree with following sentences (Encircle N=not applicable; 1=completely disagree; 7=completely agree)

Barriers	Please assess (1=completely disagree; 7=completely agree).
Inability to translate our initial idea into a business opportunity	N – 1 – 2 – 3 – 4 – 5 – 6 – 7
We had great difficulty translating scientific knowledge into market opportunities	N – 1 – 2 – 3 – 4 – 5 – 6 – 7
We had difficulty articulating our value proposition	N – 1 – 2 – 3 – 4 – 5 – 6 – 7
Other:	N – 1 – 2 – 3 – 4 – 5 – 6 – 7
Inability to run the business and explore the commercial potential of the business opportunity	N – 1 – 2 – 3 – 4 – 5 – 6 – 7
We were missing essential entrepreneurial capabilities in the management team	N – 1 – 2 – 3 – 4 – 5 – 6 – 7
We had difficulty putting a solid commitment of some management team members to develop the company	N – 1 – 2 – 3 – 4 – 5 – 6 – 7
Other:	N – 1 – 2 – 3 – 4 – 5 – 6 – 7
Inability to gain access and acquire different resources and developing existing resources for business to begin function	N – 1 – 2 – 3 – 4 – 5 – 6 – 7
We had difficulty convincing investors	N – 1 – 2 – 3 – 4 – 5 – 6 – 7
We took a long time to form a well-balanced management team	N – 1 – 2 – 3 – 4 – 5 – 6 – 7
We had troubles defining sufficient long-term options for commercialization	N – 1 – 2 – 3 – 4 – 5 – 6 – 7
Other:	N – 1 – 2 – 3 – 4 – 5 – 6 – 7
Inability to reach a level of sustainable returns in our company...	N – 1 – 2 – 3 – 4 – 5 – 6 – 7
We had difficulty establishing a stable position in product/market segments	N – 1 – 2 – 3 – 4 – 5 – 6 – 7
We had difficulty making strategic decisions under pervasive uncertainty	N – 1 – 2 – 3 – 4 – 5 – 6 – 7
Other:	N – 1 – 2 – 3 – 4 – 5 – 6 – 7

Appendix 6: Overview of interviewed facilitators

Interviewee	Function	Organization description	Region	Date	Number. of pages transcript (text)	Duration of Interview (hours)
Job Nijs	Former managing director of Yes!Delft	Science park Holland: Regional development cooperation, founded by Delft University, the city of Delft and the city of Rotterdam.	Delft	11-7-2011	5	1:08
Arnoud Jullens	New managing director of YES!Delft	Yes Delft: (school of Entrepreneurship) Consist of four centers: inspiration, education, incubation and growth.	Delft	25-5-2011	4	1:03
Gitte Schober	Managing director of Startlife at Wageningen UR	Startlife: Startlife is a foundation established last year, 2010, focusing on enhancing entrepreneurial attitude of students and employees of Wageningen University. And facilitating the start-up of high tech life sciences based companies.	Food Valley	3-5-2011	5	1:06
Jeff Gielen	Director of Kadans/Biofacilities.	Kadans/Biofacilities: Provides accommodation, knowledge, expertise and network to innovative companies	Food Valley	4-5-2011	5	1:19
Roger Van Hoesel	Director of Food Valley	Food Valley: Part of Startlife. Links organizations to start-ups, communication with organization and start-ups, provide publications.	Food Valley	31-5-2011	4	0:50
Wim Bens	Former director TU/InnovationLab	Former organization: TU/InnovationLab: The TTO of technical university in Eindhoven, focuses on the creation and support of USOs	Brainport Eindhoven	21-6-2011	8	1:32
John Berghmans	Project manager business development	TNO: Research institute focused on innovation.	Brainport Eindhoven	10-6-2011	3	1:12
Bert Tournois	Managing director TDI	TDI: Providing high quality scientific, technological, financial, marketing and management experience and the development and setting up of companies in agro- and biotechnology.	Food Valley	23-5-2011	5	1:23
Guus Verhees	Fund manager Rabobank	Dutch Greentech Fund: Consisting of four partners: Rabobank, WNF, Wageningen UR en TU Delft. Provide venture capital for techno-starters.	Food Valley and Delft	31-5-2011	4	0:43
Rob Verbakel	Director of Technostars	Technostars: Invests in young, innovative companies. Partly owned by TU/E	Brainport Eindhoven	7-6-2011	4	0:40
Joep Koene	Business developer at Oost NV	Oost NV: Business development agency. Participates in innovative companies.	Food Valley	13-5-2011	3	0:47
Jos Versleijen	Program managers spin-off fund	BOM starterscentrum: Strengthen the economic growth and innovation in Brabant.	Brainport Eindhoven	11-5-2011	4	1:07
Bart De Jong	Manager new business development	TU/InnovationLab: The TTO of technical university in Eindhoven, focuses on the creation	Brainport Eindhoven	16-5-2011	5	1:05

		and support of USOs				
Bart De Jong	IP Expert	Technical university Eindhoven	Brainport Eindhoven	16-5-2011	1	0:23
Petra Doelman	Business developer	Bicore: Focusses on open innovation in the Benelux.	Brainport Eindhoven	27-4-2011	5	1:17
Paul van helvert	IP manager	Wageningen university and research	Food Valley	12-5-2011	7	1:22
Annegreeth Lameijer	IP manager	Technical university of Delft	Delft	24-6-2011	3	0:34



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