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THE IMPACT OF THEIR SUPPORT

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To my mother for her support

throughout my entire academic career

Preface

In my opinion, conducting a PhD thesis is a unique journey for each candidate. During such a journey all candidates experience different unique moments. I started my journey with participation in an EU project in 2014 as an external PhD candidate at the Centre of Technology and Innovation Management (CETIM) in the Leiden Institute of Advanced Computer Science (LIACS).

The project was in the context of crisis management. I studied a multidisciplinary topic, viz. the intersection of innovation, technology management, and crisis management. However, due to a variety of circumstances, I had to change this topic after only two years and moved to the field of entrepreneurship.

Meanwhile, I collaborated with business incubators as a startup trainer. In this new position, I was always curious to investigate the impacts of the different supports on the performance of the NTBFs. Hence, I saw and felt the void of a measurement tool for evaluating the incubator's performance. Thus, the idea of my second PhD topic started from this gap and I have found it fascinating to address the incubators' problem in my research scientifically.

During the first three years of my research project, I received support from the international graduate school on Networks, Information Technology & Innovation Management (NITIM). During the summer schools in Trondheim, Bergamo, Milan, Munster, Northern Island, and Leiden, the NITIM committee provided great feedback and support.

Negin Samaeemofrad, Leiden, June 17, 2021

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List of Abbreviations

The list below contains the abbreviations that are used in this thesis. Normal lexical abbreviations, such as, ‘e.g.’ and ‘i.e.’, are not listed. The same applies for the names of corporations, such as SAP.

AC	Absorptive Capacity
AI	Artificial Intelligence
BI	Business Incubator
BIC	Business Innovation Centre
CBI	Corporate Business Incubator
CV	Control Variable
FTE	Full-Time Equivalent
IBI	Independent Business Incubator
KBV	Knowledge-Based View
KMO	Kaiser-Meyer-Olkin
NGO	Non-Governmental Organization
NTBF	New Technology-Based Firm
NITIM	Network of IT and Innovation Management
LT	Log Transformation
OLT	Organizational Learning Theory
PCA	Principal Component Analysis
PFA	Principal Factor Analysis
PS	Problem Statement
RBV	Resource-Based View
R & D	Research and Development
RQ	Research Question
SA	Supportive Activity

SCT	Social Capital Theory
SPSS	Statistical Package for Social Science
UBI	University Business Incubator
VC	Venture Capitalist
VRIN	Valuable, Rare, Inimitable, and Non-substitutable
VIF	Variance Inflation Factor

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Chapter 1

Supporting New Technology-Based Firms

A New Technology-Based Firm (hereafter NTBF) is a significant enabler of job creation and a driver of the economy through stimulating innovation (cf. Colombo and Delmastro, 2002). In the last two decades, we have seen an enormous development of the NTBFs. Science and technology policymakers tend to endorse the formation of NTBFs via providing proper conditions for them to generate more economic growth within their territory.

Previous studies highlighted that there are three important obstacles in the early stages of an NTBF's lifecycle. They are listed below.

(1) Liability of *smallness* relates to the small size of the firms (see Witt, 2004; Gilbert et al., 2006; Schwartz and Hornych, 2010).

(2) Liability of *newness* concerns the lack of (a) customer trust to the product, (b) a firm's reputation, (c) business skills, (d) industry information, and (e) administrative support (see Shepherd et al., 2000; Witt, 2004; Bøllingtoft and Ulhøi, 2005).

(3) Liability of *weak ties* relates to the strength of the NTBFs' networks (see Neergaard, 2005; Bøllingtoft and Ulhøi, 2005; van Weele et al., 2017).

For all NTBFs, these three obstacles have impacted the access to the required resources, such as financial and human capital resources. In fact, they were a threat to the development process of the NTBFs (cf. Gilbert et al., 2006; Sullivan and Ford, 2014; Lukeš et al., 2019). Consequently, there was a high rate of failure among NTBFs, particularly in high-technology-based sectors (cf. Lerner, 2009; Bøllingtoft, 2012; Audretsch, 2012). A remedy to avoid these failures is in using the support and resources by Business Incubators (BIs) (Soetanto and Jack, 2013). So far, they provide a supportive environment for the NTBFs (e.g., by providing administrative and finance-related support, and networking) to help them address their liabilities.

This chapter starts with an overview of the ideas behind the BIs in section 1.1. Then, section 1.2 elaborates on the motivation for the thesis. Section 1.3 presents the essential definitions of the thesis. Section 1.4 describes four perspectives with their four characteristics. The problem statement and three research questions are formulated in section 1.5. Section 1.6 provides the research methodology. Finally, section 1.7 presents the structure of the thesis.

1.1 The Idea of Business Incubator

Currently, the Business Incubator (BI) is a well-known phenomenon. It is well understood as a means to support NTBFs, particularly in the early stage when the NTBF is in its development phase. The aim of the BIs is to decrease the risk of failure among the NTBFs and to accelerate their evolution (see Grimaldi and Grandi, 2005; McAdam and McAdam, 2008; Bøllingtoft, 2012). BIs provide supportive services which promote the NTBFs capabilities and engage them with either public or private agreements (see Colombo and Delmastro, 2002). So far, there is almost no reliable evidence on the effectiveness of BIs on the performance of NTBFs (see Hackett and Dilts, 2004; Eveleens et al., 2017; van Weele et al., 2017; Lukeš et al., 2019). As a result, BIs attract a considerable amount of attention from scholars, in particular around the topics such as: What are the BIs doing? How effective are the BIs? What is the impact of the BIs? There are some quantitative studies, but the majority of all scholarly studies is qualitative, and only a few of them evaluate more precisely the performance of the BIs quantitatively (e.g., Mian et al., 2016; Lukeš et al., 2019). In 2012, Bruneel and his colleagues clearly pointed out that the scientific world was facing a clear absence of theoretical studies on the impact of the supportive activities of BIs on the performance of NTBFs, since they could have provided us with a yardstick and theory-based expectations. Five years later, Eveleens and his colleagues (2017) reviewed the recent studies of BIs and concluded that there still was an urgent need to evaluate the impact of business incubators on the performance of NTBFs. So, I observed that a contribution in this specific area was needed.

1.2 Motivation

My motivation to measure the impact of the support by BIs on the performance of NTBFs, comes from my personal experience of collaborating with BIs. For about three years, I was a business advisor for entrepreneurs in my hometown (Tehran). I was wondering why some BIs and accelerators were more effective in their support provision for the entrepreneurs than others. After my arrival in the Netherlands, I had similar practical experiences with the performance and output of the BIs in my new living environment. The differences in the effectiveness of BIs motivated me to investigating this question more deeply to find an answer. My interest goes particularly to the role of the BIs in (1) the guidance of the NTBFs in their development processes, and (2) the provision of different services by the BIs promoting entrepreneurship.

Following, Subsection 1.2.1 explains the starting position of my research. Then, two research objectives are presented in 1.2.2.

1.2.1 My Starting Position

After I had decided to conduct a study on business incubators, I started to read scientific studies in the relevant literature (e.g., Mian, 1996; Hackett and Dilts, 2004; Grimaldi and Grandi, 2005; Bergek and Norrman, 2008; McAdam and McAdam, 2008; Bøllingtoft, 2012). Later on, I became familiar with recent research efforts (e.g., Albort-Morant and Oghazi, 2016; Eveleens et al., 2017). They highlighted the unique role of BIs in empowering NTBFs in the ecosystem of entrepreneurship. Obviously, the concept of BI is rooted in innovation-system studies and in the innovation-management literature. Innovation-systems show how policymakers provide different mechanisms to foster innovation and consequently support NTBFs. The innovation-management literature revealed that there exist four clear mechanisms consisting of (1) tax incentives, (2) subsidies, (3) Technology Transfer Offices, and (4) Business

Incubators (cf. Freeman, 1987; Brown and Mason, 2014). Among these supportive mechanisms, BIs have been identified as the most effective tool for the development of NTBFs (see Grimaldi and Grandi, 2005; Bøllingtoft, 2012).

In the last two decades, the incubation studies have gained considerable attention and they have been developed with the growth in the nature of the incubators (Eveleens et al., 2017). The research efforts on business incubations have been concentrated on three issues, viz. (1) their improvement and development (see Rothaermel and Thursby, 2005), (2) their forms, classification and characteristics (see Grimaldi and Grandi, 2005; Bergek and Norrman, 2008; Vanderstraeten and Matthyssens, 2012), and (3) their identification of offering services (see Grimaldi and Grandi, 2005; Bøllingtoft, 2012).

While previous investigations clearly have shown that business incubators support their NTBFs though different mechanisms and resources, the impact and importance of these supports on the performances of their NTBFs is not still clear (cf. Ratinho et al, 2013; Eveleens et al., 2017; van Weele et al., 2017; Lukeš et al., 2019). Based on the recent investigations by Eveleens et al. (2017) and Lukeš et al. (2019), it has been indicated that on the one hand some NTBFs have more chance of survival when they receive support from BIs (see McAdam and McAdam, 2006; Scillitoe, J.L., Chakrabarti, A.K., 2010; Bruneel et al, 2012). On the other hand, some investigations have showed that BIs have no impact on the performances of the NTBFs (Chan and Lau, 2005). Further, Dvoulety et al. (2018) stated that the incubated NTBFs have worse performance than unincubated NTBFs.

Eveleens and his colleagues (2017) highlighted two main shortcomings in the incubation studies. *First,* the contradictory results in the incubation literature may be rooted in the lack of theoretical models to advance this field. *Second*, previous investigations are mostly used qualitative methods and explained best practices (see Fernández, 2012; Eveleens et al., 2017). Thus, our contribution in this study is to address these shortcomings and advance our understanding about the impact of support by BIs on the performances of NTBFs through developing a fine-grained model. To arrive our aim, we use both qualitative and quantitative methods.

1.2.2 Two Research Objectives

The objectives of this research are twofold: (1) to identify the supportive activities by University Business Incubators (hereafter called UBIs), (2) to understand to what extent the supports by UBIs have a serious impact on the performance of their NTBFs. Thus, in this thesis I will explore the relations between the support by UBIs, with emphasis on (a) the performance of the NTBFs and (b) the NTBFs' innovation strategy with a moderating role of NTBF's capability. To achieve these two objectives, I set up an explorative and explanatory study in three UBIs which are based in the Netherlands and Germany. The findings of my research will enable UBIs managers to provide more customized supports for their NTBFs via obtaining a deeper insight into the effectiveness of their supports.

1.3 Essential Definitions

Below a general definition of a business incubator is given as a fundamental concept in the thesis.

> **Definition 1.1***: A* ***Business Incubator*** *is a property-based initiative attempting (1) to connect technology, capital and knowledge to foster entrepreneurship, and (2) to generate and develop new firms via offering particular supportive activities to entrepreneurs.*

Already eight years ago, Bruneel et al. (2012) observed an absence of theoretical studies on the supportive activities by BIs. This implies a lack of studies which is still not filled. The most prevailing missing items are on (1) the effectiveness of BIs and (2) the performance by NTBFs. The fundamental underlying issues of the two items are supportive activities. In this thesis, I define the supportive activities offered by BIs as follows.

Definition 1.2*: **Supportive activities (SA)** by BIs are defined as functions and services that BIs are offering to the NTBFs to enable the entrepreneurs to develop their businesses.*

Three prevailing examples of the supportive activities are (1) shared physical facilities, (2) business-oriented services, and (3) networks. It is well known that a wide range of requirements originating from a diverse set of the NTBFs and the available set of resources as offered by the BIs may create a large set of different models of incubators. Consequently, the supportive activities lead to an emerging variety of distinguished supportive services. With regard to the role of sponsors or stakeholders of BIs and the sources of their supports, scholars such Grimaldi and Grandi (2005), Bergek and Norrman (2008), and Bøllingtoft (2012) have segmented BIs into three classes, viz. public, private, and bottom-up incubators. This typology is elaborated upon in Chapter 2. In our study, we concentrate on the *University Business Incubators* (see definition 1.3) which fall under the public class.

Definition 1.3: *A **University Business Incubator (UBI)** is defined as "an incubator set up by a university which provides office space, equipment, mentoring services as well as other administrative supports to assist the formation of new ventures" (Wonglimpiyarat, 2016, p.19)*

In addition to the concept of UBIs, a second central concept of this study is the New Technology-Based Firms (NTBFs). There are many different definitions for the concept of NTBFs (see, e.g., Storey and Tether, 1998; Saemundsson and Candi, 2017). The majority of the definitions emphasizes the newness of this type of firms and the level of their innovativeness and technology (Saemundsson and Candi, 2017). Storey and Tether (1998) reviewed the NTBFs from two perspectives. They partitioned their definition into (1) 'narrow' and (2) 'broad' perspectives. In the narrow definition, the term is limited to the new independent firms that in the end develop new industries. In the broader definition, the term applies to the wide range of new firms operating in the high-tech industry. In the latter definition, ‘new’ refers to (1) the technology, or to (2) the firm, or even to (3) both (see Storey and Tether, 1998; Saemundsson and Candi, 2017). In this thesis, I define the NTBFs as follows under one umbrella (see definition 1.4). It will be a broad definition. However, as far as I can see it serves our research purpose since we look at new initiatives in combination with new tech. Hence, our definition is straight forward and still far reaching.

> **Definition 1.4*:*** *A* ***New Technology-Based Firm*** *(**NTBF**) is an initiative that is newly established and develops new technologies (see Storey and Tether, 1998; Saemundsson and Candi, 2017).*

Previous investigations (see van Geenhuizen and Soetanto, 2009; Soetanto and Jack, 2016) reported that there is a considerable increase of public investments. The goal is to strengthen universities and to support academic NTBFs. Meanwhile, in return academic NTBFs are likely to depend on universities in receiving updated knowledge and innovation. Thus, universities with the support of industry and government attempt to help NTBFs with different policies such as UBIs. However, when compared to the performance of the other three types of incubators, the efficiency of the UBIs is questioned due to the high rate of failure and slow rate of growth among academic NTBFs (Soetanto and Jack, 2016). Therefore, in this research, I address this gap and choose UBIs to investigate to what extent their support is effective.

1.4 Four Theoretical Perspectives – Four Characteristics

As stated earlier, there is a lack of studies on the impact of the supports by UBIs on the performance of NTBFs. In summary, I reiterate there exists a research gap already for a long time due to the limited theoretical perspectives representing the impact of the supports by UBIs. Although over two decades the issue has been noted by several authors (see Hackett and Dilts, 2004; Ahmad and Ingle, 2013; Eveleens et al., 2017; Lukeš et al., 2019), the UBIs' impact is still unclear. The majority of prior studies has mainly addressed the following four theoretical perspectives: (A) Resource-Based View (RBV) (see Mian, 1996; Hansen et al., 2000; Clarysse and Bruneel, 2007; McAdam and McAdam, 2008), (B) Knowledge-Based View (KBV) (see Colombo and Delmastro, 2002; Soetanto and van Geenhuizen 2010; Sullivan and Marvel, 2011; Patton, 2014), (C) Organizational Learning Theory (OLT) (see Warren et al., 2009; Scillitoe and Chakrabarti, 2010; Patton and Marlow, 2011; Patton, 2014), and (D) Social Capital Theory (SCT) (see Fang et al., 2010; Ebbers, 2013; Eveleens et al., 2017). In this study, I address the impact of the supports by UBIs through the lens of RBV (see subsection 1.5.4). To support our own choice, we describe the main characteristic of each of the four perspectives below in the paragraph A to D.

A: Resource-Based View

The Resource-Based View (RBV) assumes that firms are characterized by collections of different resources and capabilities. In such a configuration, the resources may provide strategic direction and create sustained competitive advantage for firms (see Grant, 1991; Musiolik et al., 2012; Somsuk and Laosirihongthong, 2014; Eveleens et al., 2017). Due to the small and novel nature of NTBFs, it is obvious that such firms are in dire need of both tangible and intangible resources, such as knowledge, financial support, and human capital (see Clarysse et al., 2005; van Geenhuizen and Soetanto, 2009). Therefore, BIs can act as a means to provide different resources for NTBFs to help them grow (see Lockett and Wright, 2005; McAdam and McAdam, 2008).

B: Knowledge-Based View

Seen from the Knowledge-Based View (KBV), knowledge is a fundamental characteristics resource that will have an impact on the firms' performances. It is based on the idea that other types of resources cannot compete with knowledge as they are not easily transferable and thus, they are not able to provide strong advantages for the firms (see Grant, 1996; Eveleens et al., 2017).

C: Organizational-Learning Theory

From the Organizational Learning Theory (OLT) point of view, the knowledge needs to be acquired, distributed and interpreted to determine a firm's performance (cf. Huber, 1991). Eveleens and his colleagues (2017) show that four types of learning are characteristic for organizational learning and have an impact on the performance of the NTBFs. These types are distinguished by two possible relations, viz. individual vs social, and explorative vs exploitative, which are elaborated upon in Chapter 2. Within the entrepreneurship studies, entrepreneurial activities are considered as interactive learning processes through which they can share their knowledge (see Fang et al., 2010). All business incubation literature reviews see an incubation program as a learning context which stimulates knowledge flows for their NTBFs. As a result, the NTBFs are able to create their own social relations and obtain their own required resources (see Fang et al., 2010; Eveleens et al., 2017).

D: Social Capital Theory

Social Capital Theory (SCT) concentrates on the social relations with the others. These relationships are characteristic for SC and are able to facilitate the actions. In the context of entrepreneurship, the SCT states that the positive and negative attitudes towards entrepreneurs, lead to different consequences (see Eveleens et al., 2017). The positive consequences for the entrepreneur might be (a) access to the knowledge and (b) influence on the other actors. The negative consequences may include the risks of group thinking (see Eveleens et al., 2017).

1.5 The Problem Statement and Research Questions

In our study, we take one plain Problem Statement (PS) which is formulated below. Subsection 1.5.1 addresses our contribution to the scientific efforts. Further, we formulate a Problem Statement in subsection 1.5.2. Then, three Research Questions (RQs) in subsection 1.5.3. Their answers will guide us to an answer to the problem statement.

1.5.1 Aiming at Three Contributions

From the above point of deployment, our research aims at achieving a threefold contribution. First, I will investigate the relationship between the supports by UBIs and the performance of the NTBF. By studying their relations and the NTBF's performances, I will respond to the research calls in the incubation literature to investigate and measure the impact of UBIs on the NTBFs' performances (see already Hackett and Dilts, 2008; Eveleens et al., 2017). Second, I will evaluate the empirical evidence about the impact of the supports by UBIs on the performance of the NTBF through the employment of RBV. Third, I will provide recommendations on how UBIs can support their NTBFs more effectively, and a number of concrete avenues for future research.

1.5.2 The Problem Statement

Considering the fact that there is a paucity in previous studies on the influence of the supports by UBIs on the performance of the NTBFs, the following problem statement (PS) is formulated.

> ***PS**: How can university business incubators support their NTBFs effectively?*

1.5.3 Three Research Questions

In order to answer to the problem statement, I formulated the three research questions (RQs).

We start our discourse by assuming that UBIs have impact on the performance of an NTBF by providing a mix of services. However, the extent to where the services might have an impact on the performance of the NTBF is not clear. Indeed, the lack of any theoretical insight into the supportive activities offered by the UBIs is the main trigger of my research (see Bruneel, 2012). For the first step to investigate the impact of the supports by UBIs on the performance of the NTBF, we need to identify the supportive activities. Therefore, the following research question is formulated.

> ***RQ1***: *What are the main supportive activities offered by UBIs that influence the performance of an NTBF?*

Following the identification of the UBIs' supportive activities, we note that we do not have available a concise construct (measurement instrument) that would enable us to measure the extent of the impact of the supportive activities by UBIs on the performance of an NTBF. Furthermore, measuring the performance of the NTBFs is a challenge in the incubation studies. The most used performance criteria are efficiency, survival, market share, growth, profitability, size, goal attainment and the founder's opinion on the success of their NTBFs which they classified into the objective and subjective measure (see Eveleens et al., 2017). The choice of either objective or subjective is greatly impact on the findings of the investigations. As a result, the existing approaches in measuring the performance of the NTBFs show the contradictory outcome in current studies (Wiklund and Shepherd, 2003; Eveleens et al., 2017). In order to avoid the possible biases within each class of the performance measure, we combine both objective and subjective measures. The operationalization of all of the measurement scales are provided in section 4.4.

Below, we give a definition of such a construct.

Definition 1.5*: A* ***construct*** *(as used in this study) refers to an instrument that allows a UBI manager to measure and evaluate the offering supports to their NTBFs. We are now ready to formulate our second research question.*

We are ready to formulate our second research question.

> ***RQ2***: *How can the supportive activities be operationalized in a construct that enables us to measure the impact of the identified supportive activities by UBIs on the performance of an NTBF?*

Despite of the above operationalization of the construct, I came across that it was still not clear *to what extent* these supportive activities by UBIs do have an impact on the performance of the NTBFs. Then, I found a salient point that only a few studies (e.g., Soetanto and Jack, 2016) addressed when reporting on their observation, viz.

that each NTBF has their own innovation strategy in the usage of their support by UBIs. Starting from this salient point of view, it appears that an innovation strategy plays a prominent role in the relation between the supports by an UBI and the performance of an NTBF (see Soetanto and Jack, 2016). Thus, in line with Soetanto and Jack, (2016), I will also consider the role of the innovation strategy in the relation with the supports by UBIs and the performance of an NTBF. So, the third research question is formulated as follows.

> ***RQ3***: *In what way are the identified supportive activities related to (a) the innovation strategy of an NTBF and consequently to (b) the performance of the NTBF?*

Answering the three research questions will enable us to answer the problem statement.

1.5.4 What is the Most Appropriate Theoretical Perspective?

As mentioned earlier, we are to investigate the impact of supports by UBIs on the performances of NTBFs, and do not aim to focus on the learning processes, different type of learnings, or the impact of UBIs on learning and knowledge acquisition by the NTBFs, Therefore, the implication of KBV and Organizational Learning theoretical perspectives may not be an appropriate choice to lead us answer our RQs. Social Capital Theory concentrates also on social relations between the variables which is out of the scope of our investigation. Hence, SCT cannot be a suitable theoretical lens in our investigation. Among the four explained perspectives in section 1.4, it appears that the employment of RBV is the most appropriate theoretical view to answer the RQs and PS. Following the above argument, we see that RBV posits firms to act as a bundle of resources and capabilities which determines the firm's performance. Through the lens of RBV, the supports by UBIs can be considered as external resources which might influence the performance of NTBFs. In addition, measuring the influence of supports by BIs is not possible without considering the capability of the founders of the NTBFs in the usage of the supports. Thus, as RBV considers (1) the firm's resources (internal and external) and (2) the firm's capabilities, and we aim to investigate the possible impact of the supports and resources by UBIs on the performances of the NTBFs with the role of their capabilities, the employment of RBV appears to be the most appropriate theoretical view to address the research gap.

1.6 Research Methodology

To meet the two research objectives (see subsection 1.2.2), I will perform a literature study and an empirical study. The methodology followed consists of seven stages. Stage 1 is a theoretical study. The stages 2 to 5 attempt to answer the three RQs. Stages 6 and 7 are part of the usual scientific procedure of analyzing the results, establishing the findings (i.e., discussion), and formulating the conclusion. Below, we list the stages in full.

1) Literature review
2) Identification of the supportive activities (SA) by UBIs (RQ1)
3) Operationalizing the SA construct of the UBIs (RQ2)
4) Validation of the SA construct of the UBIs (RQ2)
5) Implementation of the SA construct of the UBIs (RQ3)
6) Analyzing the results
7) Discussion and conclusion (PS)

In summary, the seven stages attempt to answer the formulated research questions and the problem statement. For a proper understanding, we briefly discuss the stages 2 to 5 below. Subsection 1.6.1 explains the identification of supportive activities by UBIs. Subsection 1.6.2 briefly presents the operationalization of the SA construct. The validation of the construct of the supportive activities is addressed in subsection 1.6.3. Finally, subsection 1.6.4 elaborates on the implementation of the construct.

1.6.1 Identification of the Supportive Activities (SA) by UBIs

The identification of the supportive activities by the UBIs is conducted through interviews with entrepreneurs. The results answer RQ1 (see Chapter 3). This step is an explorative study which is based on qualitative research. As a first step, I employed a systematic literature review that was mainly based on a well-formulated meta-analysis. Then, I used a combination of observations and semi-structured in-depth interviews with the founders of NTBFs in UBIs. A series of eleven interviews with eleven founders of the NTBFs located in UBIs was conducted to explore the supportive activities of the UBIs from the NTBFs' perspectives. All interviewed founders of the NTBFs operated in the Netherlands. Each interview was recorded, transcribed and approved by the interviewees. Next, I categorized and coded the transcription of the interviews to analyze them.

1.6.2 Operationalization of the SA Construct of the UBIs

The operationalization of the SA construct should be conducted to measure the impact of the support by the UBIs and to facilitate their managers with a measurement tool. The operationalization stage is performed in Chapter 4, and the results will contribute to partial answering RQ2. For evaluating the reliability of the operationalization of the construct, I interviewed four NTBFs entrepreneurs, three UBI's managers and nine scholars. The interviewees were convenience-sampled (cf. Bryman, 2012). Due to the convenient access, the sample is selected from the Netherlands, France and Denmark. The scholars were faculty members in Leiden University, Delft University of Technology, Université de Lorraine, and Aarhus Business School. The entrepreneurs were affiliated to Yes!Delft UBI and Leiden Bio-Science Park.

1.6.3 Validation of the SA Construct of the UBIs

The validation of the construct of the SA is carried out in chapter 5. The results of chapter 5 will contribute to answering RQ2 completely. The procedure includes four levels. In first level, the correlation matrix, Kaiser-Meyer-Olkin index and Bartlett's

Test of Sphericity are conducted to check whether the data is appropriate for the Principal Component Analysis. In the second level, the Principal Component Analysis is performed in order to extract the components from the data. Therefore, the eigenvalues of the (a) extracted components are checked according to the Kaiser's Criterion, (b) the Scree Plot of the eigenvalues is inspected, and (c) Parallel Analysis is conducted to cross check the visual inspections. In the third level, Promax Rotation on the independent variables and the Varimax Rotation Method on the Moderators are performed to extract the items with an acceptable validity for further analysis. General threshold criteria (component-loadings > 0.6 and cross-loadings < 0.3) are checked for each item in the rotated component solution. Items not fulfilling these thresholds are excluded. As a result of these three levels, the validity of the constructs has been checked. In the fourth level, Cronbach's Alpha coefficients and Composite Reliability are calculated to evaluate the reliability of the component solution.

1.6.4 Implementing the SA Construct of the UBIs

The implementation of the construct to measure the impact of the supportive activities construct is presented in Chapter 6. This stage contributes to the RQ3. To this end, a multiple linear regression analysis method will be performed to analyze the relationships between supports by the UBIs, and the performance of the NTBF. Also, the moderation impact of NTBFs' capability on the relation between the supports by UBIs and the performance of NTBFs will be evaluated.

1.7 Structure of the Study

The thesis consists of eight chapters. The structure of the thesis is presented in Figure 1-1, and the overview of each chapter are given below.

Chapter 1: Supporting New Technology-Based Firms

Chapter 1 provides an introduction to the thesis with the aim of providing the readers with the motivation, the research objectives, the problems statement, the research questions, and the research methodology. An overview of the structure of the thesis is presented in this chapter as well.

Chapter 2: Literature Review and Theoretical Embedding

The objective of chapter 2 is to review the previous studies on business incubators. In addition, the main four theoretical perspectives in the business incubation literature are elaborated. The chapter concludes in employing the Resource-Based View (RBV) as a proper theoretical perspective to provide answers to our RQs and PS.

Chapter 3: Supports by the Business Incubators

Chapter 3 identifies supportive activities (SA) by UBIs and addresses RQ1. A qualitative research method is performed to explore the supports by UBIs. Five main supports are investigated and addressed. The explored supports are: (1) access to the networks, (2) knowledge development and dissemination, (3) finance and administrative mobilization, (4) growth control, and (5) creation of exposure.

Chapter 4: Operationalization of the SA Construct

In chapter 4, the construct to measure the relations between supports by UBIs (explored in chapter 3) and the performances of the NTBFs are described. RQ2 is addressed in this chapter. The SA construct aims to enable UBIs managers to measure the effectiveness of their supports on the performances of their incubated NTBFs.

Chapter 5: Validation of the SA Construct

Chapter 5 elaborates on the evaluation of the validity and reliability of the SA construct, which contributes to answering RQ2. In this chapter, we present the result of the interviews with scholars and entrepreneurs concerning testing the construct validity. Employing statistics enabled us to check the construct reliability.

Chapter 6: Implementation of the SA Construct

Chapter 6 provides an answer to the RQ3. Conducting a multiple regression analysis technique allows us to answer this question. Based on the statistical results of the analysis, a model for measuring the effective supports by UBIs is evaluated. Finally, the answer to the PS will be provided.

Chapter 7: Research Answers and Recommendations

Chapter 7 summarizes the answers to the formulated RQs. Thereafter, the answer to the problem statement is elaborated upon. Moreover, practical and theoretical contributions are further worked out. Subsequently, the research limitations are presented. Finally, the chapter concludes with five recommendations for future research. Table 1.1 briefly describes the research stages in this thesis.

Table 1-1: Research Stages

Research Stage		**Ch.**	**Research Methodology**	**RQ1**	**RQ2**	**RQ3**	**PS**
Stage 1	Introduction	1	-	✓	✓	✓	✓
		2	Literature review				
Stage 2	Identification of SA of UBIs	3	Interview and literature review	✓			
Stage 3	Operationalization of SA construct	4	Interview and literature review		✓		
Stage 4	Validation of SA construct	5	Quantitative Methods		✓		
Stage 5	Implementation of SA construct	6	Quantitative Methods			✓	
Stage 6	Analyzing the results	7	Quantitative Methods			✓	
Stage 7	Discussion and Conclusion	8	-	✓	✓	✓	✓

Figure 1-1: Thesis Structure

Ch.1: Supporting New Technology-Based Firms
- Motivation
- Problem Statement
- Research Questions
- Research Methodology

Ch.2: Literature Review and Theoretical Embedding
- Related Work: review the Business Incubators studies
- Theoretical Embedding: Recourse-based View, Knowledge-based View, Organizational Learning Theory, Social Capital Theory

RQ1

Ch.3: Exploration of the Supportive Activities construct by University Business Incubators
- **RQ1:** What are the main supportive activities offered by UBIs that influence the performance of an NTBF?
- **Results**: (1) access to the networks, (2) knowledge development and dissemination, (3) finance and administrative mobilization, (4) growth control, and (5) creation of exposure.

Qualitative data collection and data analysis
Procedures & Products:
One-to- one semi-structured interviews
Transcripts and Coding

RQ2

Ch.4: Operationalization of the SA Construct
- **RQ2*:*** How can the supportive activities be operationalized in a construct that enables us to measure the impact of the identified supportive activities by UBIs on the performance of an NTBF?
- **Result:** The two supportive activities integrated into a theoretical construct.

Development the construct and a measurement instrument

Procedures & Products:
Define and develop 6 measurement scales

Ch.5: Validation of the SA Construct
- **RQ2*:*** How can the supportive activities be operationalized in a construct that enables us to measure the impact of the identified supportive activities by UBIs on the performance of an NTBF?
- **Result:** The construct has an acceptable and good validity and reliability.

Quantitative data collection
Procedures & Products:
N=96
Scale reliability and validity

RQ3

Ch.6: Implementation of the SA Construct
- **RQ3*:*** In what way are the identified supportive activities related to (a) the innovation strategy of the NTBFs and consequently to (b) the performance of the NTBF?
- **Result:** The positive influence of knowledge development and dissemination by UBIs is positively moderated when NTBFs have higher learning ability (i.e., absorptive capacity)

Quantitative data analysis

Procedures & Products:
Hypothesis testing
Correlations, Multiple Regression Analysis

Discussions and Conclusion

Ch.7: Answering the Problem Statement:
Business incubators can provide their supports more effectively via:
(1) providing more tailored and customized services on training, coaching, and mentoring;
(2) intervening more strongly through the growth process of their NTBFs and help the NTBFs develop their absorptive capacity to identify and utilize knowledge resources;
(3) train their NTBFs to enrich their absorptive capacity to be more independent from incubators and have a stronger ability to utilize external knowledge resources both during their incubation process and post-incubation.

Chapter 2

Literature Review and Theoretical Embedding

Chapter 2 describes a literature review particularly conducted for our research. Section 2.1 reviews the previous studies on business incubators and addresses the research gap. Section 2.2 investigates the theoretical assumptions employed in the business incubation literature. Finally, section 2.3 summarizes all the theoretical views and addresses the selected theoretical lens for this study, viz. RBV.

Business incubators are a rather novel form of supporting entrepreneurs. They attempt to facilitate knowledge transfer and help entrepreneurs through the provision of particular services and resources (see Albort-Morant and Oghazi, 2016; Wonglimpiyarat, 2016; Wu and Han, 2017). Generally, business incubators have been created as a supportive mechanism for new technology-based firms with the goal to stimulate the formation of technology-intensive companies and their growth through the linkage between technology, business, and capital (see Chan and Lau, 2005; Grimaldi and Grandi, 2005; McAdam and McAdam, 2008). As a result of their support, NTBFs experience (1) a longer survival, (2) a more stable business, and consequently (3) a positive growth in the economy (see Schwartz and Hornych, 2008; Schwartz, 2013; Albort-Morant and Oghazi, 2016).

2.1 Three Definitions from Three Generations of Business Incubators

Over the years, BIs have garnered burgeoning interest from practitioners, scholars, and policymakers for their contribution to entrepreneurship and innovation (cf. Phan et al., 2005; Eveleens et al., 2017; van Rijnsoever et al., 2017). Current literature on BIs provides a large number of definitions for them. However, due to the existence of various kinds of organizations such as business incubators with regional and national differences (cf. Aaboen, 2009), there is no clear definition for business incubators (cf. Bruneel et al., 2012).

Bruneel et al. (2012) showed that the range of support by BIs has been evolved since the 1950s and it led to the emergence of *three generations* for BIs (see Table 2-1). In the 1980s, the first generation of BIs basically provided more shared *tangible resources* (e.g., office space, reception, conference rooms, and laboratories) (first definition) (Bruneel et al., 2012). In the 1990s, the emergence of IT changed the provision of the supports by BIs and their purposes (van Rijnsoever et al., 2017). Thus, the second generation emerged. This generation concentrated more on *organizational learning* and supplemented intangible resources (e.g., coaching, training programs, consultancy and weak-networking) for their NTBFs (second definition). The third generation is called *network-based incubators*. It attempts to provide access to the required resources for NTBFs, particularly by using networks and venture capital (third definition) (Bruneel et al., 2012; Eveleens et al., 2017). Table 2-1 summarizes the evolution of the value added by BIs.

Table 2-1: The Evolution of the Value added by BIs to the NTBFs

First Generation (1980s)	**Second Generation (1990s)**	**Third Generation (2000-2020)**
Shared office space	Shared office space Training Consultancy Weak networking	Shared office space Training Consulting Networking Venture capital

In Table 2-2, three definitions from three generations are given. They depict a complete picture of BI definitions (ranging from an emerging definition via a progressing definition to a mature definition). In conclusion, business incubators are initiatives which provide their tenants with shared physical facilities (cf. Hackett and Dilts, 2004; Phan et al., 2005; Grimaldi and Grandi, 2005), with different business-oriented services (cf. Hackett and Dilts, 2004), and with networks to increase NTBFs' chances of survival (cf. Bruneel et al., 2012).

Table 2-2: Definitions of Business Incubators

Emerging definition: BIs are a means to fostering new enterprises through the provision of office spaces and shared facilities (see Allen and McCluskey, 1990).
Progressing definition: BIs are a shared office space facility, seek to provide its incubatees with a value adding intervention system of monitoring and business assistance (see Hackett and Dilts, 2004, p.57).
Mature definition: BIs are used to describe a wide range of organizations that support entrepreneurs to launch their businesses though the provision of training, networking advising activities, and venture capital (see Eveleens et al., 2017).

Below we discuss four topics. Subsection 2.1.1 elaborates on the three goals of different generations of BIs. In Subsection 2.1.2, we address the typology of the BIs. Then, in Subsection 2.1.3, we highlight the area and domain of our research. Finally, in Subsection 2.1.4, we address the shortcomings and missings in the literature.

2.1.1 The Goals to be Achieved

In this subsection, we describe three different goals that three generations of BIs aim to reach. In the incubation literature, a number of studies focus on the advantages of business incubators for NTBFs, and explore the added value to NTBFs located within BIs (see, e.g., Colombo and Delmastro, 2002; Ferguson and Oloffson, 2004; Hackett and Dilts, 2004; Bergek and Norrman, 2008; Bøllingtoft, 2012; Bruneel et al., 2012). Three specific goals of BIs as put forward by these studies are as follows:

Goal 1: to stimulate the commercialization of research in universities and research institutes (particularly generation 1),

Goal 2: to impact economic development positively through enhancing entrepreneurship (particularly generation 2), and

Goal 3: to increase the rate of survival of new technology-based firms in their early stages (particularly generation 3) (cf. Hackett and Dilts, 2004; Bergek and Norrman, 2008; Schwartz; 2013).

A prior study by Ferguson and Oloffson (2004) compared the growth indicators of 30 NTBFs located in BIs of science parks with 36 NTBFs' performance located off-parks. Their results indicated that NTBFs located in BIs, have a better rate of survival than those that are off-BIs. Similarly, Chan and Lau (2005) assessed the development of six NTBFs within BIs. They concluded that BIs have a positive impact on the lifecycle of the NTBFs. Later on, and in line with previous studies, Mas-Verdu et al. (2015) examined the influence of BIs on NTBFs' survival. However, their findings revealed that BIs, on their own, have insufficient means to impact NTBFs' survival. The level of business innovation, size, sector, and export activities of NTBFs should affect survival (Mas-Verdu et al., 2015).

2.1.2 Typology of BIs

Based on the type of sponsors and stakeholders of the BIs or the sources of supports, BIs are classified into public, private, and no sponsored groups (see Grimaldi and Grandi, 2005; Bergek and Norrman, 2008; Bøllingtoft, 2012). More specific, Grimaldi and Grandi (2005) have proposed a spectrum ranging from (A) public to (B) private and (C) independent business incubators.

A: Public Incubators

Public incubators use public resources with the aim of economic development and job creation (Grimaldi and Grandi, 2005). They are classified into two groups: (A1) Business Innovation Centers (BICs) and (A2) University Business Incubators (UBIs). The BICs are the most popular incubators offering mostly tangible resources and basic services to their tenants. The UBIs are set up by universities and provide services for NTBFs through the interaction with universities (e.g., access to the latest knowledge, faculty consultants, educated workforce, laboratories, and technology transfer programs) (Grimaldi and Grandi, 2005; McAdam and McAdam, 2008;

Wonglimpiyarat, 2016). A cooperation with a university usually leads to a reduction in development cost for NTBFs. Furthermore, as universities are the fundamental resource of innovation, this cooperation might have a positive influence on the perceptions of NTBFs' customers that the outcome of the NTBF is based on the latest knowledge (McAdam and McAdam, 2008; Stal et al., 2016).

B: Private Incubators

Grimaldi and Grandi (2005) classify private incubators also into two categories: (B1) Corporate Business Incubators (CBIs), and (B2) Independent Business Incubators (IBIs). CBIs are set up by large companies, while IBIs are the other private type of incubators owned by single individuals, namely accelerators, to invest in NTBFs and support them to develop (Grimaldi and Grandi, 2005).

C: Independent Incubators

Later, Bøllingtoft (2012) identifies a new type of BIs called bottom-up business incubators, which is a self-generated-entrepreneurial-enabled environment. The bottom-up business incubators are set up by entrepreneurs and receive no public or private support (Bøllingtoft, 2012).

2.1.3 Our Research Area

In the thesis, I have chosen to study UBIs (i.e., type (A2)). Two main reasons for this selection are: (1) universities continuously have access to the talents and the latest knowledge. Consequently, more new ideas and businesses will be generated (see Dahms and Kingkaew, 2016), and (2) while NTBFs suffer from management knowledge, universities, particularly in collaboration with business schools, are an appropriate alternative to support them (cf. Barbero et al., 2012; Dahms and Kingkaew, 2016).

2.1.4 Shortcomings and Missings

In summary, our review of the related literature reveals that there is a large number of studies on the advantages of BIs, their characteristics, and their typology (see, e.g., Löfsten and Lindelof, 2001; Colombo and Delmastro, 2002; Hackett and Dilts, 2004; Bøllingtoft and Ulhoi, 2005; Chan and Lau, 2005; Bergek and Norrman, 2008; Vanderstraeten and Matthyssens, 2012). From these studies, we see that two shortcomings exist in the incubation literature. First, it is not still clear to what extent BIs have an impact on the performance of the NTBFs (see Hackett and Dilts, 2008; Bruneel et al., 2012; Stokan et al., 2015; Soetanto and Jack, 2016; Eveleens et al., 2017). Second, although there is growing attention to the BIs studies, there still is a missing of in-depth theoretical perspectives in the relevant literature.

To address these shortcomings and missings and to obtain more understanding about business incubators, our study concentrates on the impact of the supports by UBIs on the performance of the NTBFs.

2.2 Four Theoretical Perspectives

In this section, the four theoretical perspectives that are mostly employed to study BIs, are addressed (see Eveleens et al., 2017, and also section 1.4). Subsection 2.2.1 explains Resource-Based View. The Knowledge-Based View is addressed in subsection 2.2.2, mainly as a Theoretical perspective. Subsection 2.2.3 presents the Organizational Learning Theory perspective. Social Capital Theory is described in subsection 2.2.4. The order is chronologically based. In the beginning of BIs, it was believed that the main drivers of the support were the offered resources by BIs. Thereafter, one believed that access to capital was an important issue. The third issue to give a position to any BI was the possession of knowledge. However, even with all the mentioned three issues, the BI was not always a success. This was a thing to be remediated by organizational learning. Finally, subsection 2.2.5 reviews the four presented theoretical perspectives.

2.2.1 Resource-Based View

A Resource-Based View (RBV) explains that firms are collections of different resources that are Valuable, Rare, Inimitable, and Non-substitutable (hereafter VRIN), which possess a range of capabilities. RBV describes how firms are able (1) to achieve their competitive advantages and (2) to sustain the acquired advantages over time (Barney, 1991; Eisenhardt and Martin, 2000). Indeed, when firms have access to VRIN resources, they can obtain a sustainable competitive advantage (see Musiolik et al., 2012; Somsuk and Laosirihongthong, 2014). Some examples of VRIN resources are knowledge, credibility, and trust, which cannot be acquired easily (Eveleens et al., 2017).

The resources are classified into two clusters. First, we have tangible resources that include (a) facilities, and (b) capital goods, such as machines and financial assets (see Musiolik et al. 2012; Eveleens et al., 2017). Second, we have intangible resources that include a wide range of less visible assets, such as trademarks, knowledge, and reputation. In such a configuration, resources provide a strategic direction and show sustained competitive advantages for the firms (see Musiolik et al., 2012; Somsuk and Laosirihongthong, 2014).

While accessing the VRIN resources is necessary, they are not sufficient for the growth of the NTBFs. NTBFs also need to be equipped with capabilities (see Newbert, 2007). A capability is a firm's ability (a) to utilize its inputs such as resources and (b) to efficiently combine and transfer them into their desired objectives (Dutta et al., 2005). Indeed, capabilities are intermediaries between (1) a firm's resources, and (2) its performance (Dutta et al., 2005).

Our Conclusion on RBV in the incubation literature

Prior investigations (see, e.g., Eveleens et al., 2017) reviewed the empirical literature on the different theoretical perspectives employed in business incubator studies. They showed that the majority of previous studies on business incubators are inclined to use RBV. These studies see BIs as a means to support their NTBFs through the provision of the essential external resources and capabilities. The expectations are that they will have impact on the growth of the NTBFs (see McAdam and Marlow, 2007; Clarysse and Bruneel, 2007; McAdam and McAdam, 2008; Li and Chen, 2009; Chen, 2009; Soetanto and Jack, 2016). Supportive studies mentioned earlier have highlighted that such external resources showed indeed a positive impact on the performances of the NTBFs. In addition, other previous investigations identified different resources by business incubators for NTBFs, such as financial capital resources, a general network, technical and managerial knowledge, and human resources (see, e.g., Hansen et al., 2000; Bøllingtoft and Ulhøi, 2005; Bergek and Norrman, 2008; Eveleens et al., 2017).

Here we remark that the majority of the previous investigations which used RBV, mainly explained how these resources and capabilities are conveyed to the NTBFs (Rothschild and Darr 2005; Scillitoe and Chakrabarti 2010; Soetanto and Jack 2013; Eveleens et al., 2017). For instance, Hansen et al. (2000) discussed how organized networking supportive activities as performed by business incubators are able to provide NTBFs with their required resources in a right time and with positive impact on their performances. Moreover, Patton et al. (2009) and Soetanto and Jack (2016) also performed this type of research. This research led us to further research of the impact of relational issues and knowledge resources on the performance of the NTBFs. In the same way, the impact of different tangible and intangible resources by business incubators on the growth of NTBFs was analyzed by McAdam and McAdam (2008). The influence of relational resources (networking) by incubators on the developing stages of NTBFs has been addressed by Schwartz and Hornych (2008). Here some prior investigations had shown that business incubators were also able to have impact on the capabilities of the NTBFs (see Chen and Wang, 2008; Li and Chen, 2009; Fang et al., 2010). In line with this remark, Bøllingtoft and Ulhøi (2005) stated that business incubators provide access to the general networks for all of their NTBFs. In accordance, Rothaermel and Thursby (2005) revealed that business incubators exploited their external resources to provide their NTBFs with additional funding and technical knowledge (see Eveleens et al., 2017).

2.2.2 Knowledge-Based View

The Knowledge-Based View (KBV) emphasizes the effect of knowledge on the firm's performance. According to KBV theory, knowledge is one of most critical resources of the firms. Compared to other firm's resources, knowledge cannot be transferred easily. Therefore, the KBV is able to give particular competitive advantages to firms (Grant, 1996). Moreover, Grant (1996) showed that knowledge needs to have the following characteristics to be utilized in a firm and consequently create value. The identified characteristics are:

(1) transferability,

(2) capacity for aggregation, and

(3) appropriability (see Grant 1996).

Our Conclusion on KBV in the incubation literature

Apart from the given characteristics, knowledge has different typologies. Each type has a specific effect on the firm's performance. The following three types of knowledge have a strong influence on NTBFs' performance: (1) market, (2) technology, and (3) business and management (see Eveleens et al., 2017). Market knowledge refers to the identification of market segmentation, customer needs, and competitors. Technological knowledge explains the function of the technology and how it performs. Business knowledge addresses how founders launch new ventures, hire new staff, and acknowledge the business laws and regulations.

2.2.3 Organizational Learning Theory

The Organizational Learning Theory (OLT) emphasizes learning to consist of (1) the process of knowledge creation, acquisition, and distribution, and (2) its outcome. According to this theory, the NTBFs' activities are learning processes that lead to knowledge creation and distribution (see Fang et al., 2010). Indeed, learning is a prominent feature of the accumulation of technology to empower NTBFs to compete.

OLT posits that learning provides a key advantage to the firms over their competitors (see Eveleens et al., 2017).

OLT classifies learning into different types. For NTBFs, the four most relevant types are (1) social, (2) individual, (3) exploitative, and (4) explorative (Eveleens et al., 2017). First, while (1) the social type takes place *in relation to* the NTBFs environment, (2) individual learning occurs *within* the individuals (see Wang and Chugh 2014). Second, while (3) exploitative learning involves *the development* of current technologies, products, and services, (4) explorative learning attains *identifying new opportunities*, new markets, products, and services. Within the NTBFs, making a balance between exploitative and explorative learning is a key to obtain advantages to compete and create short-term and long-term benefits (see Eveleens et al., 2017).

Our Conclusion on OLT in the incubation literature

Previous literature in the incubation studies that employed OLT showed that BIs attempted to provide a learning environment for their NTBFs (see Hughes et al., 2007; Zolin et al., 2011). The provision of such an environment could be done through supportive networking activities by BIs (see Eveleens et al., 2017). Indeed, NTBFs achieved the mentioned three types of knowledge through the interactions with BIs' networks including mentors, advisors, corporates, and BIs' management teams (see Bruneel et al., 2012). In summary, it seems that the interactions between NTBFs in BIs, provide NTBFs with access to knowledge.

2.2.4 Social Capital Theory

The Social Capital Theory (SCT) is to be seen as a broad theoretical perspective which can be employed in sociology, economics, business, and particularly in the entrepreneurship (see Ebbers, 2013; Johnson, 2013). Here we quoted Johnson, (2013, p.4) "Social capital theory (SCT) is an efficient interdisciplinary concept for explaining how self-interested individuals engage in collective behaviors and maintain social order. Two principal components of social capital are:

(1) social networks of individuals who exchange reciprocal cooperation and build collective resources, and

(2) individual gains in personal resources by taking advantage of social networks".

In the entrepreneurship literature, SCT states that the positive or negative attitudes of others about entrepreneurs, lead to specific consequences. The positive consequences include improving access to the knowledge, obtaining more power, and increasing in a scene of belonging. The negative consequences of social capital are mainly the costs of keeping the relationships (see Eveleens et al., 2017). Within the entrepreneurship research streams, one of the fundamental aspects of SCT that has extensively been studied is social networks (see Slotte-Kock and Coviello, 2010; Ebbers, 2013). Social networks are employed to describe the use of relationships in achieving the required knowledge and resources (Chen and Wang, 2008). Indeed, the relationship with others builds the infrastructure of social capital. Eveleens et al. (2017) identified three dimensions of social capital. Below we mention the three identified dimensions and discuss them. They are (A) relational dimension, (B) structural dimension, and (C) homophily dimension.

A: Relational dimension

The relational dimension refers to the strength of the ties in a relationship. On the one hand, the family and friendship relationships have strong ties due to the emotions. These types of relations are more reliable, but the opportunity cost of maintaining them is high. On the other hand, weak ties are valuable too. They can provide firms access to several sources of information, and their maintaining cost is low (Eveleens et al., 2017).

B: Structural dimension

The structural dimension of social capital explains the level of connection between the nodes of the network. The closer connection between the actors in a network, the higher closure, and consequently, the more an actor's social capital increases.

However, less closure has the potential to increase the social capital of the actor as well. The reason is that it provides access to the required knowledge and information for the actors. For NTBFs, less closure has more impact on their performance (Stam et al., 2014).

C: Homophily dimension

The homophily dimension describes the similarity between the two actors of the networks. This similarity is about their knowledge and what they think. Either a high degree or low degree of homophily positively impacts on the social capital. The first one occurs due to a similar understanding, while the second one provides access to alternative resources. Previous studies showed that a low degree of homophily has more relation with the performance of NTBFs than the higher degree (see Stam et al., 2014; Eveleens et al., 2017).

Our Conclusion on SCT in the incubation literature

Through the lens of SCT, entrepreneurship scholars concentrate on:

(1) the content of various social network relationships such as family and close friends,

(2) their mechanisms, and

(3) their network structure for NTBFs.

The majority of previous investigations has studied the impact of networks on the performance of NTBFs. According to the three dimensions of social capital, Eveleens et al. (2017) stated that BIs have effect on the dimensions of NTBFs' social capital and therefore, help them form more relations.

For the structural dimension, NTBFs working in BIs can benefit from proximity to other NTBFs. These benefits include forming internal networks, exchanging knowledge and accessing to the resources (Bøllingtoft, 2012; Ebbers, 2013; Eveleens et al., 2017). In addition, BIs' managers attempt to connect their NTBFs with their external networks as well. As a result, BIs' networking activities lead to closer relations in different types of networks for their NTBFs.

Since BIs impact the relational dimension of the NTBFs' social capital, they also attempt to make strong ties between their NTBFs and strengthen the relations between the management team of BIs with their NTBFs. Furthermore, BIs develop weak relations between their NTBFs and other external networks as well (Bøllingtoft and Ulhøi, 2005; Eveleens et al., 2017). All in all, the BIs have a clear effect on the homophily dimension of their NTBFs' social capital.

2.2.5 Review of the Theoretical Perspectives

Reviewing the four discussed theoretical perspectives, we saw that they differ in terms of their intermediary benefits. For RBV, the intermediary benefits are resources and capabilities. The research stream of RBV concentrates on the impact of resources on the development of NTBFs. For SCT, the intermediary benefit is social relations (Eveleens et al., 2017). The investigations in the SCT area have focused on the extent that NTBFs develop their relationships and on the networking activities discussions. In KBV and OLT, intermediary benefits are knowledge and learning. Each of these perspectives has its own theoretical mechanism in the business incubation literature.

Studies with RBV perspectives see BI as a bridge between its NTBFs and its environment to leverage the required resources and capabilities (see McAdam and McAdam, 2008; Bergek and Norrman, 2008). The key resources deployed by NTBFs are business supportive activities of BIs. For NTBFs in UBIs, the proximity to a university increases the likelihood of access to the latest knowledge, facilities, and skilled labor. Here, UBIs provide their NTBFs with access to the resources of business advice and consultants (Hansen et al.,2000; Soetanto and Jack; 2016; Eveleens et al., 2017).

In contrast, theoretical mechanism for SCT concentrates mostly on networking activities and on how NTBFs develop their relations and in the networks provided by

BIs. Investigations on adopting KBV and OLT focus on the knowledge exchange and the learning process for NTBFs, with the role of BIs in between.

In order to model the resources and supports by UBIs, we employ RBV. It appears that by this combination an appropriate theoretical perspective is used. Furthermore, while this theoretical perspective considers the combination of a firm's resources and their capabilities (ability to use resources), employing this theory is able to provide us with much more insight into the extent to which NTBFs use the resources by UBIs. Table 2-3 provides us with an overview of the selected investigations on the business incubators with a focus on their supportive activities from different theoretical perspectives.

Table 2-3: Overview of the Reviewed Literature of BIs

Authors	Research Sample	Theoretical Perspectives	Research Approach	Focus
Mian (1996)	6 UBIs in US	RBV	Mixed methods	The identification of value-added by BIs for NTBFs
Colombo and Delmastro (2002)	45 NTBFs within incubators, 45 NTBFs out of incubators- Italy	KBV, RBV	Quantitative	The comparison analysis between the performance of the on- and off-incubator firms.
Grimaldi and Grandi (2005)	8 Italian incubators	RBV	Qualitative	The identification of the typology of business incubators
McAdam and McAdam (2008)	longitudinal evidence gathered from 18 HTBFs	RBV	Qualitative	The usage of resources by NTBFs during their development process
Patton et al. (2009)	12 NTBFs located in BIs in UK	RBV	Qualitative	Description on the importance of the support by BIs
Soetanto and van Geenhuizen (2010)	100 NTBFs located in UBIs in the Netherlands and Norway	SCT, RBV, KBV	Quantitative	The role of networking activities by BIs on the performance of the NTBFs
Schwarts and Hornych (2010)	150 NTBFs located in BIs in Germany	SCT, RBV, KBV	Quantitative	The comparison between support by generalized and specialized BIs

Patton and Marlow (2011)	27 NTBFs within the incubator membership at Bristol and Southampton	OL, KBV, RBV	Qualitative	The influence of support by BIs on the learning by NTBFs
Zolin et al. (2011)	214 incubated-NTBFs in Germany	OL, SCT	Quantitative	The influence of adding new members to the NTBF on the flexibility of the team.
Bruneel et al. (2012)	7 European business incubators	RBV	Qualitative	The evolution of BIs, identification of supports by BIs and their value proposition
Vanderstraeten and Matthyssens (2012)	9 non-profit incubators in Belgium	RBV	Qualitative	The identification and description of the service-based strategies of BIs
Bøllingtoft (2012)	in 2 bottom-up incubators in Denmark	RBV	Qualitative	Actual networking and cooperation activities of BIs
Ebbers (2013)	101 NTBFs in the Netherlands	SCT	Quantitative	Networking behaviour of entrepreneurs in BIs
Rubin et al. (2015)	11 incubators in Australia and Israel	KBV	Qualitative	Analyse the knowledge flows and interrelations between BIs and NTBFs.
Soetanto and Jack (2016)	141 NTBFs in BIs located in UK, the Netherlands and Norway	RBV	Quantitative	The influence of the networking and business advisory services by BIs on the performance of NTBFs
Van Weele et al. (2017)	6 European BIs	RBV	Qualitative	The identification of NTBFs' resources needs and gaps
Van Weele et al. (2018)	90 NTBFs in Europe, 191 NTBFs in US, Israel and Australia	RBV, SCT	Qualitative	NTBFs' challenges and the extent that BIs can help them
Soetanto and van Geenhuizen (2019)	100 NTBFs located in BIs in the Netherlands and Norway	RBV, SCT	Quantitative	The relations between university and NTBFs

2.3 Chapter Conclusion

Despite the growing research in business incubation studies, it is not yet clear *how* the different support activities of UBIs and the NTBF's capabilities have an impact on the performance of the NTBFs (Grimaldi and Grandi, 2005; Bergek and Norrman, 2008; Bollingtoft, 2012; Eveleens et al., 2017; Soetanto and Jack, 2018). Due to the small and novel nature of the NTBFs, it is obvious that such firms are in dire need of tangible and intangible resources, such as knowledge, finance, and human capital (Clarysse et al., 2005; van Geenhuizen and Soetanto, 2009). Therefore, BIs can act as a tool to provide different resources for NTBFs in order to help them grow (Lockett and Wright, 2005; McAdam and McAdam, 2008). It is well known that a prior investigation stated that the survival and growth of NTBFs are a competitive advantage of UBIs (see Somsuk and Laosirihongthong, 2014). Thus, the RBV theory can be implemented as a means of describing to what extent resources of UBIs enable NTBFs to create competitive advantages and a promising performance. Here we add to this, that it can explain what kind of resources by UBIs will have an impact on the superior performance of the NTBFs (Somsuk and Laosirihongthong, 2014). Further, RBV assumes that firms are collections of different resources and capabilities. In such a configuration, the resources may provide a strategic direction and create a sustained competitive advantage for firms (Grant, 1991; Musiolik et al., 2012; Somsuk and Laosirihongthong, 2014).

To conclude, as we aim (1) to investigate the influence of two supports by the UBIs on the performance of the NTBFs and (2) to consider the relevant NTBF's abilities (e.g., capability) in using these supports, we here establish that RBV's perspective is the most appropriate perspective to provide us with answers to the RQs. In contrast, the SCT, KBV, and OLT perspectives are more proper to explain specific supports by BIs (e.g., social capital and knowledge sharing), which make us more confident about the appropriateness of RBV to answer our RQs. This approach is also in line with previous studies (see McAdam and Marlow, 2007; Chen, 2009; Soetanto and Jack, 2013; Soetanto and Jack, 2018), which investigated the impact of BIs on the performances of NTBFs.

Two research streams

Due to the importance of the capabilities of the firms, previous researchers have thoroughly studied the notion of research streams (see Newbert, 2007; Koryak et al., 2015). Already Newbert (2007) has identified roughly 27 types of capabilities. In this thesis, we will build our framework based on the relevant capabilities in using the support by BIs (e.g., financial capability, absorptive capacity). The relation between firm resources and capabilities divides the RBV studies into two research streams (Rivard et al., 2006). The first research stream considers the resources including capabilities (see, e.g., McAdam and McAdam, 2008; March, 1991), whereas the second stream distinguishes resources from the capabilities (see Dutta et al., 2005; Hackett and Dilts, 2004). The second stream is characterized by the idea that the capabilities represent a firm’s capacity to utilize resources (see Dutta et al., 2005). In this thesis, I follow the second research stream in developing our research path towards the formulation of a conceptual model.

As mentioned earlier, the majority of previous investigations in analyzing the activities and processes of BIs is conducted through the lens of RBV (see Eveleens et al., 2017). However, these studies have been performed almost solely with a rather limited role assigned to the NTBF strategy (see Soetanto and Jack, 2016). The authors stated that previous investigations in the context of the interaction between support by BIs and NTBFs mainly concentrated on the outcome of the NTBFs. They overlooked that NTBFs might take a different innovation strategy when they receive support from BIs. In addition, the investigations in the context of strategy within NTBFs do not consider the influence of BIs on the performances of NTBFs. It means that they neglected the fact that NTBFs take various strategical approaches in receiving support by BIs. On top of that, the unclear quality of the current and the proposed measurement tools will result in a quite limited generalizability of the findings. All in all, I will consider the role of NTBFs’ innovation strategy by emphasizing the analysis of the impact of the support by BIs on the performance of the NTBFs.

Chapter 3

Supports by the Business Incubators

This chapter addresses *RQ1*: *What are the main supportive activities offered by UBIs that influence the performance of an NTBF?*

Despite all recent substantial research efforts, it is still unclear to what extent the activities of incubators have an impact on the performance of an NTBF and on the innovation strategy (Soetanto and Jack, 2016; van Rijnsoever et al., 2017; Soetanto and Jack, 2018). Chapter two revealed that the results of the previous studies are not sufficiently specific (see Hackett and Dilts 2008; Schwartz, 2013). It is our aim in this chapter to address the gap by investigating explicitly the *nature of the supportive activities offered by business incubators, in particular by university-based ones.*

The chapter proceeds as follows. Section 3.1 explains the reasons behind the creation of BIs. Section 3.2 gives a literature review on the nature and characteristics of the UBIs. In section 3.3 our research methodology is described. Then we address the field work in section 3.4. Finally, section 3.5 provides a conclusion.

This chapter is based on the following publication:

Samaeemofrad, N., van den Herik, H. J., and Verburg, R. (2016). **A New Perspective on Business Incubators.** In the proceedings of the 2016 ICE/ITMC International Conference, Trondheim, Norway 2016 (IEEE Xplore).

[1] The author would like to thank her co-authors for the co-operation and the publisher of the ICE/ITMC 2016 proceedings for their permission to reuse relevant parts of the article in this thesis.

3.1 Why BIs are Created?

As highlighted earlier, NTBFs stimulate innovation and are important for job-creating. As such, NTBFs are significant drivers of the economy (see Bollingtoft, 2012; Brown and Mason, 2014; Stokan et al., 2015). So far, investigations on NTBFs have concentrated on three topics:

(1) the investigation of NTBFs' requirements,

(2) the identification of their characteristics (see, e.g., McAdam and McAdam, 2008), and

(3) providing a proper environment for NTBFs to secure their survival.

Furthermore, the prior investigations remark high failure rates among NTBFs (see, e.g., Gilbert et al., 2006; Bollingtoft, 2012). Rubin and his colleagues (2015) mention four reasons for the failures by the NTBFs:

(1) High costs of research and development activities,
(2) Difficulties in covering its expenditures,
(3) Uncertainty in return on investment, and
(4) Lack of managerial skills.

As mentioned in Chapter 1, the NTBFs suffer from three issues, viz. liability of smallness, newness, and liability in weak ties within their network in the early stage of their lifecycle (Witt, 2004; Neergaard, 2005; Bøllingtoft and Ulhøi, 2005; Fisher et al., 2013; van Weele et al., 2017). Thus, providing a supportive environment (as a significant approach for endorsing NTBFs) has been recognized as an essential solution to influence the rate of NTBF survival and their development (Bollingtoft, 2012). To reach such a solution, BIs have been created as an effective mechanism to support NTBFs especially in the early stages of their lifecycle, as a ubiquitous solution to decrease the risk of failure among NTBFs and as an accelerator for their evolution (Grimaldi and Grandi, 2005; McAdam and McAdam, 2008; Soetanto and Jack, 2013; van Weele et al., 2018).

3.2 Research Approach

Our research approach has two main goals. First, to map actual supportive activities offered by BIs to the NTBFs. Concerning the classification of BIs' research orientations, we refer to the orientations proposed by Hackett and Dilts (2004). Second, we are inclined to contribute to (a) the development of incubators and (b) the incubator-incubatee impact studies as seen through the incubatees' point of view. The research of this chapter is conducted in a region of the South Holland province in the Netherlands. In this region, two science-based universities (Leiden University and Erasmus University Rotterdam) and one university of technology (Delft University of Technology) are located together with a growing bio-science park (Leiden Bio-Science Park). In addition, there is quite a number of different business incubators in the three cities of this region: Delft, Leiden, and Rotterdam. We chose this region for our study as there is a well-formed regional ecosystem that attracts a sizeable number of entrepreneurs who establish NTBFs. For our research, we conducted a series of eleven in-depth semi-structured interviews with the founders of NTBFs who received support from UBIs. In Chapter 4, we will propose four propositions for future research based on our findings.

3.3 Research Methodology

To collect relevant data and information on the actual supportive activities of the UBIs, I conducted an explorative study and used a combination of observations, and in-depth, semi-structured interviews with founders of NTBFs in the UBIs. For obtaining more insights into the UBIs' supportive activities from the owners' perspective, I registered both as a co-founder of an NTBF and as a researcher in a four-month training program for entrepreneurs (e.g., Validation Lab/ Yes!Delft). Also, I joined the informal gatherings, meetings, and social events organized in the business incubators under study. During the participation in the training programs, social and informal events, the founders were asked (1) to explain what motivated them to choose to work in UBIs, (2) the sort of support they received, (3) their expectations from a UBI, and (4) to what extent the activities lived up to their expectations.

To be more specific, the explorative study was conducted within two public UBIs in the same area of the Netherlands (Yes!Delft (Delft University of Technology Business Incubator), and PLANT (Leiden University Business Incubator)). Both universities are historical universities with their own emphasis (technical and general) in Europe with similar entrepreneurial perceptions (see Soetanto and van Geenhuizen, 2019). In addition, they are in close contact with a prominent organization of applied research (Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek (TNO)) which aims are to employ the universities' research efforts to the industrial applications. In order to avoid the sample selection bias, I randomly selected the NTBFs from a variety of sectors to minimize the influence of possible selection bias. Then, I contacted a total of 35 founders in UBIs, of which 11 agreed to participate in the study. Three out of eleven founders were selected through social events, and the others were chosen randomly from the list of registered startups within the two incubators. Prior to conducting interviews, the interview questions were sent to the program managers of UBIs and their feedback was implemented. Moreover, at the beginning of each interview, the participants were assured about the confidentiality of the data and their anonymity. I interviewed the participating entrepreneurs over a period of seven months, starting in July 2015. The interviews took approximately 60 to 90 minutes. Each interview was recorded and transcribed. Next, I coded and categorized the transcription of the interviews in order to enable further analyses. I used a web-based tool for the analysis of our textual data (http://www.saturateapp.com/). Table 3-1 provides general information on the sample. The order is by the age of the foundations. The first column contains the initials of the NTBFs, which are used to identify the quotations of entrepreneurs in section 3.4. The participants were assured of maintaining their confidentiality and using the data in an ethical manner. Thus, we use initials of the NTBFs in the following Table.

Table 3-1: General Characteristics of the NTBFs under Study

No	Initials of NTBF	Industry	Number of current employees	Foundation
1	PI	Management Consulting	1-10	2004
2	BI	Environmental Services	24	2009
3	TM	Aviation & Aerospace	8	2011
4	N	Information Technology and Services	5	2013
5	MO	Internet	5	2013
6	SK	Mechanical / Industrial Engineering	5	2013
7	SH	Computer Networking	8	2013
8	SY	Biotechnology	2	2014
9	SP	Computer Science	3	2014
10	F	Biotechnology	2	2015
11	B	Life Science	2	2015

On the basis of our interviews, I identified a total of 36 codes for activities. Subsequently, I was able to classify them into 5 different categories (see Appendix A). They were labeled as:

1) access to the networks;
2) knowledge development and dissemination;
3) finance and administrative mobilization;
4) growth control; and
5) creation of exposure.

The identified categories will be elaborated in Section 3.4.

3.4 Field Work

The motivations of NTBFs to move to UBIs is presented in subsection 3.4.1, and the analysis of the conducted interviews is given in subsection 3.4.2. Then, we make a linkage between resource categories and identified activities, which is elaborated upon in subsection 3.4.3.

3.4.1 Motivation of NTBFs to Move to UBIs

The interviews started with highlighting the main reasons why entrepreneurs decided to join a UBI. The analyses of our interviews show that eight entrepreneurs were triggered by the access to the business incubators' networks. Their motivations were: (a) to have access to the networks with potential investors, (b) possible coaches, and (c) access to a strong network of clients. Clearly, these three motivations were preferred above a proper workplace. In line with our findings, Grimaldi and Grandi (2005), and Soetanto and Jack (2016) explained that an important reason for NTBFs to choose one particular UBI is their expectations from synergy (generated among tenants) and cooperation with other firms. Concerning the other motivations, three entrepreneurs claimed that the reputation of the UBI impacted their decision to select and work in a UBI. Six entrepreneurs indicated that access to administrative facilities, and affordable offices motivated them to join a UBI. This motivation aligns with the findings of previous studies (e.g., Chan and Lau, 2005; Bollingtoft, 2012). For one entrepreneur, the idea of working in an environment which provides the entrepreneurs with more structure and discipline, was a key motivation to move into a UBI. Finally, three entrepreneurs claimed that the type of industry that incubators select and the high rate of successful ventures in UBIs, encouraged them to work there.

3.4.2 Supportive Activities

The interviews with founders concentrated on the identification of the UBIs' supportive activities through the theoretical lens of the RBV. The results of data analysis show that the UBIs support their tenants through five activities embedded in a networking environment. They are: (1) access to the networks, (2) knowledge development and dissemination, (3) finance and administrative mobilization, (4) growth control, and (5) creation of exposure. Each activity is discussed in more detail below.

***Activity 1**: Access to the Networks*

As mentioned above, the interviews show that entrepreneurs are very much triggered by the access to different networks as offered by the UBIs. Both the internal and external networking opportunities seem to be fundamental support activities of the UBIs. One entrepreneur stated this as follows.

SK: "Here [the UBIs] supports us with their networks, and their partners help you. They [the UBIs] are constantly looking for big companies and other venture capitalists and do partnership with them. Here UBIs are connecting with big corporations and get these relations and connections. .... I noticed running a company which is really new to us, we have to learn huge number of things, in that sort of time and being here links you to companies to provide you services very useful to fill this gap."

TM: "There is a huge benefit to be together in a building, sort of the ad hoc communication between them, informal helping of companies among themselves, being around peers running start-up is a life consuming thing but it is easier to be surrounded with people who also have this, and there is a benefit in building your marketing power... and here there are some companies in our industry and we are thinking about partnership to produce similar product."

The incubators' connections provide an opportunity for tenants to broaden their own networks, and connect them with potential partners, and customers. For UBIs, the first step to have impact, is providing access to potential partners and customers by holding formal and informal events and gatherings. Formal events with the presence of large companies related to tenants' industries, and venture capitalists will help entrepreneurs to connect with potential customers and partners. Subsequently, it will lead to mutual cooperation. Partners of UBIs may help tenants to broaden their networks and enhance the founders' knowledge. Founders also regard the access to networks as an opportunity for knowledge development.

***Activity 2**: Knowledge Development and Dissemination*

Many founders of NTBFs lack relevant knowledge in relation to business issues. Therefore, incubators attempt to address this inconclusiveness through functions such as coaching and business advice. The interviews show that incubators develop entrepreneurial knowledge by organizing workshops and seminars.

MO: "Here [UBIs] offers different workshops regarding to business, writing business plan, legal, accounting,... they are in form of class, and sometimes they provide coaches which is more interactive than classes... there are bunch of companies here you can talk with different fellows to tell on business side and tell you how to work, develop your business... it is a good point of networking here to learn how to set a company, find partner for our company or investors..."

Moreover, in collaboration with UBIs' industrial and academic partners, they provide tenants with access to coaches. As mentioned earlier, socializing and interacting within internal networks such as tenant to tenant, as well as UBIs' informal events, might lead to knowledge development. This type of knowledge development self-identity be regarded as 'learning by interacting'. Knowledge development and its dissemination are also stimulated by the use of mentors. Mentors support mentees through both psychological support, and career development support. On the basis of our interviews, it appears that UBIs are more inclined to offer coaching services than to engage their tenants in mentoring. Two opinions of the entrepreneurs are as follows.

MO: "*Their [UBIs] mentoring is more like classroom lectures and you don't get that level.*"

SH: "If I get a mentor, I would like to get someone who, when he gets back to you, knows your story. They [incubators' mentors] do not have to be here every time, but once in a month so could advice you better to take a right road...Here we do have advisors, but we get a mentor by ourselves not incubator to meet him each two week. I think this type of coaching is more helpful than asking once a question."

***Activity 3**: Finance and Administrative Mobilization*

UBIs provide entrepreneurs with the access to both financial and non-financial facilities, such as basic infrastructure, shared meeting rooms, administrative services, and offices. In addition, UBIs provide tenants with access to capital via their networks with the venture capitalists, and private capitalists. Below, we present two opinions.

MO: "They [UBIs] have investment meet ups (...). Basically, all they [UBIs] give you is free coffee and a desk in a stale room."

SH: "They [UBIs] will invest through convertible loan which you don't have to pay back directly."

According to the founders' opinions, the majority of the efforts by UBIs concentrates on providing their tenants with a place to work, and the access to the capital and investors. Sometimes, UBIs may also offer loans to incubatees, and provide access to the philanthropy and Governmental financial programs. It also appears that the networks of the UBIs especially with corporates, can lead to the strategic alliances between corporates and NTBFs. Thus, through this way they could raise funds.

***Activity 4**: Growth Control*

After the selection phase of NTBFs, UBIs will start providing supportive activities for the accepted ventures. The growth control activity is offered by the UBI management team and evaluates the performance of their tenants. Our interviews reveal that this activity includes three dimensions (auditor role, facilitator role, inspirational role).

The first dimension is assigning milestones for incubatees to measure tenants' growth. We call this dimension the 'auditor role'.

The second dimension is interacting continuously and actively with incubatees to ensure the qualities of services and exploring their requirements. We call this dimension the 'facilitator role'.

The third dimension is performing as a mentor for UBIs' managers, i.e., providing psychosocial support for their tenants. This might have a reasonable impact on the performance of an NTBF. It means that the behavior of their tenants influences the self-identity of the business owners. Moreover, the third dimension has a potential to teach the entrepreneurs on how to overcome challenges and how to make strategic decisions. We call this dimension the 'inspirational role'. Two entrepreneurs indicated this as follows.

SP: "The incubator manager contacts us regularly to see our problems (...). Also, every three months we have a review program."

SY: "They monitor us and introduce us to other startups to talk with them and share our experiences."

The more active the monitoring and cooperation with the tenants is, the better the evaluation of their performance will take place. Indeed, our data analysis demonstrates that active monitoring can help the team of incubators to provide related networks for their tenants. In addition, the team members have the option to support their tenants with more related and required training programs. Also, assisting the tenants can be seen by their potential customers through different channels of media. The team members can provide more psychosocial support for entrepreneurs.

Activity 5*: Creation of Exposure*

Our data analysis identified a new supportive activity offered by BIs. Previous studies show that due to the liability of newness, new ventures have less credibility than more established firms (see Witt, 2004; Bott, 2014). Our interviews show that UBIs can help new ventures to overcome their liability of newness and create more exposure by channels of social media, newspapers, technology and innovation-oriented press. Two opinions are as follows.

SP: "Here [the UBIs] has a team for marketing ... They [the UBIs] do not market your product but help you by tweeting and bring your product in the media.... the more exposures for us, our customers take us more seriously... I [founder] have got credibility from them [the UBIs] ...we get lot of publicity, this thing is the exposure, and introduce you to customers…"

SH: "Because of the exposure, we have received different offers to use our product."

The analysis of our interviews reveals that creation of exposure activities for NTBFs help them to be seen by their potential partners, customers and investors. It appears that the main reason that motivates founders to join BIs, is to obtain access to their required networks. Hence, creation of exposure will help founders to broaden their networks and reach their target market.

3.4.3 The Relations between Resource Categories and UBIs' Activities

Table 3-2 depicts an overview in four columns of the six types of resources provided to the tenants of the UBIs (column 1, also including the tangible and intangible resources). We aim to show the relations between (a) the six categories of the firms' resources (column 2) and (b) the supportive activities by UBIs (column 3). In column 4, we provide the benefits of the activities. We adapt Grant's (1991) findings on the categories of the most important resources of the firms. He classified resources into tangible and intangible (column 1). With regard to the Grant's (1991) resource classification (column 2), we discuss them all below. First, the financial resources refer to provide funding and capital for NTBFs, whereas the BIs act as a facilitator to link entrepreneurs with different funding sources. Second, physical resources include assets such as shared meeting rooms, offices, shared facilities, and administrative services. Third, in our study, we define knowledge resources as providing tenants with different training programs to increase the knowledge of the founders. Fourth, relational resources include assets such as reputation and visibility. Fifth, organizational resources refer to the regulations and evaluation programs of UBIs for their tenants. It consists of the act of monitoring and participation in the tenants' growth processes, performance measurement, and establishment of success criteria. Sixth, human resources include all the individuals, and talent managers of UBIs, and the experts of UBIs' networks who collaborate with incubators to provide services for tenants. Access to the coaches, investors, on-site business expertise, and UBI's management team, are included in this resource.

Table 3-2: The Portfolio of Supportive Activities by UBIs

Category of resource		BI activities	Functions	Benefit of the activities
Tangible resources	Financial resources	Finance and administrative mobilization	-Arrange investing and fund-raising meetings with corporations and VCs -Provide loans	Access to capital
	Physical resources		-Provide a place to work/ shared administrative services	Access to basic infrastructure Access to facilities
Intangible resources	Knowledge resources	Knowledge development and dissemination	-Arrange Training programs (seminars, workshops…) -Coaching/ Mentoring	Increase business/ technical skills of founders and NTBF's team members Access to the coaches, mentors, experienced entrepreneurs
	Relational resources	Creation of exposure	-Market NTBF through social media, press, meetings and exhibition with big corporates	Increase NTBF's credibility & reputation
		Access to their networks	-Organizing relevant events -Contact with potential investors/ customers/ partners	Access to investors, potential employees, potential partners, and clients
	Organizational resources	Growth control	-The act of evaluating tenants' performance, and identifying their requirements	Providing more focused services with regard to the tenants' requirements.
	Human resources	Access to the networks	-Organizing different events	Access to HR, investors, etc.

By our interviews, observations from UBIs and active participating in the UBI programs, we established the functions by which the UBIs deliver their support to their tenants (see column 3). Column 4 describes the functions more precisely. Column 5 explains which benefits the NTBFs may have from the access to the different supportive activities by BIs for NTBFs.

At this point, we are able to answer RQ1 (see the beginning of chapter 3). The final answer is in section 3.5.

3.5 The Answer to RQ1

This chapter has addressed *RQ1: What are the main supportive activities offered by UBIs that influence the performance of NTBFs?*

Our first finding is that the main supportive activities of UBIs are classified into five groups: *(1) access to their networks, (2) knowledge development and dissemination, (3) finance and administrative mobilization, (4) growth control, and (5) creation of exposure.*

Second finding is to identify the nature of activities of UBIs through the lens of RBV. On the basis of our data from eleven different cases, we showed that access to the networks of the UBIs, such as investors and UBIs' coaches, motivates founders to work in the UBIs. Although Chan and Lau (2005) found that networking activities offered by UBIs are unimportant, our analysis illustrated that networking and access to the different networks are very important items. This argument is in line with the findings by Bøllingtoft (2012), and Soetanto and Jack (2016) as well. Based on our observations, we may conclude that access to different networks is more important than access to the other type of supports for NTBFs. It appears that the priority of working in UBIs as previously shown by founders has been shifted from access to basic facilities and infrastructure to the networks and active mentoring. Our analysis revealed that the majority of UBIs' activities (resource mobilization, knowledge development, and creation of exposure) is offered through the networks and networking activities.

With regard to the role of UBIs' management team in facilitating the access to different resources for NTBFs, the entrepreneurs highlighted the importance of active monitoring and participation of UBIs' team within NTBFs' functions. The active participation by incubators enable them to provide more specific services for entrepreneurs (1) to meet their requirements, (2) to make a linkage between founders and their relevant networks, and (3) to provide NTBFs with their required sources.

Furthermore, our analysis showed that founders expect from incubators to help them to get access to their potential customers. We identified that UBIs use their media for announcing and marketing their NTBFs to help them to be more visible. More exposure will help the NTBFs to get noticed by their potential customers and investors. Thus, it increases the probability of NTBFs' capability and their success.

In the third finding, we faced two limitations. Although we consider NTBFs located in UBIs from different industries, the results should be generalized with caution. (3A), we only conducted our study in University-based BIs, thus, we do not know that our results are applicable in other types of BIs. In addition, the UBIs that operate only in a specific industry, for instance, Bio-science or Healthcare, may provide another sort of supports to their NTBFs. (3B), the cases analyzed are from the same country. Hence, the results from other nationalities and innovation regions can be different.

Chapter 4

Operationalization of the Supportive Activities Construct

This chapter addresses RQ2: *How can the supportive activities be operationalized in a construct that enables us to measure the impact of the identified supportive activities by UBIs on the performance of an NTBF?*

In our answer to RQ1, we identified five main supportive activities offered by the UBIs to the NTBFs, viz. *(1) access to the networks, (2) knowledge development and dissemination, (3) finance and administrative mobilization, (4) growth control, and (5) creation of exposure.*

This chapter is based on the following publications:

1. Samaeemofrad, N., and van den Herik, H. J. (2018). **The Effectiveness of Finance Mobilization by Business Incubators on the Performance of NTBFs.** In the proceedings of the 2018 ICE/ITMC International Conference, Stuttgart, Germany 2018 (IEEE Xplore).

2. Samaeemofrad, N., and van den Herik, H. J. (2018). **The Relation between Support by Business Incubators and Performance of NTBFs.** In the proceedings of the 2018 ICE/ITMC International Conference, Stuttgart, Germany 2018 (IEEE Xplore).

3. Samaeemofrad, N., van den Herik, H. J., and Verburg, R. (2016). **A New Perspective on Business Incubators.** In the proceedings of the 2016 ICE/ITMC International Conference, Trondheim, Norway 2016 (IEEE Xplore).

[2] The author would like to thank her co-author for co-operation and the publisher of the ICE/ITMC 2018 proceedings for their permission to reuse relevant parts of the article in this thesis.

To answer RQ2, we select two types of support, viz. (a) knowledge development and dissemination and (b) finance mobilization (here we disregard administrative mobilization) to evaluate their impact on the performance of NTBFs. Related literature has also studied the impact of "access to the networks" by investigating the growth and performances of NTBFs (see McAdam and McAdam, 2008; Schwartz and Hornych, 2008; Scillitoe and Chakrabarti, 2010; Bollingtoft, 2012; Ebbers, 2013; Soetanto and Jack 2016). In those investigations, the researchers have taken the importance of "knowledge development and dissemination" as supportive activity into account (see Peters et al., 2004; Grimaldi and Grandi, 2005; Bruneel et al., 2012; Soetanto and Jack, 2016). Only a few number of investigations have paid attention to the other type of supports such as finance mobilization, growth control, and creation of exposure. It appears that all of these type of supports have an influence on the growth and performances of the NTBFs. However, the entrepreneurship literature has depicted contradictory and inconclusive findings. This may be associated with the usage of different methods and approaches by researchers (cf. Soetanto and Jack, 2016; van Weele et al., 2017).

While previous investigations have focused heavily on networking and access to the network activities, I do not repeat this type of support into my research. I fully accept the positive outcomes. Meanwhile other researchers have highlighted the importance of training and business workshops for the growth of NTBFs. That is an interesting addition. However, they have overlooked the role of mentoring and coaching when performing their investigations. Therefore, I will include in my research all the training, provision of business advisory, mentoring and coaching activities under the term of "*knowledge development and dissemination*". Furthermore, I will also consider the impact of "*finance mobilization*" support by UBIs, due to the vital role of fund raising in stimulating NTBFs to grow and establish themselves in their markets.

For these two topics, we develop a theoretical model that demonstrates the relations between on the one hand these two types of supports, and on the other hand the performance of the NTBF. Then, the model will be operationalized to provide a construct that Is able to measure the supportive activities by business incubators.

The structure of this chapter is as follows. Section 4.1 describes the importance of RBV. The model development is presented in section 4.2. Then, section 4.3 highlights the essentials of the proposed model. The operationalization of the measurement scale is addressed in section 4.4. Finally, the chapter conclusion is presented in section 4.5.

4.1 The Importance of RBV

In the strategic management literature, the resource-based view (RBV) has been used as one of the prominent theoretical frameworks to explain how firms are able (1) to achieve their competitive advantages and (2) to sustain the acquired advantages over time (cf. Eisenhardt and Martin, 2000; Barney et al., 2011). This theory explains that a firm is an agglomeration of resources and capabilities that are valuable, rare, inimitable, and non-substitutable (hereafter VRIN). Indeed, when firms have access to VRIN resources, they can obtain a sustainable competitive advantage (cf. Teece et al., 1997; Eisenhardt and Martin, 2000; Musiolik et al., 2012; Somsuk and Laosirihongthong, 2014). In the entrepreneurship studies, the support by UBIs has been considered as external resources to help the NTBFs grow. Therefore, the majority of previous investigations in analyzing the activities and processes of UBIs is conducted through the lens of RBV (cf. Eveleens et al., 2017). However, these studies have been performed almost solely with a rather limited role assigned to the NTBF's strategy (cf. Soetanto and Jack, 2016). It means that previous studies neglected the fact that NTBFs take various strategical approaches in receiving support by UBIs. We keep this issue as a point of attention.

Following the relation between firm resources and capabilities, studies on RBV can be divided into two research streams (Ethiraj et al., 2005). The first research stream (see, e.g., Barney, 1991; Peteraf, 1993) defines resources, including capabilities, whereas the second stream explicitly distinguishes resources from the capabilities (cf. Grant, 1991; Amit and Schoemaker, 1993). The second stream is characterized by the idea that (1) resources include both tangible and intangible assets, but (2) that the capabilities represent a firm's capacity to utilize resources (see Amit and Schoemaker, 1993; Ethiraj et al., 2005; Cumming and Fischer, 2012). In this study, we follow the second research stream in developing our research path to the formulation of a conceptual model.

4.2 Model Development

In this section, we will present our theoretical model. Therefore, we develop four propositions in order to model the relations between each variable. In the subsections 4.2.1 to 4.2.4, the propositions that support the model are explained. The propositions are summarized in subsection 4.2.5 and depicted in Figure 4-5.

4.2.1 Innovation Strategy

Generally speaking, every innovation strategy is to be considered as indicating the importance of R&D activities. The innovation efforts may have (1) a product orientation, or (2) process orientation, or (3) a product and process orientation (see Peeters and de la Potterie, 2006; Verbano and Crema, 2015). Later, Soetanto and Jack (2016) classified the innovation strategies into two groups: (1) exploration strategies, and (2) exploitation strategies. An exploration strategy pushes the NTBF to seek new abilities or new knowledge to launch new products or to achieve new markets. In contrast, an exploitation strategy pushes the NTBF to build on their existing product line or to pay effort on developing their current market participation. Exploration and exploitation can be employed over both product and market areas (cf. Maine et al., 2012; Soetanto and Jack, 2016). Therefore, four types of innovation strategies can emerge. They contain exploration and exploitation of both areas (products and market).

Although the concept and definition of the exploitation and exploration relating to market and product is quite a challenge, Soetanto and Jack (2016) have conceptualized them and in this study, we rely on them. According to their conceptualization, the ***first*** type of innovation strategy is *product exploration* which refers to all activities that launch new products. It contributes to the R&D activities and leads to radical innovations (cf. Maine et al., 2012; Soetanto and Jack, 2016). The ***second*** type of innovation strategy is a *market exploration*, which contributes to creating new markets. The ***third*** type of innovation strategy is *product exploitation*, which focuses on the existing products and refers to incremental innovation. The ***fourth*** type of innovation strategy is *market exploitation* of which the objective is to further develop the current markets (Soetanto and Jack, 2016). Keeping the balance between exploration and exploitation is essential for the survival of the NTBFs (Soetanto and Jack, 2016). Therefore, the NTBFs attempt is to combine each two of these four strategies to achieve superior performance. The combinations create four mixed strategies. Table 4-1 presents a combination of exploration and exploitation strategies.

Table 4-1: Innovation Strategy

Product domain	**Market domain**	**Strategy outcome**	**Explanation**
Exploitation	Exploitation	The exploitation strategy	NTBFs develops both their current markets and products
Exploration	Exploration	The exploration strategy	NTBFs launch new product while attracting new markets
Exploration	Exploitation	The ambidextrous product improvement	NTBFs launch new products in current markets
Exploitation	Exploration	The ambidextrous market growth	NTBFs develop existing products in new markets

For NTBFs, their growth and development can be obtained through (1) the creation of new products, (2) entering into new markets, and (3) a combination of these two ways (see Bøllingtoft, 2012). This may lead to four possible approaches (see Table 4-1). Each of these approaches is considered to be a NTBF innovation strategy.

Definition 4.1: ***Innovation Strategy*** *is defined as an engagement in both exploitation, exploration and ambidextrous strategies across the technology and market domains and implement them (Soetanto and Jack, 2016).*

A well-established innovation strategy enables an NTBF (1) to build up and expand competitive advantages and (2) to survive in or broaden their market position (Prajogo, 2016). Apparently, an innovation strategy is one of the leading factors that influence the performance of the NTBF (cf. Sandberg and Hofer, 1987; Prajogo, 2016). Therefore, understanding the NTBF innovation strategy is essential for evaluating their performance and, in particular, for improving the performance.

A number of scholars (see Voss and Voss, 2013; Soetanto and Jack, 2016) examined the innovation strategy within the context of NTBFs. However, Soetanto and Jack (2016) concluded that there is still a scarcity of investigation on the possible role of UBIs on the relation between innovation strategy and the performances of NTBFs.

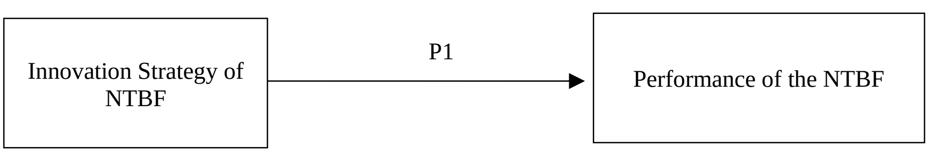
Definition 4.2***: Performance of the NTBFs*** *is defined as the growth of the NTBFs by taking into consideration to what extent NTBFs meet their milestones and achieve their objectives (Soetanto and Jack, 2016).*

Similarly, based on the relation between innovation strategy and the performance of NTBF, we posit the following proposition (P1).

P1*: Innovation strategy (explorative, exploitative, and ambidextrous) is positively related to the performance of the NTBF.*

Figure 4-1 shows the relation between innovation strategy and the performance of the NTBF.

Figure 4-1: Innovation Strategy and Performance of the NTBF

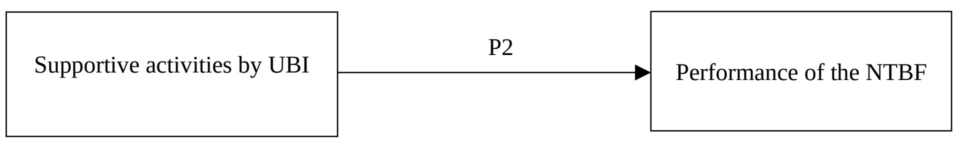


4.2.2 Supportive Activities by UBIs

As mentioned earlier, from an RBV perspective, firms are bundles of resources and capabilities which enable them to develop their products and obtain their target performance. In the RBV theory, resources can be defined as ‘tangible and intangible assets that firms use to conceive of and implement their strategies’ (Barney and Arikan, 2001, p.138). With regard to these concepts within RBV, UBIs can be viewed as a tool including the required resources to be intended externally for being used by NTBFs. The resources seem to be able to: (1) overcome NTBFs’ liabilities of smallness, newness and weak ties (which have effect upon knowledge possession), and (2) have an impact on the performance of NTBFs (see Samaeemofrad et al., 2016; Eveleens et al., 2017). Our argument on the relation between the support by UBIs and the performance of NTBFs leads us to the following proposition (P2).

***P2**: The supportive activities by UBIs (knowledge development and dissemination, and finance mobilization) positively impact the performance of the NTBF.*

Figure 4-2: Supportive Activities by UBIs and the Performance of the NTBF



In our research, we will investigate two external resources, viz. (a) knowledge development and dissemination and (b) finance mobilization. For NTBFs, knowledge development and dissemination are very important (see Bergek and Norrman, 2008; Soetanto and Jack, 2013; Samaeemofrad et al., 2016). From our discussions with entrepreneurs (see Samaeemofrad et al., 2016), we learn that access to the knowledge resources and expertise adds critical values to the development process of the NTBFs (see also Macpherson et al., 2004; Mian et al., 2016). The NTBFs possibly are able to access the knowledge resources by training programs, coaching, and mentoring activities offered by the UBIs. These services aim to increase the entrepreneurs’ business knowledge and thus have influence on the performance of the NTBFs (Somsuk and Laosirihongthong, 2014; Soetanto and Jack, 2016).

Our interviews show that in addition to the standard training programs and coaching, entrepreneurs expect to learn by doing and interacting, instead of only following a classroom approach. Following the statement on VRIN resources noted above, we will concentrate on knowledge development and dissemination by the UBIs that are characterized as VRIN resources and might impact the performance of the NTBFs (see Eveleens et al., 2017).

Definition 4.3: ***Knowledge development and dissemination*** *supportive activity is defined in our study as knowledge-based supports by business incubators which aims to increase the entrepreneurs' business knowledge though the access to the training sessions, workshops, business advisors and mentors (Eveleens et al., 2017).*

The above choice and the argument on the relation between this support by the UBIs and the performance of the NTBFs leads us to the following sub-proposition (P2a).

P2a*: Knowledge development and dissemination when seen as a supportive activity have a positive impact on the performance of the NTBF.*

The second external resource is a finance mobilization (see Bergek and Norrman, 2008; Soetanto and Jack, 2013; Samaeemofrad et al., 2016). Fundraising is one of the greatest challenges for entrepreneurs in the lifecycle development of their NTBFs (McAdam and McAdam, 2008). The entrepreneurs suffer the most from (1) shortage of finance knowledge and (2) constraints in accessing the funding resources. These two factors severely restrict the growth of the NTBFs (McAdam and McAdam, 2008). Therefore, entrepreneurs tend to join UBIs to receive assistance for their finance-related challenges. UBIs also attempt to address the challenge through their networks or their own capital resource. This supportive activity by UBIs is called finance mobilization.

Definition 4.4: ***Finance Mobilization*** *refers to the activities in facilitating the access to different capital resources for NTBFs.*

Through the lens of RBV, finance mobilization can be characterized as a VRIN resource and might have an impact on the NTBF's performance (see Eveleens et al., 2017). This argument on the relation between (a) finance mobilization by UBIs and (b) the performance of NTBFs leads us to P2b.

***P2b**: Finance mobilization has a positive impact on the performance of the NTBF.*

Previous studies highlighted that a firm's resources and strategies are highly correlated (see Soetanto and Jack, 2016; Eveleens et al., 2017). For NTBFs, their innovation strategy is crucial while they compete for rare resources. However, in the context of UBIs, less investigations have concentrated on the impact of UBI's supports on the innovation strategy taken by NTBFs (Soetanto and Jack, 2016). As a direct consequence, we highlight this research gap. We address that the growth in the performance of NTBFs may be achieved through the relation between the UBI's resources and NTBF's innovation strategy. Accordingly, we suggest the following proposition (P3) and its two sub-propositions (P3a / P3b).

4.2.3 Supportive Activities and Innovation Strategy

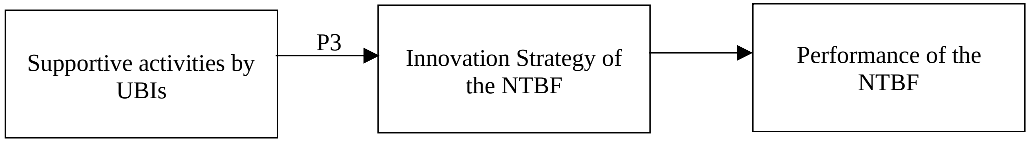
***P3**: Supportive activities by UBIs have positively impact on the innovation strategy and thus on the performance of the NTBF.*

***P3a**: Knowledge development and dissemination have a positive impact on the innovation strategy and therefore on the performance of the NTBF.*

***P3b**: Finance mobilization has a positive impact on the innovation strategy and, therefore on the performance of the NTBF.*

Figure 4-3 shows the relation between the supportive activities (knowledge development and dissemination and finance mobilization), NTBFs' innovation strategy and the performance of NTBFs.

Figure 4-3: Support by UBIs, Innovation Strategy, and NTBF's Performance



4.2.4 Capabilities of the NTBFs

For the growth of the NTBFs, access to the support by UBIs is necessary, but it is not sufficient. NTBFs also need to be equipped with capabilities (see Newbert, 2007).

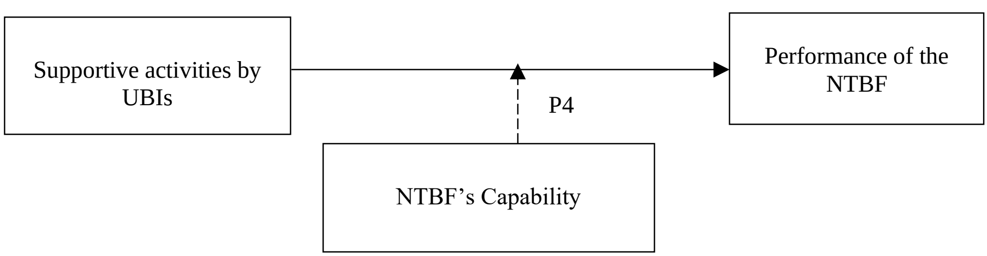
Definition 4.5: *A **capability** is defined as a firm's capacity (a) to utilize its inputs such as resources and (b) to combine and transfer them into their desired objectives efficiently (Amit and Schoemaker, 1993; Teece et al., 1997; Dutta et al., 2005).*

Indeed, capabilities are intermediaries between (1) a firm's resources and (2) its performance (Dutta et al., 2005). Due to the importance of the capabilities in strategic management literature, previous researchers have deeply studied this notion (see Newbert, 2007; Koryak et al., 2015). Newbert (2007) has identified roughly 27 types of capabilities. In this study, we will build our framework based on the relevant capabilities in using the support by UBIs. The amplification role of the capability on the relation between the support by UBIs and NTBFs' performance lead us to formulate the following proposition (P4).

***P4**: The NTBFs' capabilities amplify the impact of support by UBIs.*

Figure 4-4 demonstrates the moderating impact of NTBFs' capability on the relation between the supportive activities (knowledge development and dissemination, and finance mobilization), and the performance of the NTBF.

Figure 4-4: The Moderating Role of the NTBFs' Capability



In this study, we concentrate on the NTBFs' ability on (a) using the knowledge development and dissemination, and (b) finance mobilization supportive activities by UBIs for the identification of the relevant capabilities. Therefore, the relevant capability for the knowledge development and dissemination support is called *absorptive capacity*. Consequently, the relevant capability to the finance mobilization support is called *financial capability*. We describe them below.

Absorptive Capacity

The concept of Absorptive Capacity (AC) relies on macroeconomic studies. It refers to the economy's ability to exploit and absorb external resources and information (see Adler, 1965). The origin of the AC conceptualization is rooted in Cohen and Levinthal's (1989) investigation. A review of literature conducted by Pi (2021) showed that Cohen and Levinthal (1989, 1990) conceptualized AC into three processes (1) external knowledge recognition (EKR), (2) external knowledge assimilation (EKA), and (3) external knowledge utilization (EKU). Later, Zahra and George, (2002) expanded AC to the four dimensional concept including (1) external knowledge acquisition, (2) external knowledge assimilation, (3) knowledge transformation, and (4) knowledge exploitation (see Pi, 2021). Lewin et al., (2011) divided AC into two groups: (a) internal AC which represents the selection and replication of new knowledge, and (b) external knowledge which represents the exploration of knowledge in an external environment and its assimilation. Recently, Song et al., (2018) has classified AC into three groups: (1) absorptive knowledge base (existing knowledge within the firms), (2) absorptive effort (investment in external knowledge), and (3) absorptive process and diffusion.

The adjacent literature suggests that AC plays two roles that both correspond to the external knowledge. The first role describes that AC helps the firms to identify the accessible knowledge flows. The second role of AC indicates to what extent the firms are able to make benefit from the external knowledge. The first role is labeled potential absorptive capacity and the second role is seen as a realization of the absorptive capacity (Escribano et al., 2009).

Definition 4.6: *From the organizational perspective, **Absorptive Capacity** is defined as a firm's ability to recognize the value of new information, assimilate it, and apply it to commercial ends (Cohen and Levinthal, 1990, p.128).*

AC has been identified as a well-performing learning ability for firms to obtain knowledge from outside the organization and utilize it. Based on the importance of the AC in NTBFs and the impact of UBI's knowledge development and its dissemination supportive activity, we formulate the following sub-proposition (P4a).

***P4a**: The NTBF's absorptive capacity amplifies the impact of knowledge development and dissemination on the performance of the NTBF.*

Financial Capability

UBIs attempt to provide their NTBFs with the access to a range of different funding resources. They include venture capitals, bank loans, governmental funding as well as grants through the finance mobilization activities. Moreover, UBIs support their NTBFs by providing administrative services. As mentioned earlier, in this study, we focus on the type of support, a VRIN resource. Obviously, access to administrative support is not considered as VRIN resources (see Eveleens et al., 2017). Hence, we only evaluate the impact of finance mobilization on the performance of the NTBFs.

Due to the liability of the smallness of the NTBFs, they aim at survival by being equipped with sufficient financial support. They will accelerate their likelihood to survive (cf. Rivard et al., 2006). Accordingly, we provide a definition for the NTBFs' capability in fundraising.

> **Definition 4.7:** ***Financial capability*** *is defined in our study as NTBFs' ability in (1) fundraising, and (2) benefiting from the accessibility of capital resources.*

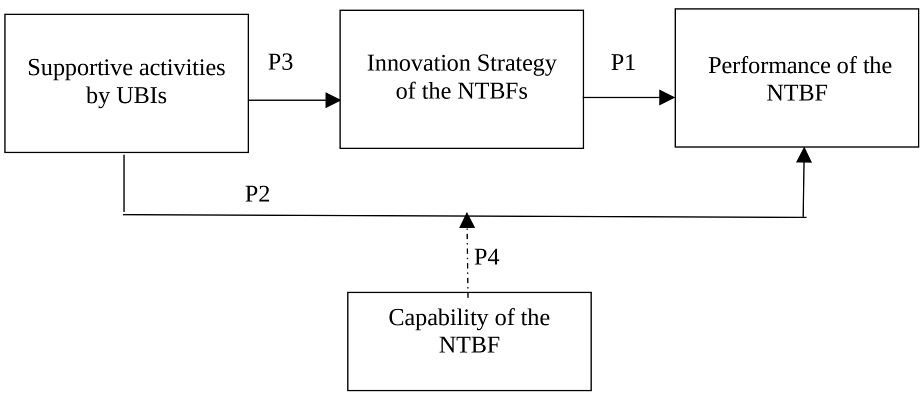
As this study aims to investigate the extent to which NTBFs have access and utilize UBIs financial support, sub-proposition (P4b) is formulated.

***P4b**: The NTBF's financial capability amplifies the impact of financial mobilization on the performance of the NTBF.*

4.3 Summarizing the Model

The four propositions integrate the two supportive activities into a theoretical model that relates (a) knowledge development and dissemination and (b) finance mobilization with innovation strategy and NTBFs' performance. Absorptive capacity and financial capability are considered to *moderate* the relation between UBIs' support and NTBFs' performance. Figure 4-5 summarizes the model and illustrates the propositions.

Figure 4-5: A Theoretical Model



4.4 Operationalization of the Measurement Scales

This section operationalize the measurement scales related to the variables that are depicted in Figure 4-5. The measurement scales are based on the utilized scales. However, we have adapted them to ensure their appropriateness in relation to the NTBFs. The evaluation of the scales is conducted through the interviews and discussions with four NTBFs entrepreneurs, three UBI's managers and eight scholars. Relying on the concepts in the literature, the discussions and interviews were tuned to be held with experts about the activities of the NTBFs in the UBIs.

Prior to our discussion meetings with the experts, the concepts, definitions and purposes of our meeting have been explained to them. After the extensive discussion Negin Samaeemofrad operationalized the measurement scales (questionnaire). At the end of all discussions, the scales were precisely formulated by Negin Samaeemofrad and approved by the project leader Jaap van den Herik. The measurement scales are applied to Innovation Strategy (4.4.1), Knowledge Development and Dissemination (4.4.2), Finance Mobilization (4.4.3), Absorptive Capacity (4.4.4), Financial Capability (4.4.5), and Performance of the NTBFs (4.4.6). The questionnaire is a 7-point Likert scale, where 1 means for "*strongly disagree / extremely dissatisfied*" and 7 for "*strongly agree / extremely satisfied"*.

4.4.1 Innovation Strategy

In line with Soetanto and Jack (2016) and Voss and Voss (2013), we consider innovation strategy for NTBFs as an employment of exploitation and exploration strategies across both technology and market domains. The scale for measuring innovation strategy is adapted from Soetanto and Jack (2016). The reason to adapt this measurement scale is that it considers both technology and market domain while other studies concentrated on technology and product side. We believe that the final acceptance of the product's innovation will be accepted by the market (or not). The original scale is a list of twelve items. However, when presenting the scale to the participants in the preparatory evaluation study, it transpired that one of the twelve items created ambiguity for the entrepreneurs. Therefore, we expanded the scale to the thirteen items.

Consequently, the final measurement scale now proposes a list of thirteen items which evaluates the state of NTBFs' innovation strategy. The scale is presented in Table 4-2. According to this scale, the participants are asked to evaluate the domains of the innovation strategy of their NTBFs. In this measurement scale, a scale of 1 means that an entrepreneur strongly disagrees with the fulfillment of that specific aspect of innovation strategy in their firm. A scale of 7 means that an entrepreneur strongly agrees with the accomplishment of that particular aspect of the innovation strategy in their business.

Table 4-2: Innovation Strategy Measurement Scale

Please indicate the extent to which you agree or disagree with the following statements	
Technology exploitation	1. we frequently refine the technology and innovation behind the existing products and services 2. we regularly add small adaptations to existing products and services 3. we regularly attempt to optimize resources, i.e., we use as less time and less money in producing our existing products and/or services 4. we regularly monitor our existing products and/or services to be aligned with customer needs
Technology exploration	5. we invent new products or services 6. we experiment with new products or services 7. we invest in the development of technology or ideas on products or services that are completely new to our company
Market exploitation	8. we increase our economies of scale in our existing markets 9. we introduce improved but existing products and services for our existing markets 10. our company expands services for existing clients
Market exploration	11. we frequently utilize new opportunities in new markets 12. our company regularly uses or tries to build new distribution channels 13. we regularly search for new approaches in new markets
1= strongly disagree; 2= disagree; 3= somewhat disagree; 4= neither agree nor disagree; 5= somewhat agree; 6= agree; 7= strongly agree	

4.4.2 Knowledge Development and Dissemination

A vital resource for the growth of the NTBFs is the possession of knowledge (Jiménez-Barrionuevo et al., 2011). However, because the NTBFs are new, they suffer from a lack of knowledge to develop business. Therefore, UBIs attempt to meet NTBFs knowledge-based needs through the activities named by knowledge development and dissemination (see Bergek and Norrman, 2008; Samaeemofrad et al., 2016). This attempt can be emphasized by providing training programs, and facilities on mentoring and coaching.

The measurement scale of this activity is based on the literature related to the mentoring studies and training experiences. Thus, the measurement scale of this type of support by UBIs is divided into the parts viz. (1) training and (2) mentoring and coaching. The scale is based on the work by Hackett and Dilts (2008), St-jean and Audet (2009), and Samaeemofrad et al. (2016). Hackett and Dilts (2008) and Samaeemofrad et al. (2016) highlights UBI training programs, and St-jean and Audet (2009) points to essential scales for the mentoring aspect.

The first part of the scale consists of six items (UBI training program):

1. Marketing strategy and sales management skills,
2. Negotiation and communication skills,
3. Human resource management,
4. Business strategy and agile management,
5. Financial statements, tax, contracts and protectability, and
6. Information technology and data management.

Then this list was presented to the participants of the evaluation study. They were invited to select the items that are provided by UBIs to the NTBFs. The participants reduced the items to five items because the last item was not related to the training sessions by UBIs:

1. Marketing strategy and sales management skills,
2. Negotiation and communication skills,
3. Human resource management,
4. Business strategy and agile management, and
5. Financial statements, tax, contracts and protectability.

The second part consists of eleven items:

1. Advisor’s availability
2. Advisor’s expertise and experience
3. Advisor’s understanding of your situation,
4. Organization of meetings between the two parties (duration, frequency, and efficiency),
5. Relationship of trust between the two parties and Compliance with moral contract,
6. Mutual liking of the two parties,
7. Increase in self-confidence as a result of the mentoring experience,
8. Access to a more extensive network of contacts,
9. Real, observable results for your venture,
10. Advisor presents to you his/her successes and failures, and
11. Receive business advise from advisors.

Then the participants of the evaluation study selected eight items out of this eleven. These eight items should be provided to the NTBFs (see Table 4-3).

The measures reveal the extent to which founders of NTBFs are satisfied with the received support by the UBIs on knowledge development and dissemination. The measures are on a 7-Likert scale. They are presented in Table 4-3. A scale of 1 means that an entrepreneur is extremely dissatisfied with that specific aspect of knowledge development and dissemination support by UBIs. A scale of 7 means that the entrepreneur is extremely satisfied with that aspect of knowledge development and dissemination support.

Table 4-3: Knowledge Development and Dissemination Measurement Scale

<table>
<tr><td colspan="2">Regarding content of training programs, the process of mentoring, and coaching support by BIs, please indicate the extent to which you are satisfied or dissatisfied with the following services offered to your venture.</td></tr>
<tr><td rowspan="2">UBI training programs & coaching</td><td>Training:
(1) Marketing strategy and sales management skills
(2) Negotiation and communication skills
(3) Human resource management
(4) Business strategy and agile management
(5) Financial statements, tax, contracts, Protectability

Mentoring and Coaching:
(1) Advisor’s availability
(2) Advisor’s expertise and experience
(3) Organization of meetings with your adviser (duration, frequency, and efficiency)
(4) There is a relationship based on trust, respect and compliance with a moral contract between you and your advisor
(5) Increase in self-confidence as a result of the advisory experience
(6) Access to a more extensive targeted network of contacts due to the collaboration with an adviser
(7) Achieve real, observable results for your business through the advisory process
(8) Adviser offers guidance regarding your successes, failures and methods for improving your business practice</td></tr>
<tr><td>1= strongly dissatisfied; 2= dissatisfied; 3= somewhat dissatisfied; 4= neither satisfied nor dissatisfied; 5= somewhat satisfied; 6= satisfied; 7= strongly satisfied</td></tr>
</table>

4.4.3 Finance Mobilization

Most NTBFs lack financial support, but they try to overcome this by joining UBIs to increase their opportunity in accessing the capital resources (see Chen et al., 2009; Samaeemofrad et al., 2016). Thus, one of the principal supports by UBIs is *finance mobilization*.

To measure the finance mobilization activities, we adapted the measurement scales based on the scales developed by Hackett and Dilts (2008) and our interviews with UBIs managers and entrepreneurs (see Samaeemofrad et al., 2016). In terms of defining the measurement scale for the financial mobilization, Hackett and Dilts (2008) asked participants how to access to the sources of capital (e.g., banks, venture capitalists, and business angels). In addition to the previous measurement scale, Samaeemofrad et al. (2016) revealed that UBIs also offer loans to their tenants and facilitate strategic alliances with established firms to raise funding. Hence, based on the obtained findings in our interviews with entrepreneurs, we asked participants to indicate their satisfaction with the support by UBIs on facilitating their access to all the identified approaches of capital sources. The measurement scale is presented in Table 4-4. They are on a 7-Likert scale. A scale of 1 means that an entrepreneur is extremely dissatisfied with that specific aspect of finance mobilization support by UBIs. A scale of 7 means that the entrepreneur is extremely satisfied with that aspect of finance mobilization support.

Table 4-4: Finance Mobilization Measurement Scale

To what extent are you satisfied with the following statements?
Our business incubator helps us to raise funding from: 1. Governmental financial programs 2. Venture Capital funds/ Private investors 3. Philanthropy 4. Loan from its financial resources 5. Strategic alliance with established firms
1= strongly dissatisfied; 2= dissatisfied; 3= somewhat dissatisfied; 4= neither satisfied nor dissatisfied; 5= somewhat satisfied; 6= satisfied; 7= strongly satisfied

4.4.4 Absorptive Capacity

As mentioned earlier, UBIs attempt to support their NTBFs through knowledge development activities. Therefore, the acknowledgment of the NTBFs' ability in the usage of this support is essential for successful cooperation. This ability is called *absorptive capacity*. It concentrates on the NTBFs' ability in acquiring, assimilating, transforming and implementing the information.

Below we discuss (A) the development of Absorptive Capacity, (B) a new measurement scale of AC issues divided into R&D-related issues and non-R&D-

related issues, and (C) a new model using Pi's (2021) division and the removal or modification of the remaining AC issues.

A: The development of the Absorptive Capacity model

One of the main comprehensive studies on absorptive capacity considers four dimensions for its construct (see Zahra and George, 2002). The first dimension is *acquisition capacity* meaning that a firm can identify the important knowledge outside of their organization. The second dimension is called *assimilation* meaning that a firm can interpret and understand the knowledge. The third dimension is *transformation* which internalizes the new knowledge. The fourth dimension is called *implementation*; it is the way along which firms can use the acquired knowledge (see Zahra and George, 2002; Jiménez-Barrionuevo et al., 2011; Saemundsson and Candi, 2017). Other previous investigations revealed that absorptive capacity is a multidimensional construct (see Jiménez-Barrionuevo et al., 2011; Saemundsson and Candi, 2017).

B: A New Measurement Scale of AC Issues With R&D and Non-R&D-Related Issues

Recently, Pi (2021) has divided the measurement scale of AC into two groups: R&D-related and non-R&D-related measures. The R&D related measures concentrate on the input or output of R&D activities of the firms. Previous investigations used for instance, the size of R&D personnel, the number of R&D publications or R&D expenditures to operationalize AC associated with R&D related measures (see Cohen and Levinthal, 1990; Deeds, 2001; Gao et al., 2008). The combination of these measurement scales can be used as one dimension (Pi, 2021).

The non-R&D related measures concentrate on the process of absorbing external knowledge within the firms. These types of measures are grouped into (a) one-dimensional and (b) multi-dimensional indicators. Within one-dimension measures, researchers have defined only one question or a set of questions that measure the overall estimation of AC (see Szulanski, 1996; Su et al., 2013). For multi-dimensional measures, researchers have to develop different scales for the whole process of AC, such as acquisition, assimilation, transformation and implementation (see Jiménez-Barrionuevo et al., 2011; Ali et al., 2013; Zobel, 2017)

Within our context of study, there is a salient point that not all the NTBFs have R&D activities. Duchek (2013) states that the provision of non-R&D related measures are more applicable in measuring AC than R&D related indicators. Furthermore, Pi (2021) concludes that the multi-dimensional non-R&D related indicators appear to be an appropriate measurement that scales well in quantitative investigations. Assuming this idea, we selected a number of multi-dimensional non-R&D related measurement scales to evaluate *the moderating impact* of AC on the relation between the support by UBIs and the performances of NTBFs in our study.

C: A New Model Using Pi's (2021) Division

Subsequently, we further based our measurement scale for absorptive capacity on the study by Jiménez-Barrionuevo et al. (2011). They have developed multi-dimensional non-R&D indicators for measuring absorptive capacity. In their investigation, we find:

The acquisition dimension including *(1) interaction, (2) trust, (3) respect, (4) friendship, and (5) reciprocity* aspects.

The assimilation dimension including *(6) common language, (7) complementarity, (8) similarity, (9) a double class of compatibility aspects (compatibility 1,and compatibility 2)* ,

The transformation dimension including *(10) communication, (11) meetings, (12) documents, (13) transformation, (14) time, and (15) flows* aspects.

The implementation dimension including (*11) responsibility,* and *(12) application* aspects.

Table 4-5 explains the mentioned scales developed by Jiménez-Barrionuevo et al. (2011).

Table 4-5: The Absorptive Capacity Measurement Scale

<u>Acquisition</u>
1.(INTERACTION) There is close personal interaction between the two organizations.
2.(TRUST) The relation between the two organizations is characterized by mutual trust.
3.(RESPECT) The relation between the two organizations is characterized by mutual respect
4.(FRIENDSHIP) The relationship with this organization is one of personal friendship.
5.(RECIPROCITY) The relationship between the two organizations is characterized by a high level of reciprocity.
<u>Assimilation</u>
1. (COMMON LANGUAGE) The members of the two organizations share their own common language.
2.(COMPLEMENTARITY) There is high complementarity between the resources and capabilities of the two organizations.
3.(SIMILARITY) The main capabilities of the two organizations are very similar/overlap.
4.(COMPATIBILITY1) The organizational cultures of the two organizations are compatible.
5.(COMPATIBILITY2) The operating and management styles of the two organizations are compatible.
<u>Transformation</u>
1.(COMMUNICATION) There are many informal conversations in the organization that involves commercial activity.
2.(MEETINGS) meetings are organized to discuss the development and tendencies of the organization.
3.(DOCUMENTS) Our team publishes informative documents periodically (reports, bulletins, etc.).
4.(TRANSMISSION) The important data are transmitted regularly to our team.
5.(TIME) When something important occurs, all members of our team are informed within a short time.
6.(FLOWS) The organization has the capabilities or abilities necessary to ensure that knowledge flows within the organization and is shared among all members.
<u>Implementation</u>
1.(RESPONSIBILITY) There is a clear division of functions and responsibilities regarding use of information and knowledge obtained from outside.
2.(APPLICATION) There are capabilities and abilities needed to exploit the information and knowledge obtained from the outside.

Following the discussion with experts in the field, we see that the first three aspects of the acquisition dimension were merged into one scale. Within the transformation dimension the (1) communication and (2) meetings aspects merge to the one scale, the (3) documents and (4) transformation aspects also shape one scale. The (5) time and (6) flows aspects merge into one aspects. From the remaining scales it has to be decided whether they should be removed from or modified on the list. As a result, the most related scales to the NTBFs are remained or modified, and a list of six measurement scales remain.

The new list of six modified items for the measures will evaluate the absorptive capacity. It is depicted in Table 4-6. Here, entrepreneurs are requested to evaluate their knowledge exchange interactions with all persons (e.g., customer, users, advisors, etc.) from whom they obtain information. A scale of 1 means that an entrepreneur strongly disagrees with the presence of the statements within NTBFs. A scale of 7 means that an entrepreneur strongly agrees with the presence of the statements within NTBFs.

Table 4-6: The Modified Absorptive Capacity Measurement Scale

Indicate the characteristics of your relationship between your venture and all persons (customer, users, advisors, etc.) from whom you obtain or exchange new information or useful knowledge to develop your activities this relationship or in your organization, showing your degree of agreement or disagreement with the following statements:
Acquisition (INTERACTION / TRUST / RESPECT) Your firm has a close relationship with its customers that is characterized by mutual trust and respect. *Assimilation* (COMMON LANGUAGE) Our team is able to understand knowledge from outside our business focus or industry-niche. *Transformation* (COMMUNICATION / MEETINGS) There are few informal conversations and formal meetings in our organization to discuss the development of our business practice. (DOCUMENTS / TRANSFORMATION) Our team publishes informative documents periodically (e.g., reports, bulletins). (TIME / FLOWS) When something important occurs, all members of our team are informed within a short time, and the knowledge is shared among all members of the organization. *Implementation* (APPLICATION) We frequently pivot our business based on the obtained knowledge from outside.
1= strongly disagree; 2= disagree; 3= somewhat disagree; 4= neither agree nor disagree; 5= somewhat agree; 6= agree; 7= strongly agree

4.4.5 Financial Capability

All NTBFs are require to be equipped with a unique capability to benefit the from finance mobilization by business incubators (see Eveleens et al., 2017). We define this capability as an NTBF's ability in fundraising and acquiring the required financial resources. Previous literature on the incubators demonstrated that business angels and venture capitalists (VCs) set explicit criteria to evaluate the *financial capability* of the new ventures (see Kollmann and Kuckertz, 2010). Kollmann and Kuckertz (2010) concluded that in the early stages of the ventures, business angels invest more than venture capitalists. Indeed, VCs prefer to invest in NTBFs at the development stages. Therefore, VCs and business angels have different sort of financial capability measurement scale. In this research, we aim (1) at studying the NTBFs that are still in BIs, and (2) measuring the NTBF's ability in fundraising. For this purpose, we will build a new scale based on business angel measures which cover the measures by VCs as well. We adapted the measurement scales by Maxwell et al. (2011). They highlighted eight criteria to evaluate the potential of NTBFs in obtaining capital.

The identified criteria are:

(1) entrepreneur's character (I can evaluate and react to risk quite well),

(2) entrepreneur's experience, (Our team have a direct and relevant experience),

(3) adaption (Our customers easily adapt to our product),

(4) product status (Our product is ready to go to market),

(5) protectability (People cannot easily copy our product / service),

(6) customer engagement (Our product meets the customer need),

(7) route to market (We have a realistic marketing plan), and

(8) market potential (There is a large market for our product).

We will build our construct based on these eight items and will operationalize them on a 7-point Likert scale. A scale of 1 means that entrepreneurs strongly disagree with that ability in their NTBFs or in themselves. A scale of 7 means that entrepreneurs strongly agree with the presence of the under questioned ability within their NTBFs or by themselves. The measurement scale is listed in Table 4-7.

Table 4-7: Financial Capability Measurement Scale

Please indicate the extent to which you rate yourself regarding your ability in raising capital.
(1) I am able to evaluate and react to risk well (2) Our team have a direct and relevant experience (3) Our customers easily adapt to our product (4) Our product is ready to market (5) People cannot easily copy our product / service (6) Our product meets customer need (7) We have a realistic marketing plan (8) There is a large market for our product (Over 20 $ Million)
1= strongly disagree; 2= disagree; 3= somewhat disagree; 4= neither agree nor disagree; 5= somewhat agree; 6= agree; 7= strongly agree

4.4.6 Performance of the NTBF

Within the entrepreneurship literature, different types of indicators have been used to measure the performance of the NTBFs. These indicators are classified into two categories: (1) objective measurement, and (2) subjective measurement. Objective measures would be used to measure the financial and growth performance of the firm, for example, sales, profitability, growth in the number of employees, and ROI (see Wu, 2007; Eveleens et al., 2017). Subjective measures are based on people’s judgment, such as the anticipation of success, survival, goal, and achievements (see Wu, 2007; Soetanto and Jack, 2016; Eveleens et al., 2017). However, none of the objective or subjective measures is superior to the other one. For measuring the performance of NTBF, the usage of objective scales includes some challenges. For instance, financial statement scales might not be achieved in some NTBFs, such as profitability or turn-over. Furthermore, the subjective measures may include psychological biases (see Soetanto and Jack, 2016; Eveleens et al., 2017). In order to overcome the bias and benefit from the advantages of both objective and subjective measurements, we employ both of them.

For objective measure, we measure the changes in the number of employees since last year.

For subjective measure, we follow the work by van Gelderen et al. (2005) and consider three self-reporting criteria for measuring the performance of NTBFs:

(1) goal achievement,

(2) skill development, and

(3) satisfaction.

We measure goal achievement by asking how entrepreneurs feel they have achieved their business goals and planned milestones. The skill development will be measured by asking about the extent that entrepreneurs have developed their skills such as financing knowledge, communicating, and marketing since they are in the incubator. Satisfaction can be measured by asking the participants to rate the level of their satisfaction with their income, and business development.

The measurement scale of the performance of NTBFs is presented in Table 4-8. A scale of 1 means that an entrepreneur extremely dissatisfies with that aspect of performance. A scale of 7 means that entrepreneurs extremely satisfy with their performance outcome.

Table 4-8: The Performance of NTBFs Measurement Scale

a) By how many employees did your company increase since last year? b) ***Regarding measuring the performance of NTBFs, participants are asked to indicate to what extent they are satisfied with the following statements?*** (Goal achievement): (1) Meet the planned milestones as scheduled (2) Able to achieve the defined business goals (Skill development): (3) Developing my business and management skills (Satisfaction): (4) I am satisfied with the income (5) I am satisfied with the process of business development
1= strongly dissatisfied; 2= dissatisfied; 3= somewhat dissatisfied; 4= neither satisfied nor dissatisfied; 5= somewhat satisfied; 6= satisfied; 7= strongly satisfied

4.5 A Partial Answer to RQ2

In this chapter, we addressed RQ2: *How can the supportive activities be operationalized in a construct that enables us to measure the impact of the identified supportive activities by UBIs on the performance of NTBFs?*

We performed three important steps of the research envisaged. First, we developed our theoretical model, which explains (a) the relation between the supports by UBIs, (b) the performances of the NTBFs, and (c) their innovation strategy. Second, in our study, we investigated the moderating role of NTBFs' capabilities and were able to show the moderating role of the capabilities of the NTBF on the impact that the supportive activities by the NTBFs have on the performances of the NTBFs (see Figure 4.5). Third, our model has been operationalized and the measurement scales for each variable have been addressed (see section 4.4). In the next chapter, we complete the answer to the RQ2 and explain the validity and reliability of the proposed measurement scale.

Furthermore, in this chapter, we explained the results of our discussions and interviews with experts in terms of ensuring that our scale really represents the variables measured. As a result, the twelve items of innovation strategy (see subsection 4.4.1) turn to the thirteen items (see Soetanto and Jack, 2016). The six items of the first section of knowledge development and dissemination decrease to five items. Then, the eleven items associated with the mentoring and business advice activities of knowledge development and dissemination decreases to eight items (see subsection 4.4.2). The scales associated with absorptive capacity are modified to six items (see subsection 4.4.4). Next chapter will presents the validity and reliability of the construct in detail.

Chapter 5

Validation of the Supportive Activities Construct

In this chapter, we are completing the answer to RQ2.

RQ2: *How can the supportive activities be operationalized in a construct that enables us to measure the impact of the identified supportive activities by UBIs on the performance of an NTBF?*

Chapter 4 successfully answered the first part of RQ2 by (1) developing a theoretical model of the study, (2) identifying the moderating role of the NTBF's capabilities, and (3) exploring how the construct can be operationalized. Following the outcome of Chapter 4, this chapter will complete the answer to RQ2 by (4) statistically evaluating the validity and reliability of the dimensions of the construct. Thus, the resultant construct will be evaluated with respect to the supportive activities by the business incubators through measuring their performances and outcomes.

The chapter proceeds as follows. The characteristics of the employed data set to evaluate the proposed measurement construct is presented in Section 5.1. Section 5.2 describes the method of analysis. Then, Section 5.3 evaluates the validity of the construct. Section 5.4 demonstrates the results of the construct's reliability. After that, Section 5.5 summarizes the results of the validity and reliability analysis of the construct. In Section 5.6, a summary of the answer to RQ2 will be given.

This chapter is based on the following publication:

Samaeemofrad, N., and van den Herik, H. J. (2020). **A Moderating Role of Absorptive Capacity within Incubation Support.** In the proceedings of the 2020 ICE/ITMC International Virtual Conference, 2020 (IEEE Xplore).

5.1 Characteristics of the Employed Data Set

This section reports the characteristics of the employed data set that is used to evaluate the construct and to measure its validity and reliability. It proceeds as follows. Subsection 5.1.1 describes the sampling design. Then, subsection 5.1.2 describes the process of data collection. Lastly, subsection 5.1.3 explains the characteristics of the sample.

Below, we provide a definition of characteristics as used by us in this research.

> **Definition 5.1**: ***Characteristics*** *are defined (in this study) as a combination of criteria on which the selection of the population of NTBFs is based.*

5.1.1 Sampling Design

Our research relies on surveys of university-based NTBFs in the Netherlands and Germany. The samples are collected from (a) UBIs, (b) Academic Accelerators, and (c) University Innovation Centers. Here, we faced a specific challenge with university-based NTBFs in designing the sample. Our challenge is twofold: (1) a majority of universities has no complete database of their NTBFs, and (2) some of them resisted to provide us with the content of their database and referred us to contact their tenants directly via internet. So, we were unable to provide an equal chance to each individual in our potential population to participate in any survey. In other words, we could not approach a probability sampling strategy for our data collection (cf. Sarstedt and Mooi, 2019). As a result, we applied a non-probability sampling strategy and selected a purposive sample technique. According to this technique, the sample is selected based on the particular characteristics of a population. In Subsection 5.1.3 the idea is elaborated upon.

Following the determination of the population's characteristics, we have employed *four* different data resources to collect our sample of NTBFs. Below, we mention the resources that the researcher has used to build up her collection of entrepreneurs and co-founders who agreed to participate in the survey.

Resource 1: Due to the author's participation in the Yes!Delft incubation program (the author as a co-founder of an NTBF), she was able to access the initial list of the existing entrepreneurs and (co-)founders. Subsequently, she looked for their names on LinkedIn to make a connection with them and invited them to participate in the survey.

Resource 2: The author collected a list of all university-supported business incubators, accelerators and innovation centers in the Netherlands. Then, she contacted the program directors and asked them to send the survey link to their entrepreneurs via their network and invite them to fill in the survey. In the case that there was no support from the incubator / accelerator, the author searched for the list of the current NTBFs on their own website and invited the (co-)founders (220) via their LinkedIn IDs or via their contact address mentioned on their website.

Resource 3: We have used a snowball sampling technique (definition 5.2). During the invitation of NTBF founders, we asked them to introduce us to the other entrepreneurs with the same characteristics.

Resource 4: The fourth source for the data collection was through the participation in Start-up Meetups. Four examples are: (a) Science Meets Business by Leiden University Bio-Science Park, (b) Start-ups Pitching Day in Yes!Delft Incubator, (c) New Business Summit 2019 by World Start-up Factory, and (d) Thursday Gathering Events by Venture Café Rotterdam and Cambridge Innovation Centre (CIC).

It is worth mentioning that the author participated in all these events regularly and invited the entrepreneurs to participate in the study. For instance, in Start-up meetups by Venture Café Rotterdam, the author had an info table to present her research and invited entrepreneurs to collaborate in her academic work.

Definition 5.2: ***Snowball Sampling Technique*** *is a type of non-probability sampling method, which enables the researcher to make contact with a small number of members of the target group and then make new connections with other persons who fit the sample via their network (see Bryman, 2012).*

5.1.2 Data Collection

Data is collected via an online survey using web-based software **Qualtrics** (http://www.qualtrics.com), and **Google Forms** (https://docs.google.com/). Qualtrics is a leading web service provider that allows a specific type of respondent and the desired sample size to be chosen. The process of data collection started in September 2018 and ended in July 2019. We used the online format of the survey with an email invitation (see Appendix B). Within the process of data collection, 308 participants were invited. Of them, 220 participants were invited via LinkedIn and 68 of them were invited through sending the link of the survey directly to their email addresses. In addition to using the online application, I used the printed format of the survey. I disseminated 20 printed formats among the entrepreneurs in the Yes!Delft Venture Capitalists (VCs) Meetups.

In total, 308 (co-)founders were invited. Out of them, 111 responses were received. Finally, 96 responses were fully completed. Table 5-1 provides an overview of the list of incubators, accelerators and innovation centers that participated in the survey. It should be mentioned that the majority of the entrepreneurs requested not to mention the name of their NTBFs in the study. Therefore, we would not provide the names of the NTBFs that participated in our survey and restrict the report by only announcing the number of the NTBFs that participated in the survey from each business incubator or accelerator.

Table 5-1: List of the Accelerators/ Incubators/ Innovation Centers

Name of the Incubator/ accelerator/ innovation center	Number of Participants	Country
Yes!Delft (Delft University of Technology Business Incubator)	35	The Netherlands
Science Park of Delft University of Technology	3	The Netherlands
PLNT (Leiden University Business Incubator)	4	The Netherlands
Leiden University Bio-Science Park	3	The Netherlands
UtrechtInc (Utrecht University Business Incubator)	2	The Netherlands
ACE (UvA Business Incubator)	1	The Netherlands
ESA BIC Noordwijk	1	The Netherlands
Start up in residence Amsterdam	1	The Netherlands
World Startup Factory (Den Haag Accelerator)	2	The Netherlands
Crosspring	2	The Netherlands
ImpactPlus	1	The Netherlands
Rotterdam Cambridge Innovation Centre (CIC) and Venture Lab	7	The Netherlands
Wageningen University Business Incubator	1	The Netherlands
EIT Health Accelerator	33	Germany
Strascheg Center for Entrepeneurship (SCE)	1	Germany

Remark on the Sample Size

As a researcher and data analyst who mainly works with big data, I have to admit that in the era of big data our readers may have expected other numbers, based on the exponential growth in the number of studies with a massive amount of data in different fields of studies. Hence, it is evident that a sample size of 96 founders is a small number compared to the terabytes of any data sample. However, within this research, access to a large quantity of NTBFs was not possible to me. Compared to five similar relevant studies (see van Geenhuizen and Soetanto, 2009; Soetanto and Jack, 2016; Albort-Morant and Oghazi, 2016; Soetanto and Jack, 2018; Soetanto and van Geenhuizen, 2019), a sample size of 96 is adequate in the UBI and NTBFs domains. To inform the reader, the sample sizes of other recent studies in this domain are as follows.

Soetanto and van Geenhuizen (2019) with a sample size of n = 100, Soetanto and Jack (2016; 2018) with a sample size of n =141, Soetanto and van Geenhuizen (2009) with a sample size of n= 78, and Albort-Morant and Oghazi (2016) with a sample size of n = 54. So, it appears that conducted studies with a large sample size within the domain of our research are still not available.

5.1.3 Identification of the Target Population

Our goal is to arrive at a carefully selected target population. Therefore, we considered the following four criteria in our sampling selection process.

Criterion 1: The respondents should be the (co-)founders of the NTBFs. Therefore, at first, we identified only the entrepreneurs and then directly invited them to participate in the survey. Obviously, no people with other roles within NTBFs have been contacted to collaborate in our research. As we communicated only with (co-)founders, no section has been considered in the survey to identify the position of the participants in their NTBFs.

Criterion 2: The NTBFs should receive support from the public and university-supported incubators or accelerators.

Criterion 3: Students, graduates or academic staff have a role in the team of the NTBFs.

Criterion 4: The NTBFs need to meet the condition of technology-based firms. It means that they develop or commercialize new technologies, technology-based services or products (cf. Soetanto and Jack, 2016).

Pretesting the Survey

In order to make sure that the survey is comprehensible for the participants and to validate the measurement tool, we did two actions: (1) we revised the text and made some modifications in selecting the words to be more understandable for the target population, and (2) we assessed the content validity through the conduction of interviews with four entrepreneurs, three UBI managers and eight scholars. For these interviewees, we used the ***convenience sampling technique*** (see Bryman, 2012).

> **Definition 5.3**: ***The convenience sampling technique*** *is one type of the non-probability sampling techniques, which refers to a straightforwardly available sample (see Bryman, 2012).*

Concerning the convenient access to the academic scholars and entrepreneurs from the Netherlands, France, and Denmark, we were able to pretest the questionnaire in a satisfactory way with them. The scholars were the faculty members in Leiden University, Delft University of Technology, Aarhus Business School, and Université de Lorraine. The entrepreneurs worked in the Science Park of Delft University of Technology (e.g., InexTeam), and Leiden University Bio-Science Park (e.g., FilterLess). The managers (manager, program director, and director) worked in the Centre for Innovation of Leiden University and in the Leiden Bio-Science Park in the Netherlands. Table 5-2 provides an overview of the interviews to evaluate the measurement scales from NTBFs, and UBIs.

Table 5-2: List of Experts to Validate the Survey

Name of Organization	Evaluation study	Industry
FilterLess (NTBF)	Co-Founder	Computer and software industry (e.g., AI, Blockchain)
	Co-Founder	Computer and software industry (e.g., AI, Blockchain)
	Co-Founder	Computer and software industry (e.g., AI, Blockchain)
InexTeam (NTBF)	Co-Founder	Healthcare and Med-tech
Centre for Innovation (Leiden University)	Manager	University Business incubator
Centre for Innovation (Leiden University)	Program Director	University Business incubator
Leiden Bio-Science Park	Director	University Business incubator

5.2 Method of Analysis

In this section, we describe the statistical method of data analysis.

The statistical analysis technique widely used by researchers in the field of technology and innovation studies, is multivariate analysis. It consists of different statistical methods to simultaneously analyze multiple variables. The main types of statistical methods in multivariate analysis are divided into two categories: (1) primarily exploratory, and (2) primarily confirmatory. Within the exploratory methods the investigations used (a) search for new patterns and (b) facts that have not been explored so far. Here, we mention four of them: Cluster Analysis, Exploratory Factor Analysis, Multidimensional Scaling, and Partial Least Squares. They are the sorts of techniques of the primarily exploratory category. The confirmatory type of methods is applied when the researchers would like to test their hypotheses and explore the relationships between the variables. The category of the confirmatory type involves Analysis of Variance, Logistic Regression, Multiple Regression, Confirmatory Factor Analysis, and Covariance-Based Structural

Equation Modeling. These techniques are regression-based approaches. It is worthwhile to consider that the distinction between exploratory and confirmatory is not always clear and the techniques can be applied either to explore or confirm (see Hair et al., 2017).

Following the above discussion, it appears that the application of linear regression analysis as a confirmatory statistical method is an appropriate tool to test our theoretical model, the construct, and subsequently its hypotheses.

In the next section, the reports on the construct validity are presented.

5.3 Construct Validity

This section evaluates the validity of our construct. The evaluation process is based on the analysis procedure by Sarstedt and Mooi (2019). Their analysis procedure to evaluate the *construct validity* requires four steps: **(1) Evaluating the appropriateness of the data, (2) Extract the factors / components, (3) Determine the number of factors / components, and (4) Interpret the factor solution (Component Rotation).** The four steps are reported in the subsections 5.3.1 to 5.3.4. Table 5-3 demonstrates the distribution of questions (second column; questionnaire items) gives a survey over the six measurement scales (first column). Appendix C gives a detailed description of the questionnaire and its items.

Table 5-3: List of the Six Types of Questions Related to the Construct

Measurement Scale	Questionnaire Items
1. Innovation Strategy	0-12
2. Knowledge development and dissemination	13-26
3. Finance mobilization	27-31
4. Absorptive capacity	32-37
5. Finance capability	38-45
6. Performance	46-50

5.3.1 Evaluating the Appropriateness of the Data

The **first step** is to check whether our data is appropriate to employ variable reduction techniques (e.g., Principal Component Analysis and Principal Factor Analysis).

> **Definition 5.4.:** ***Variable Reduction Techniques*** *are the analysis methods (e.g., Principal Component Analysis, Maximum Likelihood, Image Factoring) that aim at finding interrelationships between variables to reduce the number of unifying ones.*

The main goal of the variable reduction techniques is described as follows: "These techniques concentrate to extract a minimum number of factors that account for a maximum proportion of the variables' total variance" (Sarstedt and Mooi, 2019, p.266).

The basis of the reduction techniques is identifying the correlations between variables. Therefore, to apply reduction techniques, the variables need to be sufficiently correlated. In this regard, we apply three well-known techniques to examine the adequacy of our sample: (A) correlation matrix, (B) Kaiser–Meyer–Olkin (KMO) criterion, and (C) Bartlett's test of sphericity. We explain them below.

A: Correlation Matrix

> **Definition 5.5:** *A* ***Correlation Matrix*** *is a table which shows the correlation coefficients between variables. The correlation matrix analyses the strength of the relationship between variables on the scale from -1 to +1 (see Field, 2018).*

To test the *sufficiency* of the variable's correlations, the correlation matrix should show the correlation coefficients with a value above 0.3. The correlation matrices of the three independent variables (i.e., innovation strategy, knowledge development cs, and finance mobilization) and two moderators (i.e., absorptive capacity, and financial capability) are given in Table 5-4. Hence fort we will use knowledge development cs when we mean knowledge development and dissemination. The item operationalization of these expected variables is presented in Appendix D1 and D2. The D1 matrix associated with independent variables shows that 112 coefficients are above the 0.30 threshold criterion. It also depicts that 31 items of innovation strategy, knowledge development and dissemination (henceforth knowledge development cs), and finance mobilization are correlated. The D2 matrix associated with moderators reveals that 16 coefficients are above the 0.30 threshold criterion. Nine items of the absorptive capacity and financial capability are correlated as well.

The correlation matrix (Table 5-4) shows significant correlations between knowledge development cs and innovation strategy (r = .290), between knowledge development cs and finance mobilization (r = .457), and between finance mobilization and innovation strategy (r = .208). Therefore, we may conclude that some of the variables are correlated with each other. Thus, PCA can be an appropriated technique (see Field, 2018).

Table 5-4: Correlation Matrix of the Expected Variables

Independent Variables	**Innovation Strategy**	**Knowledge Development**	**Finance Mobilization**
Innovation Strategy	1.000		
Knowledge Development CS	**.290****	1.000	
Finance Mobilization	**.208***	**.457****	1.000
Moderator Variables	**Absorptive Capacity**	**Financial Capability**	
Absorptive Capacity	1.000		
Financial Capability	**.368****	1.000	

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

B: The Kaiser–Meyer–Olkin (KMO) Criterion.

> **Definition 5.6**: ***Kaiser–Meyer–Olkin*** *is an index for comparing the magnitudes of observed correlation coefficients with the magnitude of partial correlation coefficients. The smaller the value of the index, the less appropriate the model (cf. Henry, 2003).*

The KMO criterion also demonstrates the correlations between variables and adequacy of the sample. A small value of this index would show low appropriateness of the construct (cf. Sarstedt and Mooi, 2019). According to this measure score, the KMO index should be above 0.50 to be suitable for the variable reduction techniques.

Table 5-5 reports the computed KMO index of the independent variables with a value of 0.714, and moderator variables with a value of 0.621, which both are above the threshold level of 0.50. As a result, the reported KMOs approve the adequacy of (1) the sample and (2) the sufficient correlation of the variables for the analysis.

Table 5-5: The Results of KMO Index

Independent Variables		Moderators
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.714	.621

C: Bartlett's Test of Sphericity

The Bartlett's Test of Sphericity index indicates whether the correlation matrix is proportional to an identity matrix (cf. Field, 2018). The Bartlett's test needs to be a very limited value ($p < 0.050$) to reveal that the variables are sufficiently correlated and are suitable for variable reduction techniques.

> **Definition 5.7:** ***Bartlett's Test of Sphericity*** *indicates whether the correlation matrix is an identity matrix, which would indicate that the variables are unrelated (cf. Sobh, 2008).*

The Table 5-6 indicates that Bartlett’s test is significant at 0.000, which verifies that the variables are sufficiently correlated.

Table 5-6: The Results of Bartlett's Test

Independent Variables			**Moderators**		
Bartlett's Test of Sphericity	Approx. Chi-Square	1564.778	Bartlett's Test of Sphericity	Approx. Chi-Square	282,597
	df	496		df	91
	Sig.	.000		Sig.	.000

In conclusion, the results of the correlation matrix, KMO index, and Bartlett’s test show that our data is adequate to conduct variable reduction techniques.

5.3.2 Extract the Factors / Components

The **second step** is to extract the factors / components. To conduct variable reduction techniques, it is necessary to determine which techniques are adequate for the data set (i.e., PCA or Factor Analysis). We briefly discuss the choice between (A) PCA and Factor Analysis and (B) Factor/ Component Extraction.

A: Principal Component Analysis (PCA) or Principal Factor Analysis

Principal Component Analysis (PCA) and Principal Factor Analysis (PFA) are two similar techniques to identify patterns and structures in a group of observed variables (cf. Sarstedt and Mooi, 2019). Although the two techniques are similar in a way that they reach a solution, they *differ in their goals* and in their approach to find a solution. The goal of the PCA is to reduce a number of variables (here called components) to a set of smaller observed variables. However, the goal of PFA is to identify the underling dimensions (here called factors) (cf. Sarstedt and Mooi, 2019).

PCA use the correlations between the variables, thus PCA should be applied when there exists a correlation between variables. The focus of the research is to extract a minimum number of components which represent a maximal set of total variances of the variables. In contrast, PFA should be used when the focus of research is to *identify* latent dimensions count for the variables (cf. Sarstedt and Mooi, 2019).

Hence, we prefer PCA. Thus, we check the possible correlation between the variables to choose an application of the PCA technique.

Table 5-4 presents the correlation matrix of the three variables: innovation strategy, knowledge development cs and finance mobilization. We see from the results that there are significant correlations between finance mobilization and knowledge development cs (r = 0.457), between knowledge development cs and innovation strategy (r = 0.290), and between finance mobilization and innovation strategy (r = 0.208). In addition, there is a significant correlation between two moderators (e.g., absorptive capacity and finance capability) (r = 0.368). Hence, we may conclude that there are correlations between some of the variables and we are allowed to continue the analysis with Principal Component Analysis.

> **Definition 5.8:** *A* ***Principal Component Analysis*** *is a mathematical procedure that transforms a number of (possibly) correlated variables into a (smaller) number of uncorrelated variables called principal components. PCA is a multivariate analysis technique for identifying the linear components of a set of variables (cf. Pallant, 2010; Field, 2018).*

B: Component Extraction

Reduction techniques aim to generate a new data structure with fewer factors (variables). In order to extract the components, PCA computes the eigenvectors. The eigenvectors extract the maximum possible variance of all the variables (cf. Sarstedt and Mooi, 2019). Eigenvalues of a covariance are the core of PCA.

> **Definition 5.9**: ***Eigenvalue*** *explains the total amount of variance by each variable (Sarstedt and Mooi, 2019), and quantifies to what extent the variances of the matrix are distributed (Field, 2018).*

5.3.3 Determine the Number of Factors / Components

The **third step** determines the number of components to be extracted. This step is a challenging one in PCA. Different approaches are conducted to identify the number of components to be extracted. In this respect, multiple approaches are recommended to be employed to provide greater confidence in the results. We will conduct the three approaches to determine the number of components to be extracted. (A) Kaiser's criterion; (B) The Scree Plot of Eigenvalues; (C) Parallel Analysis. They are described below.

A: Kaiser's Criterion

Definition 5.10: ***Kaiser's Criterion*** *is the rule to drop all components with eigenvalues under 1.0 (cf. Kaiser, 1960).*

According to this approach, the Eigenvalue with value greater than 1 determines the number of components to be extracted. Table 5-7 reveals the results of the PCA with the values of the Eigenvalues.

The results show that 9 variables (here called components) related to Independent Variables have obtained Eigenvalues greater than 1 which meet the Kaiser's criterion. These components demonstrate 24.858%, 10.362%, 9.165%, 6.746%, 5.660%, 4.180%, 3.788%, 3.637%, and 3.281% of variance (third column).

Moreover, the results show that 6 components related to the **Moderators** have obtained Eigenvalues greater than 1 which meet the Kaiser's criterion. These components demonstrate 23.458%, 12.027%, 10.374%, 8.789%, 8.502% and 7.267% of variance (third column).

Table 5-7: Eigenvalues Extracted through the PCA Component for independent Variables

Total Variance Explained- Independent Variables			
Initial Eigenvalues			
Components	Total	% of Variance	Cumulative %
1	**7.955**	24.858	24.858
2	**3.316**	10.362	35.220
3	**2.933**	9.165	44.385
4	**2.159**	6.746	51.131
5	**1.811**	5.660	56.790
6	**1.338**	4.180	60.971
7	**1.212**	3.788	64.759
8	**1.164**	3.637	68.396
9	**1.050**	3.281	**71.677**
…			
31	.097	.303	99.803
32	.063	.197	100.000

Table 5-8: Eigenvalues Extracted through the PCA Component for Moderators

Total Variance Explained- Moderators			
Initial Eigenvalues			
Components	Total	% of Variance	Cumulative %
1	**3.284**	23.458	23.458
2	**1.684**	12.027	35.484
3	**1.452**	10.374	45.858
4	**1.231**	8.789	54.648
5	**1.190**	8.502	63.150
6	**1.017**	7.267	**70.417**
…			
14	.301	2.152	100.000

Overall, the results show a cumulative variance of 71.677% for Independent Variables, and 70.417% for Moderators (fourth column of Table 5-7 and Table 5-8).

Based on the results in Table 5-7, 23 components in the independent variables (from 10 to 32), and in Table 5-8, 8 components in the moderators (7 to 14) have low Eigenvalues (see the full table in Appendix E1 and E2). Accordingly, they should be rejected.

However, the number of components to extract from Kaiser's criterion is not a perfect approach (see Sarstedt and Mooi, 2019). Therefore, Scree Plot and Parallel Analysis need to be considered and compared with the results of Kaiser's criterion.

B: Scree Plot

The second approach to identify the number of components to extract is Scree Plot. The scree plot indicates the *relative importance* of each component (cf. Field, 2018).

> **Definition 5.11**: ***Scree Plot*** *is a graph in which each eigenvalue (Y-axis) in plotting against the components with which it is associated (X-axis) (cf. Field, 2018).*

The Scree Plots for (a) the Independent Variables (see Figure 5-1) and (b) the Moderators (see Figure 5-2) are depicted. The relative importance is defined by component matrix (eigenvalues) when the differences in eigenvalues are negligible

Figure 5-1: Scree Plots Associated with Independent Variables

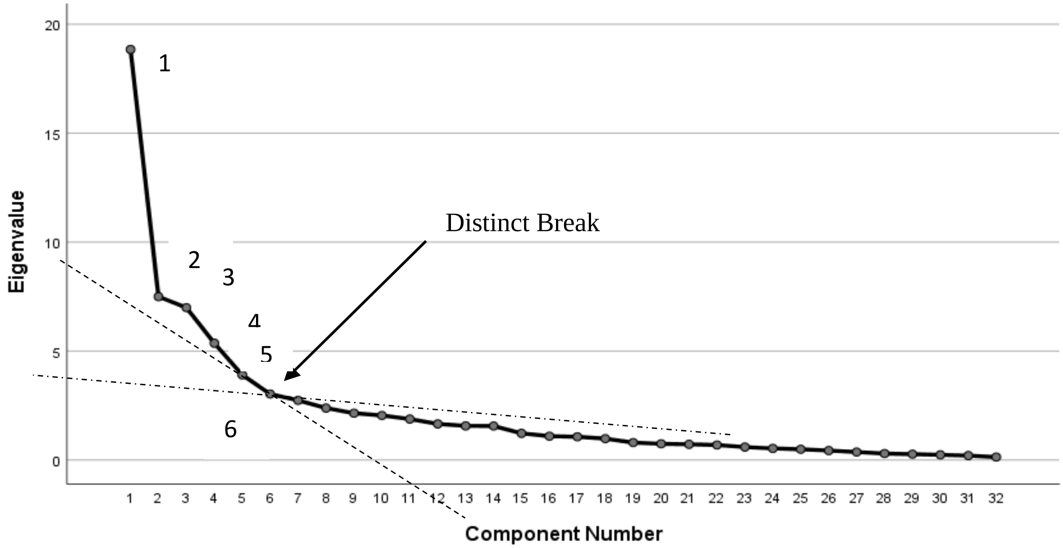
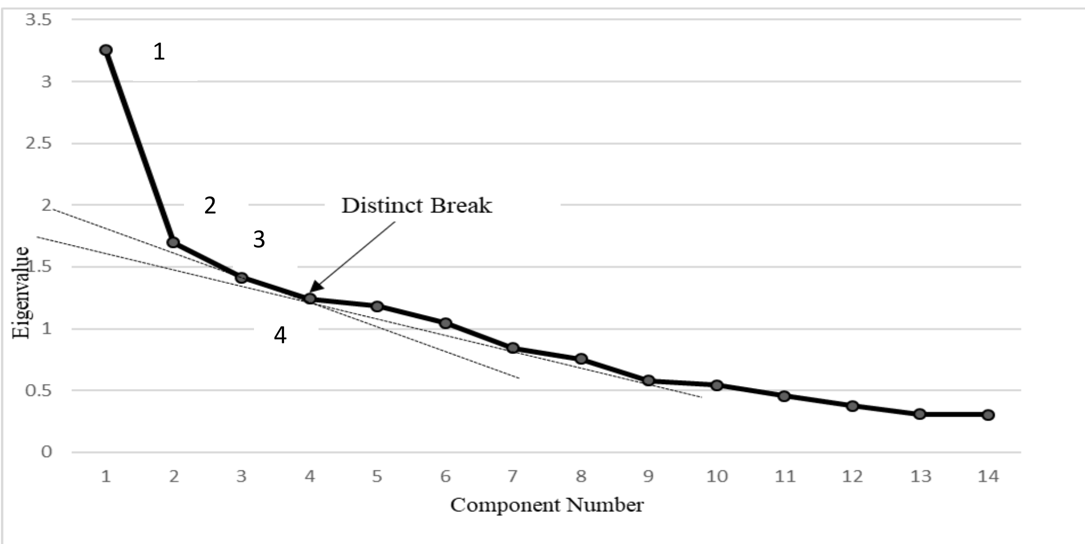


Figure 5-2: Scree Plots Associated with Moderators



The first Scree Plot computed is associated with the Independent Variables and highlights the distinct break (or elbow). We see that which the retaining components are above this break. The plot demonstrates that components 1, 2, 3, 4, 5 and 6 are above the elbow. Thus, from this plot we can decide six components to extract.

The distinct break in the second Scree Plot associated with moderators reveals that the components 1, 2, 3 and 4 are above the elbow. Therefore, based on this distinct break, four components can be extracted.

However, as the results of the plot are not statistically decided upon, the judgment of the number of components to extract is not accurate. Therefore, we include a third analysis method, the Parallel Analysis.

C: Parallel Analysis

> **Definition 5.12:** ***Parallel Analysis*** *is a Monte-Carlo-Simulation-based method that allows determining the number of components to retain in the Principal Component Analysis (cf. Ledesma and Valero-Mora, 2007).*

The method compares the observed Eigenvalues (raw data) extracted from the correlation matrix to be analysed with those obtained from uncorrelated normal variables (cf. Ledesma and Valero-Mora, 2007).

Among the mentioned approaches (e.g., Kaiser’s criterion, Scree Plot, and Parallel Analysis) for identifying the number of components to extract, Parallel Analysis is the most accurate and reliable approach (see Sarstedt and Mooi, 2019; Field, 2018).

To extract the number of components with Parallel Analysis, we run the Syntax developed by O'Connor (2000) in SPSS (see Appendix F). The results of the analysis are reported in Table 5-9. In the table, the third column labeled Prcntyle reveals the 95th percentile for each factor’s eigenvalue. This column needs to be compared with the second column (initial eigenvalues). Previously, the Subsection 5.3.3(A) demonstrated the initial eigenvalues (see Table 5-7 and Table 5-8). The number of components to extract will be identified through the comparison between initial eigenvalues and Prcntyle.

The Final Outcome of Step 3

Table 5-9 shows that four components associated with independent variables have greater initial eigenvalues than their Prcntyle. Two components associated with moderators have greater initial eigenvalues than their Precntyle. Therefore, the results of Parallel Analysis demonstrate that the number of components to extract for further analysis related to the individual variables is ***four*** and the number related to the moderators is ***two***.

These four components have the variance of 24.858%, 10.362%, 9.165%, and 6.746% (see Table 5-7). Overall, the cumulative variance of these four components is 51.131% (see Table 5-7).

The two components associated with moderators have the variance of 23.458%, and 12.027% (see Table 5-8). The cumulative variance of these three components is 35.484 % (see Table 5-8).

Table 5-9: The Result of Parallel Analysis

Component ***(Independent variables)***	**Initial Eigenvalues**	**Prcntyle**	**Decision**
1	**7.954521**	**2.532995**	**Accept**
2	**3.315843**	**2.282646**	**Accept**
3	**2.932795**	**2.094688**	**Accept**
4	**2.158695**	**1.958615**	**Accept**
5	1.811097	1.841834	**Reject**
6	1.337753	1.720791	**Reject**
7	1.212212	1.616428	**Reject**
…	…	…	**Reject**
32	.062912	.228015	**Reject**

Component ***(Moderators)***	**Initial Eigenvalues**	**Prcntyle**	**Decision**
1	**3.284**	**1.878902**	**Accept**
2	**1.684**	**1.664605**	**Accept**
3	1.452	1.408921	**Reject**
4	1.231	1.355423	**Reject**
…	…	…	**Reject**
14	.301	.505338	**Reject**

5.3.4 Interpret the Factor Solution (Component Rotation)

In the **fourth step**, we interpret the factor solution following the procedure by Sarstedt and Mooi (2019). The procedure is as follows. (1) the component rotation is conducted. Then, (2) we determine the variables that are relevant to the extracted factors as computed in the previous step. Finally, (3) we compute the components scores.

> **Definition 5.13**: ***Component Rotation*** *determines what the components represent. It shows the estimation of correlations between the variables and the estimated components (Field, 2018).*

The component rotation has two types of methods: (1) Orthogonal, and (2) Oblique rotation method. To perform the component rotation, we need to conduct it with one of the mentioned methods. In this regard, the correlations between our variables should be conducted to indicate which method is adequate to perform. Within Orthogonal methods (e.g., Varimax, Quartimax, and Equamax) the variables are not correlated. In contrast, Oblique rotation methods (Oblimin, and Promax) presume that there are correlations between variables ($r > 0.3$). Therefore, we test our data in SPSS to explore which rotation method is adequate to our construct.

> **Definition 5.14**: *An* ***Oblique Rotation*** *is a method of rotation in factor analysis that allows the underlying factors to be correlated (Field, 2018).*

Rotation is a process in factor analysis for improving the interpretability of factors. In essence, an attempt is made to transform the factors that emerge from the analysis in such a way as to maximize factor loadings that are already large and minimize factor loadings that are already small (Field, 2018).

The results of our analysis are presented in Table 5-10. In this table, the correlations between the components are reported. It shows that the highest value of the correlation is 0.350, which meets the threshold criterion ($r > 0.3$).

Table 5-10: Component Correlation Matrix Associated with All Variables

Component Independent variables	1	2	3	4
1	1.			
2	-.152	1.		
3	.114	-.004	1.	
4	**.350**	-.096	.091	1.

Component Moderators	1	2
1	1.	0.271
2	0.271	1.

According to the outcome of the Table 5-10, for Independent Variables, we can continue our analysis with the Promax rotation technique under the Oblique rotation methods category. For Moderators, the component correlation is 0.27 which is under threshold criterion. Therefore, we continue the analysis of the Moderators with Varimax rotation technique under the Orthogonal methods category.

Definition 5.15: *"**Promax Rotation** a method of oblique rotation that is computationally faster than direct oblimin and so useful for large data sets" (Field, 2018, p.1300).*

Definition 5.16: ***Varimax Rotation** is an orthogonal rotation of the component axes to maximize the variance of the squared loadings of a component (column) on all the items (rows) in a component matrix, which has the effect of differentiating the original items by extracted components (cf. Tam et al., 2007).*

The results of conducting Promax rotation technique on the Independent Variables and Varimax rotation technique on the Moderators are presented below in subsections ***A*** and ***B***.

***A**: Promax Rotation Method on the Independent Variables*

The outcome out of performing the Promax rotation method on the independent variables is depicted in Table 5-11. This table evaluates the construct validity. The criteria for the acceptable construct validity are:

(1) component-loadings should be higher than 0.6, and

(2) the cross-loadings need to be below 0.3.

The results of the initial component rotation reveal that eight items associated with component 1; six items associated with component 2; five items associated with component 3; and four items associated with component 4 have component-loadings higher than 0.6, and cross-loadings below 0.3. Therefore, we continue the analysis with the four components and the highlighted items. The rest of the items below 0.6 will be excluded.

Table 5-11: First Pattern Matrix on Independent Variables

	Component			
ITEM	1	2	3	4
Q17	**.861**			
Q15	**.848**			
Q19	**.834**			
Q18	**.809**			
Q14	**.762**			
Q16	**.751**			
Q20	**.729**			
Q13	**.727**			
Q6	.378		.363	
Q5	.306			
Q4				
Q21		**.830**		
Q22		**.794**		
Q23		**.780**		
Q24		**.774**		
Q25		**.746**		
Q26		**.701**		
Q29			**.785**	
Q31			**.748**	
Q27			**.716**	
Q28			**.707**	
Q30			**.692**	
Q1				
Q2				**.661**
Q8				**.643**
Q7				**.626**
Q11				**.615**
Q9				.584
Q12				.545
Q0				.541
Q3				.519
Q10		-.335		.478

Extraction Method: Principal Component Analysis. Rotation Method: Promax with Kaiser Normalization.

After excluding the items below 0.6 component-loadings, the next rotation component matrix is run and presented in Table 5-12. To perform the final rotation, we exclude nine out of thirteen items from innovation strategy variable. This exclusion improves the construct validity. The rest of the items associated with knowledge development and dissemination and financial mobilization retain.

Table 5-12: Final Parallel Matrix Rotation Solution on Independent Variables

	Component			
Item	1	2	3	4
Q17	**.877**			
Q19	**.847**			
Q15	**.844**			
Q18	**.823**			
Q16	**.766**			
Q14	**.750**			
Q20	**.731**			
Q13	**.723**			
Q21		**.840**		
Q22		**.815**		
Q23		**.806**		
Q24		**.795**		
Q25		**.746**		
Q26		**.736**		
Q29			**.820**	
Q28			**.767**	
Q31			**.735**	
Q30			**.724**	
Q27			**.684**	
Q8				**.766**
Q2				**.712**
Q7				**.682**
Q9				**.615**
Q11				**.600**

Extraction Method: Principal Component Analysis.

In the final rotation matrix to ensure acceptable construct validity, the items with component-loadings below 0.6 and cross-loadings above 0.3 should be excluded. Consequently, no items of the four components were excluded. The final rotation (see Table 5-12) shows that five items (Q2, Q7, Q8, Q9, Q11) out of thirteen associated with innovation strategy; fourteen items (Q13-Q26) associated with knowledge development and dissemination; and five items (Q27-Q31) associated with financial mobilization. Thus, the original thirteen items referring to the innovation strategy is reduced to the five items, and the original fourteen items associated with knowledge development and dissemination and five items associated with financial capability are remained. With the validated construct related to the independent variables, we are able to evaluate the construct reliability. Therefore, Cronbach's Alpha and Composite Reliability will be calculated for the three remaining variables (i.e., the validated four components).

B*: Varimax Rotation Method on the Moderators*

The results out of conducting the Varimax rotation method on the moderators is presented in Table 5-13. According to the criteria for the acceptable construct validity (having the items with component-loadings above 0.6 and cross-loadings below 0.3), Table 5-13 shows that three items associated with component 1 and one item associated with component 2 have component-loadings higher than 0.6, and cross-loadings below 0.3. Thus, these four items (see Table 5-13) will remain for further analysis. To ensure acceptable construct validity, we decide to exclude three items out of the original six items related to the absorptive capacity, and seven items out of the original eight items related to the financial capability to increase the construct validity. Consequently, we continue the analysis with two components and four bolded items.

Table 5-13: First Rotation on the Moderators

	Component	
	1	**2**
Q32	**.618**	.126
Q33	**.615**	-.360
Q41	.152	**.696**
Q36	**.661**	-.155
Q34	.523	.098
Q35	.339	-.108
Q37	.377	-.397
Q38	.445	-.296
Q39	.484	-.337
Q40	.228	.414
Q42	.474	.396
Q43	.548	.053
Q44	.494	.574
Q45	.503	-.047

Extraction Method: Principal Component Analysis.

Following excluding the items with below 0.6 component-loadings, the outcome of next rotation component on the Moderators is depicted in Table 5-14.

Table 5-14: Final Rotation Matrix on Moderators

	Component	
	1	**2**
Q32	**.756**	.391
Q33	**.778**	-.282
Q41	.074	**.938**
Q36	**.758**	-.192

Extraction Method: Principal Component Analysis.

This final rotation on moderators demonstrates that all the remained items have component-loadings above 0.6 and cross-loadings below 0.3. The three remaining items (Q32, Q33, and Q36) in component 1 are associated with absorptive capacity and one item (Q41) loaded in component 2 is associated with financial capability. Therefore, the original six-item scale related to the absorptive capacity is reduced to a three-item scale and the original seven-item scale referring to the financial capability is reduced to a one-item scale. However, a minimum of three items for each variable (i.e. component) with component-loadings above 0.6 is required to perform further analysis (cf. Field 2018). As a consequence, financial capability is not currently supported by sufficient items and should be rejected. In other words, component 2 which is mainly loaded through an item associated with the financial capability scale (see Table 5-14), it is decided to be excluded to improve the construct validity. We continue the analysis with one Moderator (i.e., absorptive capacity).

Having the validated construct related to the moderators, we are able to evaluate the construct reliability for the moderators. Subsection 5.4 reports the results of the reliability analysis.

5.4 Construct Reliability

For measuring the internal consistency (i.e., reliability) of the variables in the construct, **Cronbach's Alpha (**subsection 5.4.1) and **Composite Reliability** (subsection 5.4.2) criteria are suggested to be computed (see Joseph et al., 2017).

5.4.1 Cronbach's Alpha

> **Definition 5.17**: ***Cronbach's Alpha*** *is a commonly used test of internal reliability. It calculates the average of all possible split-half reliability coefficients.*

Cronbach's Alpha has a positive relationship with the intercorrelations among the test items. The intercorrelations among the test items will be maximized when all items measure the same construct. Cronbach's Alpha is accepted as an indicator of the entity's reliability (cf. Cronbach, 1951; Gliem and Gliem, 2003).

A computed Cronbach's Alpha will vary from 0.0 (no internal reliability) to 1.0 (perfect internal reliability). The acceptable range of Cronbach's Alpha is as follows:

- below 0.5 unacceptable
- above 0.5 undesirable
- above 0.6 questionable
- above 0.7 acceptable
- above 0.8 good
- much above 0.9 excellent (Gliem and Gliem, 2003).

The results of our reliability analysis are presented in Table 5-15. According to the mentioned range, the calculated results show that finance mobilization with 0.829, innovation strategy with 0.704, and absorptive capacity with 0.752 Cronbach's Alpha coefficients have a respectable internal consistency. The knowledge development and dissemination with 0.903 Cronbach's Alpha coefficients has an excellent internal consistency.

However, Cronbach's Alpha generally tends to underestimate the internal consistency reliability. Therefore, to overcome the limitation of Cronbach's Alpha, Composite Reliability as a measure of internal consistency is recommended (see Joseph et al., 2017).

5.4.2 Composite Reliability

> **Definition 5.18**: "***Composite Reliability*** *is the total amount of true score variance in relation to the total scale score variance" (Brunner and Süß, 2005, p.229).*

Composite Reliability's values vary between 0 and 1, and it has the same interpretation as Cronbach's Alpha (values of 0.60 to 0.70 are acceptable; values between 0.70 and 0.90 are satisfactory). Thus, the higher value reveals higher internal consistency (see Joseph et al., 2017).

In contrast to the Cronbach's reliability, composite reliability overestimates the results of internal consistency. Thus, it has been suggested to consider both criteria (see Joseph et al., 2017). Accordingly, the third column of Table 5-15 shows the results of composite reliability. It is obvious that all the variables are above 0.70. Hence, the construct has a satisfying internal consistency.

Table 5-15: Construct Reliability

Variables	**Cronbach's Alpha**	**Composite Reliability**
Finance Mobilization	0.829	0.877
Innovation Strategy	0.704	0.735
Knowledge Development and Dissemination	0.903	0.915
Absorptive Capacity	0.752	0.771

The above steps complete the evaluation of the validity and reliability of the construct. The following section summarizes the results of the evaluated validity and reliability.

5.5 Results of the Construct Validity and Reliability

The results of the sample analysis reveal a good validity and a good reliability. The final rotated matrix related to the independent variables (Table 5-12) shows that the items (Q2, Q7, Q8, Q9, and Q11) associated with innovation strategy; the items (Q13-Q26) associated with knowledge development and dissemination; and the items (Q27-Q31) associated with finance mobilization have component-loadings above 0.6 and cross-loadings below 0.3.

Similar to the independent variables, the final rotated matrix related to the moderators (Table 5-14) demonstrates that the items (Q32, Q33, and Q36) associated with absorptive capacity have component-loadings above 0.6 and cross-loadings below 0.3. Good construct validity is achieved when these two threshold criteria are met. These results approve that our construct has a good validity.

In terms of the construct reliability, two criteria have been evaluated (1) ***Cronbach's Alpha,*** and (2) ***Composite Reliability.*** The results of reliability analysis show that both Cronbach's Alpha and Composite Reliability for the main variables (innovation strategy, knowledge development and dissemination, finance mobilization, and absorptive capacity) are above the threshold criteria (0.70). Good construct reliability is evident as Cronbach's Alpha coefficients and Composite Reliability are both above 0.70. Therefore, the construct addresses a good validity as well. Method validity will be addressed in subsection 6.4.2.

5.6 Answer to RQ2

This chapter addressed RQ2: *How can the supportive activities be operationalized in a construct that enables us to measure the impact of the identified supportive activities by UBIs on the performance of an NTBF?*

To provide an answer to this question and validate the measurement instrument (i.e., construct), we evaluated in this chapter the construct validity and reliability. The results of the evaluation of the construct validity show that eight items of the innovation strategy, seven items of the financial capability, and three items of the absorptive capacity should be excluded to improve the construct validity. Within the other variables (knowledge development and dissemination, and finance mobilization) their original fourteen and five items retained. Subsequently, the results of the analysis on the construct reliability demonstrate the acceptable and good reliability of our construct. In the next chapter, we will test our hypotheses with the new and adapted construct.

The provided answers given in chapter 4 (steps 1-3) and in chapter 5 (step 4) together form a solid answer to the RQ2.

In summary, the answers to RQ2 are as follows.

- A theoretical model is developed that associates the two supportive activities by UBIs, their related moderators and the NTBF’s innovation strategies with the performance of the NTBTs (Chapter 4).
- A measurement tool (construct) is provided to enable us to measure the possible impact of the support by UBIs on the performance of the NTBFs (Chapter 4).
- Validity construct analysis excludes the problematic scales of the construct to produce good construct validity (Chapter 5).
- Reliability construct analysis shows acceptable and good construct reliability for the retained construct (Chapter 5).

Chapter 6

Implementing the SA Construct

This section addresses RQ3*: In what way are the identified supportive activities related to (a) the innovation strategy of the NTBFs and consequently to (b) the performance of an NTBF?*

To provide an answer to RQ3, we apply the adapted construct from chapter 5. We have conducted multiple linear regression analyses to analyze the relationship between at the one side, two supportive activities by UBIs: (a) finance mobilization, and (b) knowledge development and dissemination together with an innovation strategy, and at the other side, the performance of the NTBFs. In addition to the Independent Variables, one Moderator (i.e., absorptive capacity) is considered in the regression analysis to evaluate whether it amplifies the relation between the supports by UBIs and the performance of the NTBFs. Figure 6-1 presents a hypothesized model of these relations.

The chapter proceeds as follows. Section 6.1 reviews the perceptions of the entrepreneurs about the resources (supports) of the UBIs. Section 6.2 reports on the characteristics of sample NTBFs (e.g., educational background, prior work experience of the participants, the number of (co-)founders, and NTBFs industry). Section 6.3 develops the theoretical background and formulates the hypotheses of the research. Section 6.4 evaluates whether the multiple linear analysis technique is appropriate to test our model. Section 6.5 reports on the results of testing the model and the hypotheses.

This chapter is based on the following publication:

Samaeemofrad, N., and van den Herik, H. J. (2020). **A Moderating Role of Absorptive Capacity within Incubation Support.** In the proceedings of the 2020 ICE/ITMC International Virtual Conference, 2020 (IEEE Xplore).

6.1 The Supports by UBIs and the Capabilities of the NTBFs

Business Incubators (BIs) are considered as value-added innovation policies. They aim to stimulate entrepreneurship and innovation, and to fuel the economy (cf. Fini et al., 2011; Mian et al., 2016; Soetanto and Jack, 2016; van Weele et al., 2017). To acquire this aim, UBIs support NTBFs by providing different services, such as access to finances, physical infrastructure, knowledge development and dissemination, and access to the networks (cf. Bruneel et al., 2012; Samaeemofrad et al., 2016; van Weele et al., 2017; Lukes et al., 2019).

The theory of Resource-Based View (RBV) considers a firm as a bundle of resources. In contrast to the mature organizations, the resource bases of the NTBFs are developing and are yet not completed. Our previous chapters indicated that the NTBF's liabilities of smallness and newness lead to a scarcity of resources. Therefore, NTBFs consider UBI as a tool to address their liabilities and to help them developing their incomplete resources. Indeed, UBIs provide the sort of resources that are vital for NTBFs' growth and survival, and they can commercialize their ideas (cf. Soetanto and Jack, 2016; van Weele et al., 2017).

6.1.1 The Outcome of the Incubation Is A Challenge

However, the promising performances of the UBIs are still unclear. Some studies have revealed that NTBFs appear to have more chance of survival when they receive support from UBIs (see McAdam and McAdam, 2006; Bruneel et al., 2012; Stokan et al., 2015). However, other investigations have shown that UBIs do not have much impact on the success of the NTBFs (see Ratinho and Henriques, 2010; Schwartz, 2013). Recently, Dvouletý et al. (2018) revealed that the incubated NTBFs have a worse performance than unincubated NTBFs.

Prior studies (see Bruneel et al., 2012; Patton, 2014; van Weele et al., 2017) report that this disappointing outcome of the UBIs lies partly in the low usage of the UBIs' resources by NTBFs. Furthermore, some entrepreneurs are not willing to participate in the training and mentoring business sessions of the incubators or do not take part in the networking events. Moreover, the possibility of the insufficient quality of the offered resources leads to the low usage of the UBIs resources by NTBFs. Thus, this ambiguity in the influence of supports by UBIs, has raised a research call to obtain more insight into their impacts on the performance of the NTBFs.

Nevertheless, it is a salient point to note that assessing the outcome of the incubator is a challenge in academia. Lukes et al. (2019) reviewed the empirical literature on the performance of business incubators. They stated that most of the previous investigations (54%) can be classified as a qualitative study, and only fewer scholars (15%) conducted a quantitative approach to evaluate the performance of business incubators (see Mian et al., 2016). One explanation for the low number of quantitative studies to assess the effectiveness of the UBIs is that measuring the outcome of the incubator is a challenging risk (cf. Lukes et al., 2019). As a result, there is a lack of studies on this matter (see Lukes et al., 2019).

6.1.2 Our Point of View

Going back to the low usage of incubators' resources, van Weele et al. (2017) have argued that while the offering supports and resources by UBIs are crucial for the NTBFs, they can be beneficial when NTBFs use them. The scholars' seminal contribution highlighted that NTBFs are not aware of their resource gaps. Meanwhile, the NTBFs suffer from the capabilities to utilize the resources to help them achieve successes and be productive (cf. Jensen and Clausen, 2017). NTBFs' capabilities (absorptive capacity) refer to (a) the firm's ability to use the resources, and (b) its ability to search for the resources and develop them (cf. Jensen and Clausen, 2017).

While previous studies pointed at the entrepreneurs' unwillingness in the usage of incubators' knowledge-based resources, we aim to stress that the entrepreneurs' ability in recognizing the value of external knowledge resources as provided by UBIs in order to assimilate it and to have effect at their performance. Thus, the focus of our study is on how such an impact of absorptive capacity moderates the degree to which the supports by UBIs affect the performance of the NTBFs.

6.1.3 Two Research Gaps

The above discussions lead us to point out that the research gap between the incubator and the NTBF's literature is two-folded: (1) the impact of incubators' resources on the performance of NTBFs is still under investigation, (2) empirically evaluating the NTBFs' absorptive capacity or learning ability will moderate the impact of incubators' resources on the NTBFs' performances. Therefore, we here address these two research gaps and aim to (1) assess how entrepreneurs perceive the offering supports and resources by the incubators, and (2) evaluate entrepreneurs' learning ability associated with acquiring external knowledge resources and utilize them.

6.2 Research Participants' Information

This section reports on the basic information about the participants and their NTBFs. The section addresses (A) the educational background of the participants, (B) prior working experience of them, (C) frequency of the number of (co-)founders, and (D) the industry of the participated NTBFs. The sample size of the study is 96.

A: Educational Background of the Participants

From the 96 participants, most information on the educational background of 72 participants (founders) in our survey is as follows. 31 (co-)founders are educated in economics and business, 16 (co-)founders in engineering, 15 in the computer science, and 10 (co-)founders in healthcare.

B: Prior working experience of the founders

From the 96 participants, the majority of the (co-)founders (46) has work experience in the universities, R&D organizations, and high-tech firms. 18 (co-)founders had no previous work experience. 13 (co-)founders have experienced as a consultant before founding their NTBFs. The rest of (co-)founders (19) have working experience in business development, medicine and nursery, clinical research (healthcare), Non-Governmental Organization (NGO) and public sector.

C: The distribution of the number of founders

From the 96 participants, the distribution of the number of founders in the NTBFs is as follows: 45 NTBFs have been founded by two (co-)founders, 21 NTBFs have been founded with a single (co-) founder, 18 NTBFs have been founded with three (co-)founders, and 12 NTBFs have been initiated with four (co-)founders.

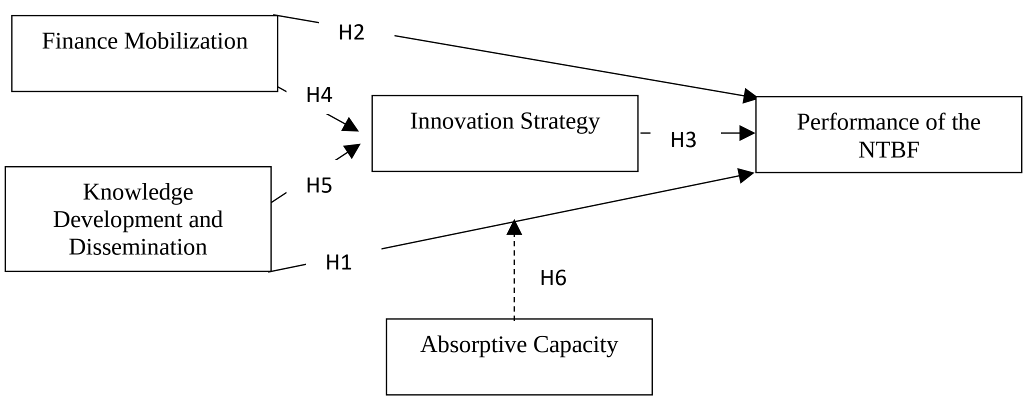
D: The industry of the NTBFs

From the 96 participants, the industry of their NTBFs consists of different sectors. 36 NTBFs are active in the Healthcare and MedTech industry, 19 NTBFs work in the Computer and Software industry (e.g., AI, Blockchain, IoT, and Robotics), and 10 NTBFs are in the Life Science and Biotechnology industry. The rest of the NTBFs (31) is active in other industries, such as Food and Agriculture, Complex Technologies, Mining, Real Estate, Environmental, and Social services.

6.3 The Development of Hypotheses

In this section, we continue our research on the constructs and develop our final hypotheses that will be tested in this chapter. Subsections 6.3.1 to 6.3.5 explain the theoretical and empirical findings as a background to develop our hypotheses. Subsequently, the obtained results from Chapter 5 will be discussed in terms of the retained variables. Then, we will continue our research. In Figure 6-1, we show six hypothesized relations (H1 to H6) among the retained variables. The hypotheses are discussed in the subsections 6.3.1 to 6.3.5.

Figure 6-1*:* The Hypothesized Model Relationships



6.3.1 Knowledge Development and Dissemination and the Performance of the NTBFs

Knowledge development and dissemination (cf. supportive activities) refer to the provision of business training programs, mentoring and coaching facilities by UBIs that may influence the performance of their NTBFs. The operationalization of the original knowledge development and dissemination measures (Q13-Q26) has been explained in Chapter 5. In addition, subsection 6.4.1 will briefly review the results of the retained measures for further analysis.

Naïve entrepreneurs often suffer from the business knowledge and skills including: (1) personal skills (e.g., creativity, self-confidence), (2) management skills (e.g., planning, leadership), and (3) technical skills (e.g., presentation, communication) (see Albort-Morant and Oghazi, 2016). Previous studies (see Arenius and Autio, 2002; Kirwan et al., 2006) state that knowledge is the most prominent resource for NTBFs. Obtaining relevant business knowledge and keeping up to date with recent changes in their fields influence the success of the NTBFs (cf. Kirwan et al., 2006). One approach to overcome the liability of business knowledge and experience appears to have access to business training and customized coaching and monitoring. UBIs, accelerators, and Science Parks are such entities that aim to facilitate these services. The training and mentoring services include how to develop a new business, build new teams, conduct marketing and sales, and be familiar with the laws and obligations of their host countries. Such services (e.g., training and monitoring) are helpful to develop the abilities and capabilities of the entrepreneurs to manage more effectively their business (Bae et al., 2014; Huynh et al., 2017). Therefore, it appears that UBIs' training and mentoring support services have the potential to help entrepreneurs to fill their knowledge gap, and consequently, improve the performance of their NTBFs (see Albort-Morant and Oghazi, 2016; Dahms and Kingkaew, 2016).

The above argument leads us to hypothesis H1.

H1: Knowledge development and dissemination are supportive activities that have a positive impact on the performance of the NTBFs.

6.3.2 Finance Mobilization Supportive Activity and the Performance of the NTBFs

Most entrepreneurs start their business with only a few numbers of financial resources. In the early stages of their NTBFs, their limited revenue flows cannot meet the expenses of their research and developments (Kirwan et al., 2006). Therefore, they attempt to raise funds from different financial resources such as grants, venture capitalists, university funds, strategic alliances with corporates, and governments. In this regard, UBIs help NTBFs to access the finance, which we call Finance Mobilization.

A finance mobilization supportive activity by UBIs refers to the type of services that UBIs facilitate to have access to different capital and financial resources for their NTBFs. We assume that UBIs can help their NTBFs effectively to have access to finances and to raise funds. Subsequently, their support influences the performance of the NTBFs. Hence, we test the following hypothesis.

H2: Finance mobilization has a positive impact on the performance of the NTBFs.

The operationalization of the five original finance mobilization measures (Q27-Q31) has been presented in Chapter 5. Subsection 6.4.1 will summarize the results of the retained measures for further analysis.

6.3.3 Innovation Strategy and the Performance of the NTBFs

In a well-known investigation, March (1991) identified two types of innovation strategies, namely (1) explorative and (2) exploitative. The first type is the explorative strategy by which the firms develop new products, services, or pursue new markets. With the second type of innovation strategy, the exploitative strategy, firms concentrate on improving and developing their current services, products, or markets. (March, 1991). Via the exploration strategy, NTBFs create new technologies and products and consequently develop new markets. Through conducting the exploitation strategy for the current market, NTBFs attempt to implement incremental innovations in their products. In parallel, through exploiting in their current products and technologies, development in the current markets will be achieved (see Soetanto and Jack, 2016). Thus, we may assume that the innovation strategy has a certain influence on the performance. Therefore, we formulate the following hypothesis.

H3: Innovation Strategy has a positive impact on the performance of the NTBFs.

The operationalization of the thirteen original finance mobilization measures (Q0-Q12) has been presented in Chapter 5. Subsection 6.4.1 summarizes the results of the retained measures for further analysis.

6.3.4 Supportive Activities by UBIs, Innovation Strategy and Performance of NTBFs

Soetanto and Jack (2016) state that the literature on the business incubators pays less attention to the relations between on the one side (A) the NTBF's innovation strategies and, (B) the supportive activities by UBIs, and on the other side (C) the performance of the NTBFs. Indeed, the majority of the studies concentrates on the incubation process but have overlooked the impact of the support by UBIs on (1) the NTBF's innovation strategies and consequently on (2) their performance. This means that there is a real gap between the literature and the procedures. The literature on the NTBFs mainly focuses on the outcomes of the NTBFs during the participation in the incubation programs. At that point, there is a scarcity of concentration on the impact of the support by UBIs on the NTBFs' innovation strategies. Therefore, we attempt to address this research gap and increase our understanding about the relations between UBIs' support (e.g., knowledge development and dissemination, and finance mobilization), NTBF's innovation strategy and their performances. Hence, the following two hypotheses are formulated.

H4: Finance mobilization has a positive impact on the innovation strategy and, therefore, on the performance of the NTBFs.

H5: Knowledge development and dissemination have a positive impact on the innovation strategy and therefore on the performance of the NTBFs.

6.3.5 Amplifying the Impact of Knowledge Development and Dissemination

We expect that absorptive capacity will amplify the impact of knowledge development and dissemination on the performance of the NTBFs. Previous studies (see Oakey, 2012; Schwartz, 2013; van Weele et al., 2017) reported that NTBFs do not make benefit from the UBIs' resources. As a result, the outcome of the incubators is in general disappointing. Low quality of the knowledge resources of incubators, or a flawed intention of entrepreneurs to take part in training sessions, are possible reasons for this outcome as already announced by Patton, (2014) and Lalkaka, (2001).

We assume that (a) the entrepreneurs' ability to acquire knowledge, (b) their ability to utilize and (c) to assimilate them might have an impact on taking advantage from knowledge development and dissemination supports by UBIs. Therefore, we develop the following hypothesis.

H6: Absorptive capacity has a positive moderating effect on the relation between (a) knowledge development and dissemination and (b) the performance of the NTBFs.

Figure 6-1 depicts all the hypothesized assumptions. In the next sections (6.4 to 6.6), we will test these hypotheses to see whether our data has to reject them or cannot reject them. Section 6.4 elaborates the measures to be tested within the mentioned hypotheses.

6.4 Research Design

Our data set and the process of collecting the sample to test (1) the formulated hypotheses and (2) the model are already presented in chapter 5 (Section 5.1). Moreover, the measures that we used to operationalize our model, are explained in brief in Chapter 4 (Section 4.4), and Chapter 6 (Section 6.3). Here in subsection 6.4.1, we discuss the remaining measures to continue the analysis. The method is validated in subsection 6.4.2. After that, the appropriateness of linear regression analysis to analyse our data is evaluated in subsection 6.4.3.

6.4.1 Measures

This subsection explains (a) the dependent variables, (b) the independent variables, (c) the moderators, and (d) control variables to be examined by regression analysis. Chapter 4 has presented the operationalization of the measures of all variables. This subsection briefly reviews them. In addition, the *measures* of the control variables are provided in this subsection. Appendix C reports all the measurement scales of the model.

A: Dependent Variable

We use the performances of the NTBFs as a dependent variable. Entrepreneurship studies and research reports categorize the measurement scales of the firm’s performance into two categories: (1) objective performance measures and (2) subjective performance measures.

Objective Measures

Objective measures include (a) growth-related criteria and (b) profitability-related criteria. Ad (a) previous studies argue that growth-related criteria can be more reliable and acceptable with respect to financial measures (see Soetanto and van Geenhuizen, 2019). It seems that among the objective measurement criteria, the growth in the number of employees (job growth) can be considered as an acceptable measure of performance for small firms. However, some of the growth-related criteria such as sales growth, are useful measures in established firms and are not accurate for new and small businesses. Ad (b), profitability-related criteria (e.g., return on invest (ROI), return on assets (ROA)) are not appropriate measures to evaluate the performance of small and new businesses. The reason is that most of these firms have not reached the profit-making point (see Garrett and Covin, 2013).

Subjective Measures

Subjective measures refer to the founder's evaluation about the perceived success, their goals, and milestones achievement. In our empirical study, we use a single measure (i.e., the founder's anticipation) on five items (viz. Goal Achievement (2 items); Skill Development (1 item), and Satisfaction on Income and Business Development (2 items)). Therefore, we asked founders to indicate to what extent they are satisfied with the measurement items on their NTBFs' performance on a 7-point scale from strongly dissatisfied to strongly satisfied. We assume that the participants are acknowledged about the performance of their NTBFs. The measurement scale for the performance of NTBFs is an adapted and modified version from the work by van Gelderen et al. (2005). A reliability assessment of the performance scale is $\alpha = 0.8$, which is a high Cronbach's Alpha coefficient.

Different Dimensions

As measuring the performance of NTBFs has different dimensions, the combination of them can be beneficial for empirical investigation (see Soetanto and van Geenhuizen, 2019). Moreover, considering only objective or subjective measures contains a bias as well. Thus, in order to overcome the research bias and to capture different aspects of the performance of NTBFs, we consider both objective and subjective measures. As an objective measure, we use the changes in the number of employees (job growth) and ask participants to indicate the number of employees that they have hired since last year. Then, we transform the changes in job growth into a 7-point scale.

B: Independent Variables

In our study, we have three independent variables (innovation strategy, knowledge development and dissemination, and finance mobilization). The *innovation strategy* measure builds on the construct developed by Soetanto and Jack (2016). The thirteen-item scale is explained in Table 4-2 (Chapter 4). The measure concentrates on the innovation strategies of the NTBFs from both: (1) market domain, and (2) technology domain. The *knowledge development and dissemination* supportive activity measure is adapted from Hackett and Dilts (2008), St-jean and Audet (2009), and Samaeemofrad et al. (2016). It reflects the extent to which UBIs provide training, mentoring and coaching supportive activities for the NTBFs. The thirteen-item scale is provided in Table 4-3 (Chapter 4). The *finance mobilization* measure focuses on financing NTBFs with the support of BIs. The five-item scale is presented in Table 4-4 (Chapter 4), which is adapted from our observations and interviews with founders and UBI's managers (see Samaeemofrad et al., 2016).

The Application of PCA

As reported in Chapter 5, we applied Principal Component Analysis to all the 31 items of the independent variables. The analysis confirmed the presence of innovation strategy, knowledge development and dissemination, and finance mobilization (see Table 5-12). The results have shown that five items associated with innovation strategy, thirteen items associated with knowledge development and dissemination, and five items associated with finance mobilization were examined through Promax rotation technique, and then retained for further analysis. All the remaining items have Eigenvalues higher than one, component loadings greater than 0.60, and cross-loadings below 0.30. The items associated with the innovation strategy scale (see Table 4-2) have shown the component loadings below 0.6. Therefore, nine items of innovation strategy were excluded from further analysis. In the end, the original thirteen-item scale for innovation strategy was reduced to the five-item scale.

C: Moderator Variables

As depicted in Chapter 5, the six items associated with absorptive capacity and seven items associated with finance capability were examined through Varimax rotation technique (see Table 5-13). The results have shown that the original six-item scale related to the absorptive capacity is reduced to a three-item scale and the original seven-item scale referring to the financial capability is reduced to a one-item scale. However, financial capability is not supported by sufficient items and should be excluded from further research (see Table 5-14). Thus, we continue the analysis with one Moderator (i.e., absorptive capacity).

The measurement scale of absorptive capacity concentrates on the founders' capability in the usage of knowledge development and dissemination support by UBIs. We assume that absorptive capacity amplifies the relation between (A) knowledge development and dissemination by UBIs and (B) the performance of the NTBF. The six measurement items associated with absorptive capacity are obtained from the Jiménez-Barrionuevo et al. (2011) study. The items are presented in Table 4-5, Chapter 4.

D: Control Variables

For testing our model and the hypotheses, we control the effect of three NTBF items: (1) size, (2) age, and (3) the level of innovativeness. The measurement scales of these three control variables are presented in Appendix C. Below, the reasons for including these control variables in our research are provided.

Size

NTBF's size is expected to have an impact on the innovative performance and growth of the firms (cf. Becchetti and Trovato, 2002). Small firms can grow if they become innovative and flexible (Lenihan et al., 2010). Furthermore, in comparison with large firms, while small firms have a flexible organizational structure, these firms are more able to implement small incremental innovations (see McGuirk et al., 2015). Thus, it appears that small firms may be more innovative than larger firms (see Freel, 2005; Soetanto and Jack, 2016).

However, some studies provided contradictory evidence in terms of the effects of the size on the firms' innovation performance (see Roper and Hewitt-Dundas, 2008; Roper et al., 2008). Roper et al. (2008) argue that "size" effects on the innovation process, do not produce innovation. Roper and Hewitt-Dundas (2008) report that large firms are more innovative than small firms. Therefore, according to the above arguments, we control the impact of size on the performance of NTBFs. NTBF's size is measured with the number of employees (FTEs).

Age

NTBF's age is found (1) to be related to the firm's growth and (2) to have impact on their performances. In the case of small firms, the younger firms grow faster than older ones (see Löfsten and Lindelöf, 2001; Sternberg, 2014). Furthermore, younger NTBFs have fewer routines, and they seem to be more innovative (see Soetanto and Jack, 2016). The age of the NTBF is measured by asking the foundation year of the NTBFs.

Level of Innovativeness

NTBF's level of innovativeness reflects the degree of tendency to be creative, pursuit new ideas, and novel solutions to obtain competitive advantages. The variable shows that high-level innovative NTBFs acquire different innovation strategies in comparison with low or medium-level innovative firms. The level of innovativeness is included as a control variable as it may have an impact on the performance of the NTBFs (see Soetanto and Jack, 2016). This variable is measured whether the NTBF has a patented technology (=1) or not (= 0).

6.4.2 Method Validity

In this subsection, three potential biases are discussed with which BIs and NTBFs investigations are confronted. The potential biases are: (1) sample selection bias, (2) social desirability bias, (3) and common method bias.

Ad (1) *Sample selection bias* within the context of UBIs may be presented when sample has been conducted within a single or a very small number of UBIs because the entrepreneurs of a particular UBI might overestimate the effectiveness of the UBI's support (Siegel et al., 2008). Therefore, we attempted to conduct our survey in different UBIs to minimize the possibility of the influence of this bias. In addition, we selected the NTBFs of the UBIs that we felt they were representative of the population under the study (in terms of background of the entrepreneurs, age of the NTBF, and sector), and included the UBIs which support NTBFs from different technology-based industries in different level of growth stage. The reason is that different types of tech-based industries need access to special facilities and knowledge. Thus, in this situation, UBIs should offer a mix of resources to fulfill their NTBFs' needs (Baraldi and Havenvid, 2016; van Weele et al., 2017). As a consequence, this high level of variation within our sample lead to the increase of the generalizability of our findings. Further, our data shows that the participated entrepreneurs have different perspectives on the support by their UBIs, which depicts that the influence of this bias is minimized or did not occur.

Ad (2) *Social desirability bias* also is another limitation which our research is confronted. This type of limitation occurs when the participants answer questions in a manner which is favored by others. Thus, in our study we guaranteed to the participants that the data is kept confidential and minimized the potential impact of this bias.

Ad (3) *Common method bias* occurs when the subjective measures are used and lead to the variation in responses (Podsakoff et al., 2003). As our data is gathered by a usage of a self-reported assessment from participants, it might generate a potential common method bias especially our dependent and independent variables are self-reporting measures. Hence, to check whether our data is influenced by this error, Harman's one-factor test (see Definition 6.1) was conducted on all variables. The results (18.393% which is under the criteria) showed that the relationships among (a) the performance of the NTBFs, (b) their capabilities, (c) innovation strategy, (d) finance mobilization and (e) knowledge development and dissemination, it is not possible to influence by common method bias. This test is conducted by using principal component analysis in SPSS (see Appendix H).

Definition 6.1: *"A **Harman One-Factor Analysis** is a post hoc procedure that is conducted after data collection to check whether a single factor is accountable for variance in the data" (Tehseen et al., 2017, p. 155).*

According to this test, the data is not limited by common method bias if no single factor emerges. The total variance of a single factor (less than 50%) indicates that common method bias has no influence on the data. (cf. Podsakoff et al., 2003; Tehseen et al., 2017).

Furthermore, to avoid this bias, we conducted proper measurement tools and check their validity and reliability. The results show that our construct is both valid and reliable (see section 5.5).

6.4.3 The Appropriateness of Linear Regression Analysis

In this subsection, we test the general trends in our sample and examine whether it fits to the linear regression techniques. In this regard, four types of analysis will be conducted, namely: (A) skewness analysis, (B) residual analysis, (C) heteroscedasticity analysis and (D) multicollinearity analysis. Finally, the subsection will conclude on the results of (E) the model diagnostics.

A: Skewness Analysis

Definition 6.2: ***Skewness Analysis*** *reveals the asymmetrically distribution of variables.*

The skewed-data can be negative or positive (cf. Sarstedt and Mooi, 2019). A positive skew occurs when the frequency of the observations is clustered on the left side of the distribution and produces a long right tail. A negative skew occurs when the frequency of the observations is clustered on the right side of the distribution and produces a long-left tail (see Fields, 2018; Sarstedt and Mooi, 2019). Table 6-1 reports the level of skewness of all the variables.

Table 6-1: The Results of the Skewness Analysis

Variables	Skewness	Corrected Skewness
Main Variable		
Innovation Strategy	-.853	-.853
Knowledge Development	-.661	-.661
Finance Mobilization	-.121	-.121
Absorptive Capacity	**-1.072**	**-0.700**
Performance	-.231	-.231
Control Variable		
Age	.564	.564
Level of Innovativeness	-.107	-.107
Size	**3.321**	**0.525**

The Table shows that the significant skewness belongs to the *size* of the NTBFs (control variable), and *absorptive capacity* (moderator). To decrease the level of skewness, we apply Log Transform function in SPSS. Following its application, the function corrects the skewness of the size of the NTBFs from 3.321 to 0.525, and absorptive capacity from -1.072 to 0.700. Indeed, this correction influences the quality of data, and makes it fit for further analysis.

B: Residual Analysis

Definition 6.3: ***Residual*** *is an error between the value which a model predicts and the value it observes in a dataset (Field, 2018).*

Residual plots are graphs that have on the horizontal axis the dependent variable and on the vertical axis the residuals. The linear regression techniques will be applicable when the points in the residual plots are randomly dispread.

In this paragraph, residual plots are created between the performance of the NTBFs (dependent variable) on the horizontal axis, viz. finance mobilization, knowledge development and dissemination, innovation strategy (independent variables), absorptive capacity (moderator), the age of the NTBF, the size of the

NTBFs, and the level of NTBF's innovativeness (control variables) on the vertical axis. Appendix G provides all the residual plots among all variables.

Field (2018) states that a sample of data is normally distributed when 95% of the points in the residual plots are between −1.96 and +1.96; 99% of them are between −2.58 and +2.58; and 99.9% (i.e., nearly all of them) are between −3.29 and +3.29.

According to these scales, we observe that the distribution of data in the eight residual plots (see Appendix G) are in the right range. In addition, any error or bias has not been observed by us among the distributed data. Hence, we may conclude that (1) the level of an error in our model is acceptable, (2) our model is a strong representation of data, (3) and the linear regression techniques are appropriate for analysing our data.

C: Heteroscedasticity Analysis

Definition 6.4: ***Heteroscedasticity*** *is a situation in regression analysis in which the variance of the residual is not consistent (cf. Sarstedt and Mooi, 2019).*

The used syntax for Heteroscedasticity analysis[3] was installed as a Custom Dialogue in SPSS and then ran among the mentioned variables. The syntax can be found online (the link is provided in footnote 3).

To test the heteroscedasticity (not homoscedasticity), we conducted Breusch-Pagan and Koenker tests (see Table 6-2). Table 6-2 reports the results of the Breusch-Pagan and Koenker tests. The p-values of the Breusch-Pagan and Koenker tests are above 0.05 which provide an evidence that our data is homoscedastic and is not constrained by heteroscedasticity effects. However, the residual plots in the previous step approve the homoscedasticity of the data.

[3] https://sites.google.com/site/ahmaddaryanto/scripts/Heterogeneity-test

Table 6-2: Breusch-Pagan and Koenker Tests

Test	**p**
Breusch-Pagan	0.889
Koenker	0.844

D: Multicollinearity Analysis

Definition 6.5: ***Multicollinearity*** *is a condition when two or more variables are highly correlated (Field, 2018).*

Thus, multicollinearity skews the results of the regression model. As the multicollinearity increases, it impacts on the interpretation of being variate due to the existence of high correlations between variables (cf. Hair et al., 2014).

In this section, we conduct multicollinearity analysis among all the variables. The computation of the Variance Inflation Factor analyses possible multicollinearity effects. Below, its definition is provided.

Definition 6.6: ***Variance Inflation Factor*** *quantifies the severity of multicollinearity in an ordinary least squares regression model (cf. Webster, 2013).*

Variance Inflation Factors (VIF) of the all variables were calculated based on the procedure explained by Aiken et al. (1991). The results revealed that the highest value of VIF is 1.351, which is far below the critical value of 10 or higher that would represent the multicollinearity effects (see Tabachnick and Fidell, 2007). Since all the VIFs are below 10 (threshold criterion of VIF), we may conclude that our analysis is not influenced by multicollinearity effects.

6.4.4 Model Diagnostics Conclusion

Based on the outcome of the four analytical tests for measuring the appropriateness of linear regression analysis (see 6.4.3), we may conclude that the linear regression analysis is an appropriate technique to analyse our data. The four outcomes that we achieved are as follows.

(1) The results of the skewness analysis show that the distribution of all the variables except for the team size of the NTBFs and absorptive capacity, are in the range of linear regression. As reported in Table 6-1, the two variables mentioned above revealed a high level of skewness.

In order to improve the quality of analysis, we corrected their skewness by applying the Log Transformation (LT) in SPSS. After the conduction of the Log Transformation;

(2) the distribution of all variables is set in a range for linear regression;

(3) the residual plots report that the outliers are not significant in the analysis. Thus, the linear regression analysis would be an appropriate technique;

(4) the heteroscedasticity analysis shows that our data is homoscedastic; and

(5) the multicollinearity analysis reveals that the Variation Inflation Factor of all variables is below the critical value. Thus, multicollinearity effects would not constrain our analysis.

According to the above reports and results, we may conclude that the linear regression analysis is an appropriate technique for our data analysis.

6.5 Data Analysis

This section reports the results of the data analysis. Table 6-3 demonstrates the mean values, the standard deviations of all the variables and the correlations among them. The correlations among the independent variables is relatively modest, ranging from 0.05 to 0.45. Not surprisingly, there is a positive correlation between the size of the NTBFs and the age of NTBFs (.258), meaning that as the NTBFs get older, they get larger as well. In addition, we observe that the performance of the NTBFs has positive correlations with three variables: (1) knowledge development and dissemination (.277), (2) finance mobilization (.276), and (3) absorptive capacity (.398). Here we remark that the correlation between the performance of the NTBFs and absorptive capacity (.398) is a strong and significant positive correlation (see Table 6-3).

Table 6-3: Descriptive Statistics and Correlation Analysis

	Mean	S.D	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Performance	4.1180	.83832	.114	**.277**	**.276**	**.398**	.084	.025	.009
(2) Innovation Strategy	4.8742	1.13753		.134	.053	**.200**	.008	.026	-.035
(3) Knowledge Development cs	4.8064	1.01060			**.450**	.119	.074	-.106	-.123
(4) Finance Mobilization	3.8685	1.26092				**.227**	.191	-.077	-.042
(5) Absorptive Capacity (LT)	.5119	.27883					.079	.042	-.060
(6) Team Size (LT)	.5220	.31037						.140	**.258**
(7) Level of Innovativeness	.5618	.31820							.080
(8) NTBF’s Age	2.00	1.108							

Furthermore, there are correlations between absorptive capacity and innovation strategy (.200), absorptive capacity and finance mobilization (.227). However, they are not significant. There is also a strong positive correlation between knowledge development cs and finance mobilization (.450).

After the statistical analysis of the variables, we conduct the stepwise multiple regression analyses on the performance of the NTBFs. We distinguish three models. In Model 1, all main variables are used to test H1, H2, and H3. In Model 2, the absorptive capacity (a moderating variable) is introduced. In Model 3, two-way interactions between finance mobilization and knowledge development cs, innovation strategy and absorptive capacity are used to test H4, H5, and H6. Table 6-4 depicts the results of the regression analysis.

6.5.1 Model 1

In Model 1 (the first step) of the stepwise multiple regression, we introduce all main variables (e.g., dependent, independent variables, and control variables,) to test

H1 to H3. In this Model, all the introduced variables are regressed with the performance of the NTBFs. This step tests the effects of knowledge development cs (H1), finance mobilization (H2), and innovation strategy (H3) on the performance of the NTBFs. The Model shows one significant regression coefficient, which is a positive relationship between knowledge development cs and the performance of the NTBFs ($\beta = 0.277$, $p < 0.01$), meaning that **H1 cannot be rejected**. However, we have not observed any significant regression on the interactions either between innovation strategy or finance mobilization on the performance of the NTBFs. Thus, **H2 and H3 must be rejected**.

6.5.2 Model 2

In Model 2 (the second step), we introduce the Moderator variable viz. absorptive capacity. The interesting outcome of this model is that there is a significant regression coefficient on the interaction between absorptive capacity and the performance of the NTBFs ($\beta = 0.370$, $p < 0.001$). Model 2 retains the significance of the regression coefficients on the interaction between knowledge development cs and the performance of the NTBFs ($\beta = 0.233$, $p < 0.05$).

6.5.3 Model 3

Finally, in Model 3 (the third step), we introduce the two-way interactions of adopting finance mobilization and knowledge development cs in the innovation strategy to be used to test H4 and H5. Meanwhile, the moderation effect of absorptive capacity on the interaction between the knowledge development cs and the performance of the NTBFs is evaluated (H6). Hence, we see that the results from Model 3 show that the interactions of innovation strategy with either knowledge development cs or finance mobilization are non-significant meaning that **H4 and H5 must be rejected**. However, the result reveals a positive moderation effect of absorptive capacity with a considerable regression coefficient on the interaction between the knowledge development cs and the performance of the NTBFs ($\beta = 0.443$, $p < 0.001$). Thus, the findings show that **H6 cannot be rejected**.

Table 6-4: Regression Results

Variables		Model 1	Model 2	Model 3
Main effects				
NTBF Size (CV) (Log Transformed)		0.064	0.070	.034
NTBF Age (CV)		0.044	0.070	.061
Level of Innovativeness (CV)		0.055	0.053	.016
Knowledge Development cs	H1	**0.277****	**0.233***	.083
Finance Mobilization	H2	0.189	0.152	.134
Innovation Strategy	H3	0.078	0.050	.013
Moderating Variables				
Absorptive Capacity			**0.370*****	.005
Two-way interactions				
Finance Mobilization * Innovation Strategy	H4			0.173
Knowledge Development cs * Innovation Strategy	H5			0.114
Knowledge Development cs * Absorptive Capacity (moderation effect)	H6			**0.443*****
R^2		0.077	0.212	0.196
Adjusted R^2		0.066	0.194	0.187
F		7.161**	11.439***	20.947***

* p <0.05; ** p <0.01; *** p<0.001.
Independent Variable: The performance of the NTBFs

In summary, we have three results.

(Result 1) the results of the regression analyses do not lead to rejection for H1, which predicts that knowledge development cs supportive activities have a positive impact on the performance of the NTBFs.

(Result 2) The results also support H6, which predicts that absorptive capacity amplifies the relation between knowledge development and dissemination with the performance of the NTBFs.

(Result 3) With regard to the innovation strategy and finance mobilization, our study tested their impacts on the performance of NTBFs. The findings however fail to confirm their influences on the performance of NTBFs (H4 and H5 must be rejected). Table 6-5 summarizes the results for testing the hypotheses.

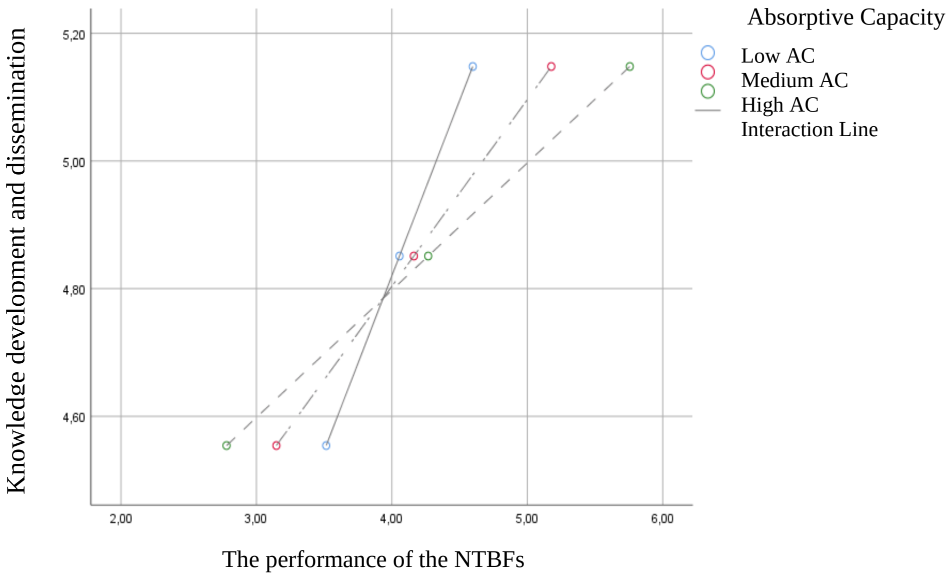
Table 6-5: The Result of the Hypotheses Testing

Hypotheses		Result
Hypothesis 1	Knowledge development and dissemination supportive activities have a positive impact on the performance of the NTBF.	Cannot be rejected
Hypothesis 2	Finance mobilization has a positive impact on the performance of the NTBF.	Rejected
Hypothesis 3	Innovation Strategy has a positive impact on the performance of the NTBF.	Rejected
Hypothesis 4	Finance mobilization has a positive impact on the innovation strategy and therefore, on the performance of the NTBF.	Rejected
Hypothesis 5	Knowledge development and dissemination have a positive impact on the innovation strategy and therefore on the performance of the NTBF.	Rejected
Hypothesis 6	Absorptive capacity has a positive moderating effect on the knowledge development and dissemination and thus on the performance of the NTBF.	Cannot be rejected

Figure 6-2 depicts the moderation impact of absorptive capacity on the relation between (a) knowledge development cs support and (b) the performance of the NTBFs. The Figure shows that the performance of the NTBFs associated with knowledge development cs is higher with high absorptive capacity compared to the low or medium absorptive capacity. The computation and interpretation of the moderator's figure has been adopted from PROCESS MACRO syntax developed by Hayes (2018)[4]. If H2 and 3 rejected even presisten research we have 4 topics 2 approve 2 rejected.

[4] https://processmacro.org/download.html

Figure 6-2: Interaction of Knowledge Development and Dissemination and Absorptive Capacity



Thus, according to Figure 6-2, the impact of knowledge development cs on the performance of the NTBFs is stronger when NTBFs have a high absorptive capability. In other words, as NTBFs have more abilities in acquisition, assimilation, transformation and implementation of external knowledge resources. Hence, NTBFs can benefit more from the knowledge development cs supports by UBIs. Consequently, knowledge development cs has a positive impact on the performance of the NTBFs.

6.6 Discussion

In this section, four topics have been evaluated: (1) knowledge development and dissemination, (2) finance mobilization, (3) innovation strategy, and (4) absorptive capacity. Our empirical results support the positive impact of two topics (i.e., knowledge development and dissemination (H1), and absorptive capacity (H6)) on the performances of the NTBFs cannot be rejected, but, they do not support the impact of the other two topics (i.e., finance mobilization (H2), and (H3) innovation strategy) on the performances of the NTBFs. Consequently, the hypothesis related to the rejected topics were rejected as well (i.e., H4 and H5).

This section explains how entrepreneurs evaluate the impact of supports by UBIs and relates that impact to the performance of the NTBFs. Subsection 6.6.1 reviews the influence of knowledge development and dissemination support on the performance of the NTBFs. Subsequently, subsection 6.6.2 does a similar review for finance mobilization and the performance of the NTBFs. Subsection 6.6.3 addresses the findings resulting from testing the innovation strategy hypothesis. Finally, the results of assessing the moderating impact of absorptive capacity on the relation between the incubator's knowledge-based supports and the performance of NTBFs are presented in Subsection 6.6.4.

6.6.1 Knowledge Development and Dissemination Support

With regard to the supports by UBIs, we test the influence of two sorts of supports on the performance of the NTBFs. The findings do not lead to rejection of the hypothesis that knowledge development and dissemination (H1) have an impact on the performance of the NTBFs. Indeed, we find that the type of support with the aim of enriching marketing, sales, business management, HR, communication, and laws and regulations knowledge has a positive impact on the performance and growth of the NTBFs. Our data reveals that the entrepreneurs in our sample are satisfied with the training, coaching and mentoring supports by the incubators. As stressed in the incubator's literature, access to the knowledge resources of the incubators is provided in many incubators and has been identified by entrepreneurs as the most important resource provided by the incubators. In contrast, while the entrepreneurs lack business knowledge and entrepreneurial experience, UBI teams focus more on this type of resource to provide them to their NTBFs (cf. McAdam and McAdam, 2006; Soetanto and Jack, 2016; van Weele et al., 2017). Thus, it is no surprise to see that knowledge development and dissemination supportive activities positively impact on the performance of the NTBFs. Our findings are in line with previous studies showing that entrepreneurs are satisfied with the knowledge resources of UBI and have revealed their have a positive impact on the performance of the NTBFs (see Soetanto and Jack, 2016; van Weele et al., 2017).

6.6.2 Finance Mobilization Support

The hypothesis that finance mobilization is a supportive activity that has a direct impact on the performance of the NTBFs (H2) had to be rejected. With regard to the measurement scales of this variable, it appears that our sample entrepreneurs were not satisfied with the UBIs' supports in terms of access to the different sources of finance capitals. Previously, Lofsten (2010) found that except for the provision of access to the bank loan, there is a very limited connection between financial mobilization by UBIs and the performance of the NTBFs (measured as sales and employment growth) (see Lukes et al., 2019).

This finding should be cautiously interpreted as similar studies (see Soetanto and Jack, 2013; van Weele et al., 2017) have found that the most important reason for entrepreneurs to join incubators is to get access to the financial resources. Indeed, access to the financial resources is the main expectation of entrepreneurs from incubators. However, in the context of Europe, the most sort of resources that they have received from UBIs, is knowledge development and dissemination supports by UBIs (see van Weele et al., 2017).

Referring to the contributions by van Weele et al. (2017), one explanation for why our sample of entrepreneurs have stated dissatisfaction about finance mobilization, leading to no impact on their NTBFs' performances, might be associated with insufficient quality of financial resources by UBIs. As highlighted above, another explanation can be related to the mismatch between the entrepreneurs' expectations and the incubators' resources to access more funding resources, whereas the entrepreneurs experienced more knowledge-based resources instead of financial resources (see Bruneel et al., 2012; Samaeemofrad et al., 2016; van Weele et al., 2017).

6.6.3 Innovation Strategy

With regard to the innovation strategy, our study concentrates on its impact on the performance of the NTBFs (H3). Our data led to a clear rejection that innovation strategy had any impact on the performance of NTBFs. We adopted the measurement scale from Soetanto and Jack (2016) and our findings were not in line with their results. However, all the variables representing innovation strategy were non-significant. Thus, we were forced to reject the statement that innovation strategy has an impact on the performance of the NTBFs. Hence, we did not find any relation between innovation strategy and the performance of the NTBFs. Consequently, we also did not observe any influence of (a) knowledge development and dissemination (H5), and (b) finance mobilization (H4) supports on the innovation strategy of the NTBFs. Consequently, we did not find any impact on the performance of NTBFs. A possible explanation might be that the measurement scales developed by Soetanto and Jack (2016) were not sufficiently strong to identify the small differences representing the innovation strategy.

6.6.4: Absorptive Capacity

In examining the moderating impact of absorptive capacity on knowledge development and dissemination support by UBIs (H6), we have found no reason to reject the statement that absorptive capacity moderates and amplifies the relation between this support by UBIs and their performance. Surprisingly, we found that absorptive capacity or "learning ability" of the entrepreneurs has a direct impact on the performance of the NTBFs. Our data shows that as entrepreneurs have a stronger learning ability, they can benefit more from training, coaching, and mentoring supports by incubators and then will have impact on their NTBFs' growth. This finding is in line with van Weele et al. (2017) that the knowledge development supportive activity is stronger when entrepreneurs have the ability to use them.

We discovered that a larger ability in acquiring, assimilating, transforming, and implementing external knowledge resources led to more usage of knowledge resources by the incubators, and thus to more impact on the performance. Our finding is in line with extant literature reporting that the low usage of the incubator's resources backfires on the envisioned capabilities of the entrepreneurs (Oakey, 2003; van Weele et al., 2017). Therefore, this finding suggests that any business incubator team needs to take a stronger intervention approach to increase the entrepreneurs' self-awareness about their low ability in the usage of the knowledge resources. The UBIs should help them to develop this type of capability. It is important to note that the NTBFs would not always stay in UBIs. Thus, for NTBFs it is recommended to develop their capabilities to be able to survive and to grow after the initial leaving from business incubators and to become independent (cf. Lukeš et al., 2019).

6.7 Answer to RQ3

This chapter provided an answer to RQ3. Below, we summarize the answer.

Following our data analysis given in this chapter, with the implication of a multiple regression analysis, we are able to provide a final answer to RQ3*: Are the identified supportive activities related to (a) the innovation strategy of the NTBFs and consequently to (b) the performance of an NTBF?*

Our findings show that knowledge development and dissemination have a positive impact on the performance of the NTBFs. However, our data could not support that finance mobilization has impact on the performance of the NTBFs. Thus, Hypothesis 1 cannot be rejected, but Hypothesis 2 must be rejected. With regard to the innovation strategy, our data did not find any relation between innovation strategy and the performance of the NTBFs. Therefore, Hypotheses 4 and 5 which explain the two-way relations between the supports by UBIs, innovation strategy and the performance of the NTBFs, must be rejected. We also tested whether the relation between knowledge development and dissemination, and the performance of the NTBFs is affected by absorptive capacity. Hence, the moderating impact of this variable has been evaluated. Figure 6-2 shows that absorptive capacity can amplify the relation between support by UBIs and the performance of the NTBFs. This indicates that hypothesis 6 cannot be rejected.

In our paper, we reported that prior investigations (Bruneel et al., 2012; van Weele et al., 2017) argued that three reasons are associated with low usage of incubators' resources: (a) the insufficient quality of the incubators' resources, and (b) a mismatch between NTBFs' demands and incubators' supplies, and (c) a mismatch between the resources that entrepreneurs need and want from business incubators. Our findings indicate an additional reason for the low usage of incubators' knowledge-based resources: (d) the lower absorptive capacity of the NTBFs in making benefit from incubators' resources, the lower usage of incubators' resources. Furthermore, according to the literature review by Escribano et al. (2009), firms are not able to take advantages from external knowledge resources by being exposed to them (see Cohen and Levinthal, 1990).

Accordingly, in this chapter, we highlighted the role of the business incubator team to create awareness and help entrepreneurs to enhance their absorptive capacity. As far as the NTBFs are not aware of how to acquire external knowledge resources, assimilate, and utilize them, they will not able to make benefits from the incubators' supports. Besides, the incubator team should consider that although their NTBFs received the same amount of external knowledge flows, they may not derive equal advantages. It occurs because NTBFs have different ability to acquire and utilize incubators' knowledge resources (cf. Giuliani and Bell, 2005; Escribano et al., 2009). Thus, the incubator teams needs to evaluate the absorptive capacity of their NTBFs (1) to help them develop this ability, and consequently (2) to provide a tailored knowledge development and an adequate dissemination support for them. We thereby provide only a partial explanation for the managers of the incubators associated with the low impact and usage of their training, coaching, and mentoring services from their NTBFs' points of view.

Chapter 7

Research Answers and Recommendations

This chapter provides answers to the three research questions (RQs) and to the problem statement (PS) that were formulated in Chapter 1. Chapters 3 to 6 have integrated the three RQs and produced answers to each of them. In this chapter, we summarize the answers to the three RQs. The chapter proceeds as follows. Section 7.1 summarizes the answers to these RQs. Then, Section 7.2 provides an answer to the PS which is also based on the research results of Chapter 6. Subsequently, theoretical and practical contributions are presented in Section 7.3. Finally, research limitations and further research recommendations are given in Section 7.4.

7.1 Answers to the Three Research Questions

This section provides answers to three research questions. First, we identify the supportive activities by UBIs (RQ1-Chapter 3). Second, we operationalize the identified supportive activities of the UBIs (RQ2-Chapter 4). Third, we evaluate the validity and reliability our proposed measurement tool (RQ2-Chapter 5). Fourth, we investigate the extent of the impact of the supports by the UBIs on the performances of the NTBFs (RQ3-Chapter 6). Sections 7.1.1 to 7.1.3 summarize the answers to each RQ.

7.1.1 Supportive Activities by UBIs

The extant literature presented in Chapter 2 showed that new technology-based firms (NTBFs) positively impact job creation, innovation, and economy (cf. Colombo and Delmastro, 2002; van Praag and Versloot, 2008). However, due to the liabilities of smallness and newness and a lack of sufficient resources to grow, the NTBFs face more significant obstacles than medium-sized or large firms (cf. Bøllingtoft and Ulhøi, 2005; van Weele et al., 2017; Lukeš et al., 2019). Therefore, policymakers attempt to support them via different forms of tools. A business incubator is one of the public policy tools to help NTBFs to overcome their liabilities and to access required resources such as financial capital, social capital, and knowledge (McAdam and McAdam, 2008; Bøllingtoft, 2012).

Prior studies (see, e.g., Mian et al., 2016) reported that there are more than 7000 business incubator programs in the world, but so far there is no reliable evidence on the effectiveness of their supports on the performances of NTBFs (Autio and Rannikko, 2016; Eveleens et al., 2017; van Weele et al., 2017; Lukeš et al., 2019). Our literature review (Chapter 2) shows that one possible explanation for the existence of this black box, is the absence of sufficient theoretical insights into evaluating the impact of a supportive environment as given by incubators. To shed light upon this issue, we formulated three research questions (see Chapter 1). First, we formulated RQ1 to identify the supportive activities by UBIs.

RQ1: *What are the main supportive activities offered by UBIs that influence the performance of an NTBF?*

Chapter 3 provided an answer to this research question. To arrive at this answer, we conducted eleven in-depth semi-structured interviews with entrepreneurs who have received supports from UBIs. Below we provide a summary of the results. Consistent with the literature, we found that UBIs support their NTBFs through (1) access to their networks; (2) knowledge development and dissemination; (3) finance and administrative mobilization; (4) growth control; and (5) creation of exposure. The identified supportive activities will be summarized below.

Ad (1) Access to their networks refers to the sort of support that the UBIs facilitate, viz. the access to their internal and external networks via organizing formal or informal events, and connect their NTBFs with potential partners, investors or customers.

Ad (2) Knowledge development and dissemination of supportive activities are provided by UBIs to help NTBFs overcome their lack of business and technical knowledge resources. This can be met through organizing business sessions and workshops, sessions for coaching and mentoring with experienced entrepreneurs and business experts. Some training sessions are developing sales and marketing skills, negotiation, communication, and pitching skills. The proximity of a university provides access for the NTBFs to their laboratories and also technical advices.

Ad (3) Finance and administrative mobilization supportive activities refer to the provision of basic infrastructures, sharing meeting rooms, office spaces, administrative services, and access to different financial resources. As NTBFs face difficulties to find an affordable office space, this type of support is beneficial for them in their early stages. Clearly, one of the main reasons for NTBFs to join UBIs is fundraising (see van Weele et al., 2017).

Ad (4) Growth control concentrates on monitoring the growth process of NTBFs to explore their requirements and ensure the quality of their supports. In addition, UBIs provide some psychological support to enrich the self-identity of the entrepreneurs to overcome their challenges.

Ad (5) Creation of exposure by UBIs helps entrepreneurs to be seen by potential customers, investors, and partners. Indeed, due to the liability of newness, NTBFs suffer from reputation. Thus, appearing on media via UBIs' channels helps them overcome this liability and obtain more credibility.

7.1.2 Operationalizing the UBIs' Supportive Activities Construct

In Chapter 4, we proposed a measurement instrument (construct) to evaluate the impact of supportive activities by UBIs on the performances of the NTBFs. For our construct, we selected two types of supports identified in Chapter 3 to assess their impacts, viz. (1) knowledge development and dissemination, and (2) finance mobilization. Depending on the literature, we developed a theoretical model that demonstrates the relations between two selected supports, viz. innovation strategy and the performance of the NTBFs. In our model, we introduced a novel contribution to the literature by including the moderating impact of two NTBFs' capabilities (i.e., finance capability and absorptive capacity) on the relations between the supports by UBIs and the performances of the NTBFs (see Figure 4-5). The research question that we attempted to answer in Chapter 4 was as follows.

RQ2: *How can the supportive activities be operationalized in a construct that enables us to measure their impact on the performance of an NTBF?*

To provide an answer to RQ2, Chapter 4 explained the measurement scales for the main four variables:

(1) performances of the NTBFs (dependent variable),

(2) innovation strategy,

(3) supportive activities by UBIs (independent variables),

(4) NTBFs' capabilities (moderators),

and three control variables:

(1) size of the NTBFs,

(2) age of the NTBFs, and

(3) the level of innovativeness of the NTBFs as implemented in our model.

Following the operationalization of the construct in Chapter 4, Chapter 5 evaluated statistically the validity and reliability of the measurement instrument. In this regard, we applied variable reduction techniques to check the validity and reliability. The procedure to evaluate the construct validity and reliability was conducted in four steps. We adopted this procedure from the work developed by Sarstedt and Mooi (2019).

In the *first* step, we tested the data to check whether it is adequate for the application of variable reduction techniques (e.g., Principal Component Analysis or Principal Factor Analysis). Through the conduction of the correlation matrix, KMO index, and Bartlett's test, we confirmed that our data is suitable for variable reduction techniques. In the *second* step, we determined one technique which is adequate for our data set. Based on the correlations between variables, we concluded that Principal Component Analysis is adequate to be applied. In the *third* step, we determined the number of factors to extract for the next steps in data analysis for independent and moderating variables. After the implementation of Kaiser's criterion, the Scree Plot, and Parallel Analysis, the number of factors to extract for further analysis (a) associated with Independent Variables is four and (b) associated with Moderators is two. In the *fourth* step, we conducted component rotation to investigate the variables that should be remained for regression analysis. The correlation between variables showed which component rotation method is suitable for determining the variables to be retained. The results of our analysis (see Table 5-10, Chapter 5) revealed that for independent variables, the Promax rotation technique, and for moderators, the Varimax rotation technique was appropriate.

All in all, the outcome of the Varimax rotation technique (see Table 5-14, Chapter 5) demonstrated that the item measures associated with finance capability were excluded, whereas three-item measures related to absorptive capacity remained. The remained items associated with both independent variables and moderators confirmed the satisfying validity of the construct.

To ensure the construct reliability, we conducted Cronbach's Alpha and Composite Reliability. The results of these two criteria (see Table 5-15, Chapter 5) showed the satisfying reliability values of the innovation strategy, the knowledge development cs, and the finance mobilization. All constructs exhibited satisfying values, and they revealed loadings of more than the threshold criteria (0.7). Thus, our proposed construct suggested satisfying and sufficient validity and reliability.

7.1.3 The Impact of the Construct on the Performance of the NTBFs

In Chapter 6, we continued our analysis to assess the impact of the identified supportive activities (i.e., knowledge development cs), innovation strategy, and one moderator (i.e., absorptive capacity) on the performances of the NTBFs. Meanwhile, we considered the influence of innovation strategy on the performances of the NTBFs. We also investigated the moderating impact of absorptive capacity on the relations between supports by UBIs and the performances of the NTBFs. The results of Chapter 6 provided an answer to RQ3.

RQ3: In what way are the identified supportive activities related to (a) the innovation strategy of the NTBFs, and consequently to (b) the performance of an NTBF?

In the first step to answer this question, we examined whether the multiple linear regression technique is *appropriate* to be conducted with our sample data via four examinations. We tested whether our sample is (1) asymmetrically distributed, (2) randomly dispread, (3) homoscedastic and is not constrained by heteroscedasticity effects, (4) not influenced by multicollinearity effects.

Subsection 6.4.3 (see A and B) reported the results of skewness analysis (asymmetrically distributed), and residual analysis (randomly dispread). The results showed that the data analysis is not constrained through outliers. It should be mentioned that the skewness level of one control variable (size of the NTBFs) and a moderator (absorptive capacity) needed to be in control. Following the log transformation technique, we normalized the skewness of these two variables. The final results confirmed that our data is appropriate for multiple linear regression analysis.

Subsection 6.4.3 (see C and D) demonstrated the results of heteroscedasticity and multicollinearity analysis, which confirmed that our data is constrained by heteroscedasticity and not influenced by multicollinearity effects. Therefore, multiple linear analysis was approved as an appropriate technique to test the data.

After evaluating the appropriateness of the data to be applied by multiple linear analysis, we tested in the second step, the impact of supports by UBIs on the performances of the NTFBs (see Section 6.5).

The results revealed that knowledge development and dissemination have a positive impact on the performances of the NTBFs. However, our data could not support the relation between finance mobilization and the performances of the NTBFs (see Model 2, Table 6-4). The reported regression results in Table 6-4 provided answers to RQ3.

7.2 Answer to the Problem statement

This section summarizes the answers to the problem statement (PS). They are based on the results of the regression analysis conducted in Chapter 6. The PS is formulated as follows.

PS: How can business incubators support their NTBFs effectively?

Following the results of the regression analysis (Table 6-4), we may clearly observe (1) which type of support by the UBIs have an impact on the performance of the NTBFs, and (2) how their support can be affected. From the answers to the RQs, we may conclude that the empirical model provides a clear evidence that knowledge development and dissemination are positively associated with the performances of NTBFs. The model also shows that knowledge development and dissemination are amplified with the effect of absorptive capacity.

Accordingly, business incubators can provide their supports more effectively via: (1) providing more tailored and customized services on training, coaching, and mentoring; (2) intervening more strongly through the growth process of their NTBFs and help the NTBFs develop their absorptive capacity to identify and utilize knowledge resources; (3) train their NTBFs to enrichen their absorptive capacity to be more independent from incubators and have stronger ability to utilize external knowledge resources both during their incubation process and post-incubation. Depending on our empirical model, we now answer the problem statement in three ways.

First, how should UBIs offer more tailored and matched knowledge resources to the needs of NTBFs to have a positive impact on their performances? As van Weele et al. (2016) mentioned in their research, one reason for a disappointing performance by the business incubators lies in the unwillingness of the entrepreneurs to participate in the knowledge development and dissemination programs of the UBIs. In line with their finding, our data supports that as NTBFs make more usage from the knowledge resources of the UBIs, they grow in their performances. Thus, our (first) recommendation is that UBIs should even more push their NTBFs to use their training, coaching and mentoring programs that are expected to influence their performance (see also 7.3.2).

Second, how should UBIs trigger the NTBFs (a) to participate in knowledge development and dissemination supportive programs, and (b) to take UBIs seriously? Through the participation in incubation learning programs, NTBFs have an opportunity to fill in their business-related knowledge gap partially. As a result, the NTBFs would then positively influence their performance and create a satisfactory outcome for the business incubators.

Third, UBIs should make the NTBFs aware of the learning abilities in making benefit from external knowledge resources. This ability is named absorptive capacity. It refers to the capability to identify and acquire external knowledge to assimilate and exploit it within the business processes. Absorptive capacity provides NTBFs with strategic agility to pivot in the highly uncertain environment and generate innovative outcomes (Saemundsson and Candi, 2017).

7.3 Contributions

The contributions of our thesis are twofold. First, our empirical results contribute by shedding new light on theoretical implications to the existing literature on the NTBFs and UBIs for the scholars. Subsection 7.3.1 explains the theoretical contributions. Second, our results also hold practical implications for both the entrepreneurs as well as the UBIs' management team. Subsection 7.3.2 summarizes the practical implications.

7.3.1 Theoretical Contributions

Our model and empirical results indicate that the performance of the NTBFs is positively affected by knowledge development and dissemination supportive activity by UBIs. Moreover, this effect is moderated and amplified through the absorptive capacity of the NTBFs. The results of this study increase our understanding about the effect of supports by UBIs on the performance of NTBFs. This research area has still many unknown sides (cf. Mian et al., 2016; Dvouletý et al., 2018; Lukeš et al., 2019). According to our findings, we have been able to contribute by two critical theoretical contributions to the research field of NTBFs and UBIs. Remarkably, the findings are rooted in an empirical evidence.

Contribution 1: We contribute to the literature on incubators and NTBFs, which successfully act in the real world. We do so by providing extensive response to the call for conducting more research on examining the impact of the support by UBIs (cf. Hackett and Dilts, 2004; Mian et al., 2016; Soetanto and Jack, 2016; Dvouletý et al., 2018; Lukeš et al., 2019). Our main contribution is the development of a new model that shows the relations between the supports by UBIs and the performance of the NTBFs. Through our model, we contribute by a new measurement instrument that enables scholars to measure the precise impact of the support.

Further, our study makes a novel contribution by explicitly taking into account the impact of the NTBFs' absorptive capacity in the relation between UBIs' resources and NTBFs' performances. Here we remark (a) our thesis is among the first investigations to examine the absorptive capacity in the incubation literature, and (b) we bring the absorptive capacity in the context of the small tech-based firms, not the medium or established ones. Thus, from our point of view, the current study differs with the related empirical literature.

Contribution 2: Prior investigations (Bruneel et al., 2012; van Weele et al., 2017) stated that three reasons are associated with the low utilization of UBIs' resources: (a) the insufficient quality of the UBIs' resources, (b) a mismatch between NTBFs' demands and UBIs' supplies, and (c) a mismatch between the resources that entrepreneurs need and the resources that they request from business incubators. Our second contribution is associated with the NTBFs' capability to increase the usage and impacts of the UBIs' resources. Our findings indicate that there is an additional reason for the low usage of UBIs' knowledge-based resources: (d) the lower absorptive capacity of the NTBFs in making benefit from the UBIs' resources. This is a delicate point. It might be time to recall the literature review by Escribano et al. (2009) that firms are not able to take advantage of external knowledge resources only by being exposed to them. Hence, technology is invited to bring us new ways to stimulate the knowledge absorption by small enterprises.

Accordingly, we highlight the role of the UBIs' team to create awareness and help entrepreneurs to enhance their absorptive capacity. As far as the NTBFs are not aware of how to acquire external knowledge resources, assimilate, and utilize them, they are not able to make benefits from the UBIs' support. Besides, the UBIs' team should consider that although their NTBFs received the same amount of external knowledge flows, they may not derive equal advantages. It happens this way because NTBFs have a different ability to acquire and utilize the UBIs' knowledge resources (cf. Giuliani and Bell, 2005; Escribanoa et al., 2009).

In summary, our findings differentiate themselves from the previous studies which recognize BIs only as a tool to provide resources for the NTBFs. We emphasize that the NTBFs' ability to make usage from knowledge resources is even more effective on the performances of the NTBFs than the impact of knowledge resource of UBIs. Thus, NTBFs should use new technological tools themselves to stimulate the absorption of knowledge.

7.3.2 Practical Implications

Our research has led us to straight forward recommendations for all UBI management teams. Obviously, participation in intensive training and mentoring programs will create value for NTBFs, especially for inexperienced entrepreneurs. Thus, we recommend the UBIs to create awareness for their early-stage and to teach the inexperienced entrepreneurs about the importance of these programs (see also 7.2). Hence, UBIs should have a stronger intervention approach to push the NTBFs to participate in such programs.

The entrepreneurs should acknowledge that developing their absorptive capacity is vital. In the future, the entrepreneurs will be able to take advantages from (a) the offered UBIs' knowledge-based resources and also from (b) other external resources such as universities and corporates. This would help the entrepreneurs to be independent from any support by UBIs and therefore possibly able to survive.

7.4 Limitations and Recommendations for Further Research

In our study, we attempt to ensure the validity and reliability of our results. However, we are facing five main limitations that somewhat constrain the generalizability of our findings. The constraints so defined are a source of inspiration for the formulation of five recommendation for future research.

First, our survey was conducted at one point in time (limitation 1). The entrepreneurs' evaluation of the effectiveness of the supports by the UBIs might be different from the incubation process to the graduation of UBIs. The impact of the support by UBIs on the performances of the NTBFs compared to the role of NTBFs' capabilities needs more attention. Hence, we will announce a call for further longitudinal studies or a cross-sectional study with respect to the control group to obtain more understandings in this context (Recommendation 1).

Second, the characteristics of our sample need to be considered when generalizing the research results. (a) In this study, we only focused on the university-based business incubators and the NTBFs that were incubated there. The quality of the resources and supports by UBIs may differ in other types of business incubators. For instance, corporate business incubators may provide their NTBFs with a different quality of the finance mobilization. Thus, the results of our model may not be generalizable in other types of business incubators (limitation 2a). Therefore, we encourage further research to evaluate our findings in other types of business incubators. (b) The business incubators in our sample were located in the Netherlands and Germany. Hence, our sample may contain biases, because the data do not portray the real situation across the whole of these two countries. (limitation 2b) In addition, the regional characteristics and cross-cultural differences may have an impact on the quality of the offered resources and supports by UBIs or the capabilities of the NTBFs. Therefore, further research is required to assess whether our findings are applicable in other regions (Recommendation 2).

Third, we have not taken the other types of support by UBIs in our scope. Our study focused on two categories of support by UBIs: (1) knowledge development and dissemination, and (2) finance mobilization (limitation 3). Thus, further studies are needed to assess other types of support by UBIs, such as access to the networks (Recommendation 3). Furthermore, while in our study, the importance of NTBFs' capabilities is highlighted, we encourage further investigations to take the NTBFs' capabilities and their abilities in resource absorptive into consideration and evaluate the capabilities' direct and moderation impacts on the performances and success of the NTBFs (Recommendation 4).

Fourth, the transferability of our results may be limited (limitation 4) due to the size of the sample (96 NTBFs). However, multiple studies in the context of the study (see Soetanto and Jack, 2016) stated that access to the large dataset of NTBFs is challenging. As discussed in Section 5.1, the small sizes can be acceptable while access to the other resources is limited. In this regard, the following related studies also provide evidence that our sample size is acceptable. Soetanto and van Geenhuizen (2019) had a sample size of n = 100, Soetanto and Jack (2016; 2018) had a sample size of n =141, van Geenhuizen and Soetanto (2009) had a sample size of n = 78 (see Subsection 5.1.2).

Fifth, limitation 5 is the measurement criteria of the NTBFs' capabilities (i.e., absorptive capacity and finance capability). To measure the financial capabilities of the NTBFs, we used the measurement criteria that venture capitalists employ to evaluate the NTBFs ability in fundraising. To measure knowledge-related capability, we used the absorptive capacity, which measures the learning ability of the NTBFs in general. Both capabilities do not completely represent NTBFs' abilities associated with making benefit support by UBIs. Thus, further studies are required to develop a new AI-based measuring instrument of the NTBFs capabilities related to the support by UBIs (Recommendation 5).

References

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

Adler, J. H. (1965). ***Absorptive Capacity: The Concept and its Determinants***. Washington: Brookings Institution. Aiken.

Allen D.N. & McCluskey R. (1990). ***Structure, Policy, Services, and Performance in the Business Incubator Industry***. Entrepreneurship Theory and Practice. Winter pp. 61- 77.

Ali, S., Green, P., and Robb, A. (2013). ***Measuring Top Management's IT Governance Knowledge Absorptive Capacity***. Journal of Information Systems, 27 (1), 137–155.

Ahmad, A. J., & Ingle, S. (2013). ***Business incubators and HTSF development: Setting an agenda for further research***. In R. Oakey, A. Groen, C. Cook, & P. Van Der Sijde (Eds.), New technology-based firms in the new millenium (Vol. X, pp. 119–140). Bingley: Emerald Group Publishing Limited.

Aiken, L. S., West, S. G., & Reno, R. R. (1991). ***Multiple Regression: Testing and Interpreting Interactions:*** Sage.

Audretsch, D. B. (2012). ***Determinants of High-Growth Entrepreneurship :High-Growth Firms*** .Local Policies and Local Determinants, (March), 1–37.

Autio, E., & Rannikko, H. (2016). ***Retaining winners: can policy boost high-growth entrepreneurship?*** Res. Policy 45, 42–55.

Albort-Morant, G., & Oghazi, P. (2016). ***How useful are incubators for new entrepreneurs?*** Journal of Business Research, 69(6), 2125–2129.

Amit, R., & Schoemaker, PJH. (1993). ***Strategic assets and organizational rent.*** Strategic Management Journal, 14(1), 33–46.

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

Baraldi, E., Havenvid, M.I. (2016). ***Identifying new dimensions of business incubation: a multi-level analysis of Karolinska Institute's incubation system***. Tech- novation 50–51, 53–68.

Barney, J. (1991). ***Firm Resources and Sustained Competitive Advantage.*** Journal of Management, 17(1), 99-120.

Barney, J. B. & Arikan, A. M. (2001). The resource- based view: origins and implications in M. A. Hitt, R. E. Freeman and J.S. Harrison (eds), ***Handbook of Strategic Management***. Oxford: Blackwell Publishing, pp. 124–188.

Barney, J. B., Ketchen, D. J., & Wright, M. (2011). ***The future of resource-based theory: Revitalization or decline***? Journal of Management, 37(5), 1299–1315.

Bae, T. J., Qian, S., Miao, C., & Fiet, J. O. (2014). ***The relationship between entrepreneurship education and entrepreneurial intentions: A meta-analytic review. Entrepreneurship***: Theory and Practice, 38(2), 217–254.

Becchetti, G. & Trovato, L. (2002). ***The Determinants of Growth for Small and Medium Sized Firms. The Role of the Availability of External Finance***. Small Business Economics 19(4):291-306

Bergek, A., & Norrman, C. (2008). ***Incubator best practice: A framework***. Technovation 28(1-2): 20–28.

Bott, R. (2014). ***Networking behavior and contracting relationships among entrepreneurs in business incubators***. Igarss 2014, (1), 1–5.

Bøllingtoft, A. (2012). ***The bottom-up business incubator: Leverage to networking and cooperation practices in a self-generated, entrepreneurial-enabled environment***. Technovation 32 (5): 304–315.

Bøllingtoft, A., & Ulhoi, J.P. (2005). ***The networked business incubator—leveraging entrepreneurial agency?*** Journal of Business Venturing 20 (2): 265–290.

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

Brunner, M., & SÜß, H. M. (2005). ***Analyzing The Reliability Of Multidimensional Measures: An Example From Intelligence Research***. Educational and Psychological Measurement, Vol. 65 No. 2, April 227-240.

Brown, R., & Mason, C. (2014). ***Inside the high-tech black box: A critique of technology entrepreneurship policy***. Technovation 34(12): 773–784.

Bryman, A. (2012). ***Social Research Methods***. Oxford University Press.

Chan, K. F., & Lau, T. (2005). ***Assessing technology incubator programs in the science park: the good, the bad and the ugly***. Technovation, 25(10), 1215–1228.

Chen C. J. (2009). ***Technology commercialization, incubator and venture capital, and new venture performance.*** J Bus Res. 62:93-103.

Chen, M.-H., & Wang, M.-C. (2008). ***Social networks and a new venture's innovative capability: the role of trust within entrepreneurial teams***. R&D Management, 38(3), 253–264.

Chen, YS., Lin, MJJ. & Chang, CH. (2009). ***The positive effects of relationship learning and absorptive capacity on innovation performance and competitive advantage in industrial markets***. Industrial Marketing Management 38(2): 152–158.

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

Cohen, W.M., Levinthal, D.A. (1989). ***Innovation and learning: the two faces of R&D***. The Economic Journal 99 (September), 569–596

Cohen, W., & Levinthal, D. (1990). ***Absorptive capacity: A new perspective on learning and innovation***. Admin. Sci. Q., 35, pp. 128–152.

Cronbach, L. J. (1951). ***Coefficient alpha and the internal structure of tests***. Psychometrika, 16(3): 297-334.

Clarysse, B., & Bruneel, J. (2007). ***Nurturing and growing innovative start-ups: the role of policy as intgrator.*** R&D Management, Volume 37, Issue 2, 139-149.

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

Dahms, S., & Kingkaew, S. (2016). ***University Business Incubators: An Institutional Demand Side Perspective on Value Adding Features***. Entrepreneurial Business and Economics Review, 4(43), 41–56.

Deeds, D.L. (2001). ***The role of R&D intensity, technical development and absorptive capacity in creating entrepreneurial wealth in high technology start-ups***. Journal of Engineering and Technology Management, 18 (1), 29–47.

Dvouletý, O., Longo, M.C., Blažková, I., Lukeš, M., & Andera, M. (2018). ***Are publicly funded Czech incubators effective? The comparison of performance of supported and non- supported firms***. Eur. J. Innov. Manag.

Dutta, S., Narasimhan, O., & Rajiv, S. (2005). ***Conceptualizing and measuring capabilities: methodology and empirical application***. Strategic Management Journal 26, 277–285.

Duchek, S. (2013). ***Capturing absorptive capacity: a critical review and future prospects***. Schmalenbach Business Review (SBR), 65 (3), 312–329.

Ebbers, J. J. (2013). ***Networking behavior and contracting relationships among entrepreneurs in business incubators.*** Entrepreneurship: Theory and Practice.

Eisenhardt, K. M., & Martin, J. A. (2000). ***Dynamic capabilities: What are they?*** Strategic Management Journal 21(10–11): 1105–1121.

Ethiraj, S., Kale, P., Krishnan, M.S., & Singh, J.V. (2005). ***Where do capabilities come from and how do they matter? A study of the software services industry***. Strategic Management Journal, 26, 25–45.

Escribano, A., Fosfuri, A., & Tribó, J. A. (2009). ***Managing external knowledge flows: The moderating role of absorptive capacity***. Research Policy, 38(1), 96–105.

Eveleens, C. P., van Rijnsoever, F. J., & Niesten, E. M. M. I. (2017). ***How network-based incubation helps start-up performance: a systematic review against the***

background of management theories. Journal of Technology Transfer (Vol. 42). Springer US.

Fang, S.-C., Tsai, F.-S., & Lin, J. L. (2010)***. Leveraging tenant-incubator social capital for organizational learning and performance in incubation programme***. International Small Business Journal, 28(1), 90–113.

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

Ferna´ndez, M. (2012). ***Promotion of social entrepreneurship through public services in the Madrid region: Successful aspects***. Amfiteatru Economic, XIV, 774–785

Fisher, G., Lahiri, A., & Kotha, S. (2013). ***Changing with the Times: An Integrated View of Legitimacy, Logics and New Venture Lifecycles***. Academy of Management Proceedings, 17126–17126.

Field, A. (2018)***. Discovering Statistics Using IBM SPSS Statistics.*** SAGE Publications Ltd.

Fini, R., Grimaldi, R., Santoni, S., & Sobrero, M. (2011). ***Complements or substitutes? The role of universities and local context in supporting the creation of academic spin-offs***. Res. Policy 40 (8), 1113–1127.

Freel, M. S. (2005). ***Patterns of innovation and skills in small firms***. Technovation, 25(2), 123–134

Freeman, C. (1987). ***Technology Policy and Economic Performance: Lessons from Japan.*** Frances Pinter, London.

Garrett, R. P., & Covin, J. G. (2013). ***Internal Corporate Venture Operations Independence and Performance: A Knowledge-Based Perspective***. Entrepreneurship Theory and Practice.

Gao, S., Xu, K., & Yang, J. (2008). ***Managerial ties, absorptive capacity, and innovation***. Asia Pacific Journal of Management, 25 (3), 395–412.

Giuliani, E., & Bell, M. (2005). ***The micro-determinants of meso-level learning and innovation: evidence from a Chilean wine cluster***. Research Policy 34 (1), 47–68.

Gliem, J. A., & Gliem, R. R. (2003). ***Calculating, interpreting, and reporting Cronbach's alpha reliability coefficient for Likert-type scales***.

Grant, R. M. (1991). ***The resource-based theory of competitive advantage Implications for strategy formulation***. Strategic Management Journal, 17(S2), 109–122.

Grant, R.M. (1996). ***Toward a knowledge-based theory of the firm***. Strategic Management Journal 17, 109–122.

Gilbert, B. a., McDougall, P. P., & Audretsch, D. B. (2006). ***New Venture Growth: A Review and Extension***. Journal of Management 32 (6): 926–950.

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

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

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

Hair, J.F., Sarstedt, M., Pieper, T.M., & Ringle, C.M. (2012). ***The use of partial least squares structural equation modeling in strategic management research: a review of past practices and recommendations for future applications. Long Range Plan.*** 45 (5–6), 320–340. ISSN 0024-6301

Hayton, J., & Zahra, S.A. (2005)***. Venture team human capital and absorptive capacity in high technology new ventures***. International Journal of Technology Management 31, 256–274.

Huynh, T., Patton, D., Arias-Aranda, D., & Molina-Fernández, L. M. (2017). ***University spin-off's performance: Capabilities and networks of founding teams at creation phase***. Journal of Business Research, 78(October 2016), 10–22.

Hall, J., & Hofer, C. W. (1993). ***Venture capitalists' decision criteria in new venture evaluation.*** Journal of Business Venturing, 8(1), 25–42

Hansen, M.T., Chesbrough, H.W., & Sull, D.N. (2000). ***Networked incubators: hothouses of the New Economy***. Harvard Business Review (Septem- ber–October), 75–83.

Henry, C. (2003). ***Microsoft poverty assessment tool:*** World bank publications

Hughes, M., Hughes, P., & Morgan, R. E. (2007). ***Exploitative learning and entrepreneurial orientation alignment in emerging young firms: Implications for market and response performance***. British Journal of Management, 18(4), 359–375.

Huber, G.P. (1991). ***Organizational learning: the contributing processes and the literatures. Organization Science*** 2, 88–115.

Jiménez-Barrionuevo, M. M., García-Morales, V.J., & Molina, L. M. (2011). ***Validation of an instrument to measure absorptive capacity***. Technovation, 31(5–6), 190–202.

Johnson C. D. (2013). S***ocial Capital: Theory, Measurement and Outcomes (Social Issues, Justice and Status)*** UK ed. Edition.

Jensen, A., & Clausen, T. H. (2017). ***Origins and emergence of exploration and exploitation capabilities in new technology-based firms***. Technological Forecasting and Social Change, 120, 163–175.

Joseph F., Hair Jr, J., Hult, G. T., Ringle, C., & Sarstedt, M. (2017). ***A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*** - SAGE Publications, Inc.

Kaiser, H. F. (1960). ***The application of electronic computers to factor analysis.*** Educational and psychological measurement, 20: 141-151.

Koryak, O., Mole, K.F., Lockett, A., Hayton, J.C., Ucbasaran, D., & Hodgkinson, G.P. (2015). ***Entrepreneurial leadership, capabilities and firm growth***. Int. Small Bus. J. 33 (1), 89–105.

Kirwan, P., Van Der Sijde, P., & Groen, A. (2006). ***Assessing the needs of new technology-based firms (NTBFs): An investigation among spin-off companies from six European Universities.*** International Entrepreneurship and Management Journal, 2(2), 173–187

Kollmann, T., & Kuckertz, A. (2010). ***Evaluation uncertainty of venture capitalists' investment criteria.*** Journal of Business Research, 63 (7), pp. 741-747.

Lalkaka, R. (2001). ***“Best practices” in business incubation: Lessons (yet to be) learned. Paper presented at the International Conference on Business Centers, Actors of Economic and Social Development***, Brussels, Belgium

Lerner, J. (2009). ***Boulevard of Broken Dreams: Why Public Efforts to Boost Entrepreneurship and Venture Capital Have Failed--and What to Do about It***. Princeton University Press.

Lenihan, H., Andreosso-O’Callaghan, B., & Hart, M. (2010). ***SMEs in a Globalised World: Conceptual Issues***. In: Lenihan, H., Andreosso-O’Callaghan, B., Hart, M. (Eds.), SMEs in a Globalised World: Survival and Growth Strategies on Europe’s Geo- graphical Periphery. Edward Elgar, Cheltenham, UK, pp. 1–15.

Lewin, A.Y., Massini, S., and Peeters, C. (2011). ***Microfoundations of internal and external absorptive capacity routines***. Organization Science, 22 (1), 81–98

Ledesma, R. D., & Valero- Mora, P. (2007). ***Determining the number of factors to retain in EFA: An easy-to-use computer program for carrying out parallel analysis***. Practical Assessment, Research & Evaluation, 12(2): 1-11.

Li, Y.-R., & Chen, Y. (2009). ***Opportunity, embeddedness, endogenous resources, and performance of technology ventures in Taiwan’s incubation centers***. Technovation, 29(1), 35–44.

Lockett, A., & Wright, M. (2005). ***Resources, capabilities, risk capital and the creation of university spin-out companies***. Research Policy, 34(7), 1043–1057.

Löfsten, H., & Lindelöf, P. (2001). ***Science parks in Sweden–industrial renewal and development?*** R&D Management, 31(3), 309–322.

Löfsten, H. (2010)***. Critical incubator dimensions for small firm performance - a study of new technology-based firms localised in 16 incubators***. Int. J. Bus. Innov. Res. 4 (3), 256–279.

Lukeš, M., Longo, M. C., & Zouhar, J. (2019). ***Do business incubators really enhance entrepreneurial growth? Evidence from a large sample of innovative Italian start-ups.*** Technovation, 82–83(July), 25–34.

Macpherson, a, Jones, O., & Zang, M. (2004). ***Evolution or Revolution? Dynamic Capabilities In A Knowledge Depending Firm.*** R&D Management 24 (2): 161–177

Mas-Verdú, F., Ribeiro-Soriano, D., & Roig-Tierno, N. (2015). ***Firm survival: the role of incubators and business characteristics***. J. Bus. Res. 68 (4), 793–798.

March, J.G. (1991). ***Exploration and exploitation in organizational learning***. Organization Science 2, 71–87.

Maine, E., Lubik, S., & Garnsey, E. (2012). ***Process-based vs. product-based innovation: value creation by nanotech ventures***. Technovation 32, 179–192.

Maxwell, L., Jeffrey, S. A., & Lévesque, M. (2011). ***Business angel early stage decision making.*** Journal of Business Venturing, 26 (2), pp. 212-225.

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

McAdam, M., & Marlow, S. (2007). ***Building futures or stealing secrets? Entrepreneurial cooperation and conflict within business incubators***. International Small Business Journal 25 (4), 361–382.

McGuirk, H., Lenihan, H., & Hart, M. (2015). ***Measuring the impact of innovative human capital on small firms' propensity to innovate.*** Research Policy, 44(4), 965–976.

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

Mian, S., Lamine, W., & Fayolle, A. (2016). ***Technology Business Incubation: An overview of the state of knowledge.*** Technovation, 50–51, 1–12.

Musiolik, J., Markard, J., & Hekkert, M. (2012). ***Networks and network resources in technological innovation systems: Towards a conceptual framework for system building***. Technological Forecasting and Social Change, 79(6), 1032–1048.

Neergaard, H. (2005). ***Networking activities in technology based entrepreneurial teams***. International Small Business Journal 23 (3), 257–278.

Newbert, S. L. (2007). ***Empirical research on the resource-based view of the firm: an assessment and suggestions for future research***. Strategic Management Journal 28 (2), 121–146.

Oakey, R. (2003). ***Technical entreprenenurship in high technology small firms: some observations on the implications for management***. Technovation 23, 679–688.

Oakey, R. (2012). ***High-Technology Entrepreneurship***. Routledge, London and New York.

Patton, D., Warren, L., & Bream, D. (2009). ***Elements that underpin high-tech business incubation processes.*** Journal of Technology Transfer, 34(6), 621–636.

Patton, D. (2014). ***Realising potential: The impact of business incubation on the absorptive capacity of new technology-based firms***. International Small Business Journal.

Patton, D., & Marlow, S. (2011). ***University technology business incubators: Helping new entrepreneurial firms to learn to grow***. Environment and Planning C: Government and Policy, 29(5), 911–926.

Pallant, J. (2010). SPSS Survival Manual 4th Edition**- *A step guide to data analysis using the SPSS program***. Osterrike: Allen & Unwin Book Publisher.

Peeters, C., & de la Potterie, B.V.P. (2006). ***Innovation strategy and the patenting behavior of firms***. Journal of Evolutionary Economics, 2006, vol. 16, issue 1, 109-135

Peteraf, M. A. (1993). ***The Cornerstones of Competitive Advantage: A Resource-Based View***. Strategic Management Journal, 14(3), 179–91.

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

Pi, L. (2021). ***External knowledge absorption in Chinese SMEs*** (doctoral dissertation), Leiden University, the Netherlands.

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). ***Common method biases in behavioral research: A critical review of the literature and recommended remedies***. Journal of Applied Psychology, 88(5), 879-903

Prajogo, D.I. (2016). ***The strategic fit between innovation strategies and business environment in delivering business performance.*** International Journal of Production Economics, 171, 241–249.

Rivard, S., Raymond, L., & Verreault, D. (2006). ***Resource-based view and competitive strategy: An integrated model of the contribution of information technology to firm performance***. Journal of Strategic Information Systems, 15(1), 29–50.

Ratinho, T., & Henriques, E. (2010). ***The role of science parks and business incubators in converging countries: evidence from Portugal***. Technovation 30, 278–290.

Ratinho, T., Harms, R., & Groen, A. (2013). ***Business incubators: (How) do they help their tenants? New Technology-Based Firms in the New Millennium***, 10(10), 161–182. doi:10.1108/S1876-

Rubin, T. H., Aas, T. H., & Stead, A. (2015). ***Knowledge flow in Technological Business Incubators: Evidence from Australia and Israel***. Technovation, 41-42, 11–24

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

Roper, S., & Hewitt-Dundas, N. (2008). ***Innovation persistence: survey and case-study evidence***. Research Policy 37, 149–162.

Roper, S., Du, J., & Love, J.H. (2008). ***Modelling the innovation value chain***. Research Policy 37, 961–977

Saemundsson, R. J., & Candi, M. (2017). ***Absorptive capacity and the identification of opportunities in new technology-based firms***. Technovation, 64–65(November 2016), 43–49.

Samaeemofrad, N., & van den Herik H. J. (2020). ***The Impact of Business Incubation Support: Moderating Role of Absorptive Capacity*****.** In the proceedings of the 2020 ICE/ITMC International Virtual Conference, 2020 (IEEE Xplore).

Samaeemofrad, N., & van den Herik H. J. (2018). ***The Relation between Support by Business Incubators and Performance of NTBFs***. In the proceedings of the 2018 ICE/ITMC International Conference, Stuttgart, Germany.

Samaeemofrad, N., & van den Herik H. J. (2018). ***The Effectiveness of Finance Mobilization by Business Incubators on the Performance of NTBFs***. In the proceedings of the 2018 ICE/ITMC International Conference, Stuttgart, Germany.

Samaeemofrad, N., van den Herik H. J., & Verburg, R. (2016). ***A New Perspective on Business Incubators.*** In the proceedings of the 2016 ICE/ITMC International Conference, Trondheim, Norway).

Sarstedt, M., & Mooi, E. (2019). ***A Concise Guide to Market Research, The Process, Data, and Methods.*** Using IBM SPSS Statistics.

Sandberg, W., & Hofer, C. (1987). ***Improving new venture performance: the role of strategy, industry structure, and the entrepreneur***. Journal of Business Venturing, 14: 165–187

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

Schwartz, M., & Hornych, C. (2008). ***Specialization as strategy for business incubators: an assessment of the Central German Multimedia Center***. Technovation 28, 436–449

Schwartz, M., & Hornych, C. (2010). ***Cooperation patterns of incubator firms and the impact of incubator specialization: empirical evidence from Germany***. Technovation

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

Shepherd, A. (1999). ***Venture capitalists assessment of new venture survival***. Management Science. 45(5).

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

Siegel, D. S., Westhead, P., Wright, M., & Wright, M. (2018). ***Science Parks and the Performance of New Technology-Based Firms: A Review of Recent U . K. Evidence and an Agenda for Future Research.*** Small Business Economics**.** 20(2), 177–184.

Slotte-Kock, S. & Coviello, N. (2010). ***Entrepreneurship research on network processes: A review and ways forward***. Entrepreneurship Theory and Practice, 34(1), 31–57.

Sobh., T. M. (2008). ***Advances in computer and information science and engineering.*** Springer Science and Business Media.

Soetanto, D., & Jack, S. L. (2018). ***Slack resources, exploratory and exploitative innovation and the performance of small technology-based firms at incubators***. Journal of Technology Transfer, 43(5), 1213–1231.

Soetanto, D., & Jack, S. (2016). ***The impact of university-based incubation support on the innovation strategy of academic spin-offs***. Technovation, 50–51, 25–40.

Soetanto, D. P., & Jack, S. L. (2013). ***Business incubators and the networks of technology-based firms***. The Journal of Technology Transfer, 38(4), 432–453.

Soetanto, D. P., & van Geenhuizen, M. (2010). ***Social capital through networks: The case of university spin- off firms in different stages.*** Tijdschrift voor Economische en Sociale Geografie, 101(5), 509–520.

Soetanto, D., & van Geenhuizen, M. (2019***). Life after incubation: The impact of entrepreneurial universities on the long-term performance of their spin-offs***. Technological Forecasting and Social Change, 141(October), 263–276. https://doi.org/10.1016/j.techfore.2018.10.021

Somsuk, N., & Laosirihongthong, T. (2014). ***A fuzzy AHP to prioritize enabling factors for strategic management of university business incubators: Resource-based view***. Technological Forecasting and Social Change, 85, 198–210.

Spanos, Y. E. & Lioukas,S. (2001). ***An examination into the causal logia of rent generation: Contrasting Porter's competitive strategy framework and the resource-based perspective***. Strategic Management Journal, 22, 907–934.

Stal, E., Andreassi, T., & Fujino, A. (2016). ***The role of university incubators in stimulating academic entrepreneurship***. RAI Revista de Administração E Inovação, 13(2), 89–98.

Stam, W., Arzlanian, S., & Elfring, T. (2014). ***Social capital of entrepreneurs and small firm performance: a meta-analysis of contextual and methodological moderators***. J. Bus. Ventur. 29, 152–173.

Sternberg, R. (2014). ***Success factors of university-spin-offs: Regional government support programs versus regional environment***. Technovation, 34(3), 137–148.

St-jean, E., & Audet, J. (2009). ***Factors Leading to Satisfaction in a Mentoring Scheme for Novice Entrepreneurs.*** International Journal of Evidence Based Coaching and Mentoring journal, 2009, 7(1), 148–162.

Storey, D.J., & Tether, B.S. (1998). ***Public policy measures to support new technology-based firms in the European Union***. Research Policy 26, 1037–1057.

Stokan, E., Thompson, L., & Mahu, R. J. (2015). ***Testing the Differential Effect of Business Incubators on Firm Growth***. Economic Development Quarterly, 29(4), 317–327.

Su, Z., Ahlstrom, D., Li, J., & Cheng, D. (2013). ***Knowledge creation capability, absorptive capacity, and product innovativeness***. R&D Management, 43 (5), 473–485.

Sullivan, D. M., & Ford, C. M. (2014). ***How entrepreneurs use networks to address changing resource requirements during early venture development***. Entrepreneurship Theory & Practice, 38(3).

Sullivan, D. M., & Marvel, M. R. (2011). ***Knowledge acquisition, network reliance, and early-stage technology venture outcomes.*** Journal of Management Studies, 48(6), 1169–1193.

Szulanski, G., (1996). ***Exploring internal stickiness: Impediments to the transfer of best practice within the firm***. Strategic Management Journal, 17 (S2), 27–43

Tabachnick, B. G., & Fidell, L. S. (2007). ***Using Multivariate Statistics***: Pearson Education, Limited.

Tam, C. Thomas, K., & Zhang, H. (2007). ***Decision making and operations research techniques for construction management***: City University of HK Press.

Tehseen, S., Ramayah, T., & Sajilan, S. (2017). ***Testing and Controlling for Common Method Variance: A Review of Available Methods***. Journal of Management Sciences, 4(2), 142–168. https://doi.org/10.20547/jms.2014.1704202

Teece, D., Pisano, G., & Shuen, A. (1997). ***Dynamic capabilities and strategic management***. Strategic Management Journal, 18(7), 509–533.

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

Van Gelderen, M., van De Sluis, L., & Jansen, P. (2005). ***Learning opportunities and learning behaviours of small business starters: Relations with goal***

achievement, skill development and satisfaction. Small Business Economics, 25(1), 97–108.

Van Praag, C.M., & Versloot, P.H. (2008). ***The economic benefits and costs of entrepreneurship: a review of the research. Found***. Trends Entrep. 4 (2), 65–154

Van Rijnsoever, F. J., Van Weele, M. A., & Eveleens, C. P. (2017). ***Network brokers or hit makers? Analyzing the influence of incubation on start-up investments***. International Entrepreneurship and Management Journal, 13(2), 605–629.

Van Weele, M., van Rijnsoever, F. J., Eveleens, C. P., Steinz, H., van Stijn, N., & Groen, M. (2018). ***Start-EU-up! Lessons from international incubation practices to address the challenges faced by Western European start-ups***. Journal of Technology Transfer, 43(5), 1161–1189.

Van Weele, M., van Rijnsoever, F. J., & Nauta, F. (2017). ***You can't always get what you want: How entrepreneur's perceived resource needs affect the incubator's assertiveness***. Technovation, 59

Vanderstraeten, J., & Matthyssens, P. (2012). ***Service-based differentiation strategies for business incubators: Exploring external and internal alignment***. Technovation 32 (12): 656–670.

Verbano, Ch., & Crema, M. (2015). ***Linking technology innovation strategy, intellectual capital and technology innovation performance in manufacturing SMEs***. Technology Analysis & Strategic Management. 28 (5), 424-540.

Voss, G. B., & Voss, Z. G. (2013). ***Strategic ambidexterity in small and medium-sized enterprises: implementing exploration and exploitation in product and market domains***. Organization Science. 24 (5), 1459–1477.

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

Wang, C. L., & Chugh, H. (2014). ***Entrepreneurial learning: Past research and future challenges.*** International Journal of Management Reviews, 16(1), 24–61.

Webster, A. (2013). ***Introductory Regression Analysis: With Computer Application for Business and Economics***: Routledge.

Wernerfelt, B. (1984). ***A resource-based view of the firm.*** Strategic Management Journal, 5: 171-180.

Witt, P. 2004. ***Entrepreneurs' networks and the success of start-ups***. Entrepreneurship & Regional Development 16 (5): 391–412.

Wiklund, J., & Shepherd, D. (2003). ***Knowledge-based resources, entrepreneurial orientation, and the performance of small and medium-sized businesses***. Strategic Management Journal, 24(13), 1307–1314.

Wonglimpiyarat, J. (2016). ***The innovation incubator, University business incubator and technology transfer strategy: The case of Thailand***. Technology in Society, 46, 18–27.

Wu, L. Y. (2007). ***Entrepreneurial resources, dynamic capabilities and start-up performance of Taiwan's high-tech firms***. Journal of Business Research, 60(5), 549–555.

Wu, W. and Han, Q. (2017). ***Revenue and Knowledge Cooperation Mechanisms between Business Incubators and Venture Capitalists for Collaborative Start-Ups***. Theoretical Economics Letters, 7, 1335-1356.

Zahra, S. A., & George, G. (2002). ***Absorptive Capacity: A Review, Re-Conceptualization, and Extension***. Academy of Management Review 27 (2): 85–203.

Zobel, A.-K., (2017). ***Benefiting from Open Innovation: A Multidimensional Model of Absorptive Capacity***. Journal of Product Innovation Management, 34 (3), 269–288.

Zolin, R., Kuckertz, A., & Kautonen, T. (2011). ***Human resource flexibility and strong ties in entrepreneurial teams***. Journal of Business Research, 64(10), 1097–1103.

Appendices

The list of Appendices consists of ten parts as given below.

Appendix A: From Codes to Categories

Appendix B: Invitation Letter to Participate in a Research

Appendix C: The Measurement Instrument (Questionnaire)

Appendix D1: Correlation Matrix of Two Supports by Business Incubator Scales and Innovation Strategy

Appendix D2: Correlation Matrix of Two Moderators

Appendix E1: Results of Kaiser's Criterion for Independent Variables

Appendix E2: Results of Kaiser's Criterion for Moderators

Appendix F: Syntax to Perform Parallel Analysis in SPSS

Appendix G: Residual Plots of The Variables Used in the Regression Analysis

Appendix H: Results of Common Method Bias

APPENDIX A: FROM CODES TO CATEGORIES

Appendix A presents the 36 codes obtained from interviews with entrepreneurs, and classifies them into the five different categories.

No.	Codes	Categories
1	Attract big cooperation and companies by incubator	Access to the networks
2	Partnership	
3	Cooperation with different well-known companies by incubator	
4	networks of incubators	
5	Strong communication of the incubator	
6	Get relationship with big companies by NTBF	
7	Interaction with university	
8	Reaching customers by NTBF	
9	Meeting Potential Customers/VS/Advisors	
10	Synergy	
11	Meetups/events	
12	Engagement	
13	Brand visibility	Creation of exposure
14	Reputation/ credibility	
15	Increase awareness about NTBF’s brand, product, service	
16	Being present in the incubators’ social media	
17	Knowledge creation	Knowledge development and dissemination
18	Learning from other startups	
19	Advisory / coaching	
20	Access to a default platform for legal issues	
21	Knowledge diffusion and development	
22	Develop personal skills	
23	Interactive Training	
24	Mentoring	
25	Evaluate the progress	Growth control
26	Evaluate the problems	
27	Monitoring	
28	Set Milestones by incubator	
29	Get loan	Finance and administrative mobilization
30	Fundraising	
31	Venture Capital	
32	Financial sponsor	
33	Facilities	
34	IT infrastructure	
35	Place to work	
36	Administrative Services	

APPENDIX B: INVITATION LETTER TO PARTICIPATE IN A RESEARCH

Appendix B shows the invitation letter of the survey for the entrepreneurs. This letter addresses the objective of the survey.

Universiteit Leiden

Dear Founder and Entrepreneur.

I invite you to participate in a research study entitled “Business Incubators: How effective are they?”

I am Negin Samaee a Ph.D. candidate in the field of Innovation Management in Leiden University. The purpose of the research is to determine the effect of the supports by business incubators or accelerators on the performance of startups. The enclosed questionnaire has been designed to collect information on the founder’s opinion on the received support by business incubators. Your participation in this research project is completely voluntary. Your responses will remain confidential and anonymous. Data from this research will be kept and reported only as a collective combined total. No one other than the researchers will know your individual answers to this questionnaire.

If you agree to participate in this project, please answer the questions on the questionnaire as best you can. It should take approximately 10-15 minutes to complete. If you have any questions about this project, feel free to contact: n.samaeemofrad@liacs.leidenuniv.nl or to my LinkedIn account (Negin Samaee)

Thank you for your assistance in this important endeavor.

Sincerely yours,

Negin Samaeemofrad	Prof. Jaap van den Herik
Ph.D. Candidate, Leiden University	Graduate School of Mathematics
	Leiden University

APPENDIX C: THE MEASUREMENT INSTRUMENT QUESTIONNAIRE

Appendix C demonstrates the questionnaire that we disseminated among entrepreneurs to collect data. The questionnaire gathers (1) general information from the participants (Q1-Q4) and information on the supports by BIs and the performance of the NTBFs (Q5-Q16).

Q1: Email:
Q2: Name of Business Incubator/Accelerator
Q3: Prior working experience:

- First working experience
- Consultant
- University and other R&D organizations
- High-Tech firm
- Others:

Q4: Graduate degree in:

- Computer science
- Mathematics
- Physics
- Chemistry
- Economics and Business
- Biology
- Others:

Q5: Number of Founders:

Q6: Please state the year of your firm's establishment (start to work)
Q7 What is the total number of employees in your team?

- Number of Full-Time Employees
- Part-Time Employees

Q8 How many employees do you increase since last year?
Q9 Please indicate the industry of your business.

- Computer and software industry (e.g., AI, Blockchain)
- Energy industry
- ICT
- Life science
- Healthcare and MedTech
- Manufacturing industry
- Robotics

Agriculture
General services
Aerospace and aviation industry
Complex technologies (e.g., Nanotech, CleanTech)
Others:

Q10 Please indicate whether or not your organization has a patented technology.
Yes / No
Q11 Has your firm produced one or more new products and/or services in the last two years?
Yes / No

Q12 Please assess the extent to which you agree or disagree with the following statements.

Statement	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
(1) The technology and innovation behind our existing products and services need improvement.							
(2) We invest in the development of new technologies, patents, products and /or services that are completely new to our company.							
(3) We aim to develop new products or services.							
(4) We invent new products and/or services.							
(5) We intend to add small adaptations to existing products and/or services.							
(6) We regularly attempt to use optimize resources, as well as less time and less money in producing our existing products and/or services.							
(7) We regularly monitor our existing products and /or services to be aligned with customer needs.							
(8) We have plan to increase the amount of production and/or services in our existing markets.							
(9) Our company builds new distribution channels.							
(10) We regularly search for new approaches into new markets.							
(11) We utilize new opportunities in new markets.							
(12) Our company develops at least two new services each year for our existing clients.							
(13) We introduce improved our existing products and services for our existing market.							

Q13 Business incubators attempt to support their tenants via offering business-oriented training programs. Please indicate the extent to which you find them effective in the development of your business.

Statement	Extremely satisfied	satisfied	Slightly satisfied	Neither satisfied nor dissatisfied	Slightly dissatisfied	dissatisfied	Extremely dissatisfied
(1) Marketing strategy and sales management skills							
(2) Negotiation and communication skills							
(3) Business strategy and agile management							
(4) Human Resource Management							
(5) Financial statements, tax, contracts, protectability (Intellectual Property)							

Q14 Please indicate the extent to which you are satisfied or dissatisfied with the following support offered to your business.

Statement	Extremely satisfied	satisfied	Slightly satisfied	Neither satisfied nor dissatisfied	Slightly dissatisfied	dissatisfied	Extremely dissatisfied
(1) Adviser's availability							
(2) Adviser's expertise and experience							
(3) Organization of meetings with your adviser (duration, frequency, and efficiency)							
(4) There is a relationship based on trust. respect and compliance with a moral contract between you and your adviser.							
(5) Increase in self-confidence as a result of the advisory experience							
(6) Access to a more extensive targeted network of contacts due to the collaboration with an adviser							
(7) Achieve real, observable results for your business through the advisory process							
(8) Adviser offers guidance regarding your successes, failures and methods for improving your business practice							

Q15 Business incubators attempt to support their tenants via the access to different capital resources. How do you evaluate their fundraising attempts to get access to capital resources for your business?

Statement	Extremely satisfied	satisfied	Slightly satisfied	Neither satisfied nor dissatisfied	Slightly dissatisfied	dissatisfied	Extremely dissatisfied
(1) For governmental subsidy							
(2) For Venture Capital funds, Private investors							
(3) For philanthropy (donations)							
(4) For a loan from your business incubator							
(5) For strategic alliance or partnership with established firms							

Q16 Emphasis is on characteristics of your relationship between your firm and whoever (e.g., customers. users. advisers) from whom you may obtain or exchange new information or useful knowledge. Please indicate the degree of agreement or disagreement with the following statements.

Statement	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
(1) Your firm has a close relationship with its customers that is characterized by mutual trust and respect							
(2) Our team is able to understand knowledge from outside our business focus or industry-niche							
(3) There are many informal conversations and formal meetings in our organization to discuss the development of our business practice							
(4) Our team publishes informative documents periodically (e.g., reports. bulletins)							
(5) When something important occurs. all members of our team are informed within a short time, and the knowledge is shared among all members of the organization							
(6) We frequently pivot our business based on the obtained knowledge from outside							

Q17 Please indicate the extent to which you rate yourself regarding your ability in raising capital.

Statement	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
(1) I am able to evaluate to risk well							
(2) Our team has direct and relevant experience							
(3) Our customers easily adapt to our product							
(4) Our product is ready to market							
(5) People can NOT copy our product/ service							
(6) Our product meets customer needs							
(7) We have a realistic marketing plan							
(8) There is a large market for our product (Over 20 Million $)							

Q18 Regarding measuring the performance of your firm. please indicate to what extent you are satisfied with the following statements.

Statement	Extremely satisfied	satisfied	Slightly satisfied	Neither satisfied nor dissatisfied	Slightly dissatisfied	dissatisfied	Extremely dissatisfied
(1) Meet the planned milestones as scheduled							
(2) Able to achieve the defined business goals (excluding personal development and learning goals)							
(3) Developing my business and management skills							
(4) I am satisfied with the income							
(5) I am satisfied with the process of business development							

APPENDIX D1: CORRELATION MATRIX OF TWO SUPPORTS BY BUSINESS INCUBATOR SCALES AND INNOVATION STRATEGY

Appendix D1 describes the correlations between three measurement scales of the support by business incubators. These scales are: Innovation Strategy (Q1-Q12), Knowledge development (Q13-Q26), and finance mobilization (Q27-Q31).

Item	Q1	Q6	Q5	Q4	Q2	Q3-1	Q3-2	Q7	Q11	Q12	Q10	Q9	Q8	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31
Q1	1																															
Q6	.069	1																														
Q5	.035	**.345**	1																													
Q4	-.015	**.349**	.232	1																												
Q2	-.011	-.113	.122	-.115	1																											
Q3-1	-.043	-.022	.010	.008	.205	1																										
Q3-2	-.008	.140	.057	.123	**.329**	.299	1																									
Q7	.128	-.009	.092	.001	**.416**	**.319**	.251	1																								
Q11	.063	.087	-.094	.014	.236	.211	.205	**.354**	1																							
Q12	.016	.037	.105	.074	.128	.205	**.371**	.179	**.305**	1																						
Q10	.087	.210	**.365**	.051	.193	.174	.222	.172	**.422**	**.559**	1																					
Q9	-.110	.002	-.051	.260	.296	.167	.187	.146	.284	.231	.124	1																				
Q8	.043	-.017	.033	-.093	**.443**	.154	.184	**.411**	.292	.168	.150	**.420**	1																			
Q13	.200	.222	.238	.102	.058	-.076	.109	.004	-.029	.076	.104	-.073	.124	1																		
Q14	.247	.258	.162	.186	.027	-.088	.165	.035	.069	-.018	.101	-.076	.040	**.793**	1																	
Q15	.246	**.441**	.253	.117	.130	-.011	.102	.050	.112	.001	.238	-.110	.042	**.677**	**.682**	1																
Q16	**.362**	**.305**	.026	.091	.126	.091	.093	.232	.189	.032	.096	-.124	.200	**.523**	**.539**	**.666**	1															
Q17	.077	**.357**	.177	.085	.114	.059	.181	.180	.117	.111	.280	-.070	.096	**.545**	**.534**	**.560**	**.616**	1														
Q18	.147	.297	.157	.038	.127	.032	.104	.198	.215	.061	.277	-.028	.123	**.435**	**.425**	**.489**	**.534**	**.745**	1													
Q19	.244	**.378**	.215	.161	.075	.079	.133	.127	.105	.121	.228	-.145	-.027	**.492**	**.547**	**.652**	**.638**	**.701**	**.700**	1												
Q20	.241	**.393**	.285	.072	.192	.070	.158	.275	.080	.051	.173	-.166	.096	**.391**	**.424**	**.644**	**.669**	**.656**	**.585**	**.750**	1											
Q21	-.053	.209	-.046	.053	.111	-.103	.272	-.043	-.011	.028	-.092	.026	.009	.171	.192	.163	.264	.196	.145	.230	**.308**	1										
Q22	-.002	.103	.135	.092	.190	-.042	.274	-.044	-.053	.089	-.047	-.017	.025	.282	**.313**	.235	.253	.190	.158	.223	**.319**	**.654**	1									
Q23	.028	.230	.063	.032	.163	-.051	.195	-.053	.001	.030	-.019	-.046	.063	**.439**	**.394**	**.336**	**.326**	.272	.238	**.305**	**.345**	**.682**	**.745**	1								
Q24	.025	.171	.018	.141	.115	.035	.197	.073	.063	.132	-.030	.069	.133	**.310**	.296	.126	.208	.190	.134	.258	.259	**.618**	**.671**	**.636**	1							
Q25	.050	.025	.084	-.109	.204	.023	.106	.168	-.009	-.033	-.068	.032	.208	.254	**.322**	.116	.188	.144	.079	.186	.271	**.555**	**.522**	**.579**	**.637**	1						
Q26	-.099	.185	-.094	.130	-.133	-.154	-.022	-.057	-.066	-.094	-.154	.082	.041	.273	**.363**	.110	.210	.283	.198	.198	.138	**.587**	**.442**	**.479**	**.421**	**.416**	1					
Q27	.111	**.363**	.285	.111	.014	-.112	.038	.067	-.072	.127	.192	-.056	.010	.298	.253	.198	.240	.223	.156	**.309**	.296	**.314**	**.446**	**.404**	**.381**	**.352**	.216	1				
Q28	.205	.246	-.010	.078	.204	.027	.159	.197	.169	.117	.098	-.001	.081	.277	.257	**.320**	**.410**	.227	.220	**.356**	**.342**	**.364**	**.337**	**.381**	**.324**	.266	.159	**.522**	1			
Q29	.237	.243	-.088	-.147	.057	.045	.067	.014	.043	.036	.052	-.124	.146	.143	.097	.216	.233	.138	.078	.204	.189	.178	.130	.161	.295	.134	.070	**.404**	**.635**	1		
Q30	.108	.243	.101	-.008	.040	.044	.131	.146	-.115	.166	.022	-.010	-.027	.115	.127	.213	.201	.149	.150	.165	**.312**	.173	.254	.149	.111	.278	-.031	**.481**	**.427**	**.312**	1	
Q31	.201	**.488**	.146	.119	-.049	-.019	.118	.140	.132	.138	.262	-.152	-.026	**.339**	**.370**	**.417**	**.369**	**.323**	**.363**	**.423**	**.304**	.211	.280	**.341**	**.337**	.265	.133	**.589**	**.588**	**.542**	**.416**	1

APPENDIX D2: CORRELATION MATRIX OF TWO MODERATORS

Appendix D2 describes the correlations between two moderators. These scales are: Absorptive capacity (Q32-Q37), and Financial capability (Q38-Q45).

Items	Q32	Q33	Q34	Q35	Q36	Q37	Q38	Q39	Q40	Q41	Q42	Q43	Q44	Q45
Q32	1.													
Q33	**0.380**	1.												
Q34	**0.312**	**0.308**	1.											
Q35	0.263	-0.031	0.099	1.										
Q36	**0.342**	**0.410**	0.288	**0.336**	1.									
Q37	0.175	**0.338**	0.111	0.209	**0.310**	1.								
Q38	0.121	0.231	0.126	0.210	0.077	0.082	1.							
Q39	0.231	**0.310**	0.113	0.112	0.130	0.224	**0.512**	1.						
Q40	0.047	0.002	0.211	-0.053	-0.028	0.146	0.004	0.080	1.					
Q41	0.246	-0.119	0.121	0.066	-0.050	-0.107	-0.028	-0.005	0.140	1.				
Q42	0.122	0.111	0.168	0.045	0.283	-0.097	0.246	-0.007	0.115	0.222	1.			
Q43	0.229	0.257	0.297	-0.015	0.283	0.018	0.133	0.220	0.014	-0.025	0.260	1.		
Q44	**0.368**	0.127	0.115	0.121	0.224	0.067	0.024	0.135	**0.349**	**0.349**	0.296	0.277	1.	
Q45	0.078	0.223	0.114	0.104	**0.324**	0.086	0.244	0.125	0.119	-0.059	0.435	**0.333**	0.068	1.

APPENDIX E1: RESULTS OF KAISER'S CRITERION FOR INDEPENDENT VARIABLES

Appendix E1 describes the results of Principal Component Analysis with the Eigenvalues for Independent Variables.

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	**7.955**	**24.858**	**24.858**
2	**3.316**	**10.362**	**35.220**
3	**2.933**	**9.165**	**44.385**
4	**2.159**	**6.746**	**51.131**
5	**1.811**	**5.660**	**56.790**
6	**1.338**	**4.180**	**60.971**
7	**1.212**	**3.788**	**64.759**
8	**1.164**	**3.637**	**68.396**
9	**1.050**	**3.281**	**71.677**
10	.905	2.828	74.505
11	.859	2.685	77.191
12	.820	2.562	79.752
13	.702	2.194	81.947
14	.658	2.057	84.004
15	.636	1.988	85.992
16	.535	1.671	87.663
17	.497	1.554	89.217
18	.454	1.420	90.637
19	.357	1.115	91.752
20	.347	1.085	92.837
21	.323	1.010	93.847
22	.314	.981	94.828
23	.280	.875	95.703
24	.252	.789	96.492
25	.235	.733	97.225

26	.204	.639	97.864
27	.164	.512	98.376
28	.122	.383	98.758
29	.121	.377	99.135
30	.117	.365	99.500
31	.097	.303	99.803
32	.063	.197	100.000

APPENDIX E2: RESULTS OF KAISER'S CRITERION FOR MODERATORS

Appendix E2 describes the results of Principal Component Analysis with the Eigenvalues for Moderators Variables.

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	**3,284**	**23,458**	**23,458**
2	**1,684**	**12,027**	**35,484**
3	**1,452**	**10,374**	**45,858**
4	**1,231**	**8,789**	**54,648**
5	**1,190**	**8,502**	**63,150**
6	**1,017**	**7,267**	**70,417**
7	,861	6,147	76,564
8	,730	5,217	81,781
9	,581	4,151	85,932
10	,534	3,813	89,745
11	,446	3,188	92,933
12	,382	2,729	95,662
13	,306	2,187	97,848
14	,301	2,152	100,000

APPENDIX F: SYNTAX TO PERFORM PARALLEL ANALYSIS IN SPSS

In this appendix, the SPSS scripts for performing the Parallel Analysis are presented. The following article provides more information on the script: O'Connor. B. P. (2000). SPSS and SAS programs for determining the number of components using parallel analysis and Velicer's MAP test, Behavior Research Methods, Instrumentation and Computers. 32. 396-402.

*** Parallel Analysis Program For Raw Data and Data Permutations.**

* To run this program, you need to first specify the data for analysis and then RUN, all at once, the commands from the MATRIX statement to the END MATRIX statement.

* This program conducts parallel analyses on data files in which the rows of the data matrix are cases/individuals and the columns are variables; Data are read/entered into the program using the GET command (see the GET command below); The GET command reads an SPSS data file. which can be either the current. active SPSS data file or a previously saved data file; A valid filename/location must be specified on the GET command; A subset of variables for the analyses can be specified by using the "/ VAR =" subcommand with the GET statement; There can be no missing values.

* You must also specify:

the # of parallel data sets for the analyses; the desired percentile of the distribution and random data eigenvalues; whether principal components analyses or principal axis/common factor analysis are to be conducted. and whether normally distributed random data generation or permutations of the raw data set are to be used in the parallel analyses.

* Permutations of the raw data set can be time consuming;

Each parallel data set is based on column-wise random shuffling of the values in the raw data matrix using Castellan's (1992. BRMIC. 24. 72-77) algorithm; The distributions of the original raw variables are exactly preserved in the shuffled versions used in the parallel analyses; Permutations of the raw data set are thus highly accurate and most relevant. especially in cases where the raw data are not normally distributed or when they do not meet the assumption of multivariate normality (see Longman & Holden. 1992. BRMIC. 24. 493. for a Fortran version); If you would like to go this route. it is perhaps best to (1) first run a normally distributed random data generation parallel analysis to familiarize yourself with the program and to get a ballpark reference point for the number of factors/components; (2) then run a permutations of the raw data parallel analysis using a small number of datasets (e.g.. 100). just to see how long the program takes to run; then (3) run a permutations of the raw data parallel analysis using the number of parallel data sets that you would like use for your final analyses; 1000 datasets are usually sufficient. although more datasets should be used if there are close calls.

* These next commands generate artificial raw data (500 cases) that can be used for a trial-run of the program. instead of using your own raw data; Just select and run this whole file; However. make sure to delete the artificial data commands before attempting to run your own data.

```
set mxloops=9000 printback=off width=80  seed = 1953125.
matrix.
* Enter the name/location of the data file for analyses after "FILE =";
  If you specify "FILE = *". then the program will read the current.
  active SPSS data file; Alternatively. enter the name/location
  of a previously saved SPSS data file instead of "*";
  you can use the "/ VAR =" subcommand after "/ missing=omit"
  subcommand to select variables for the analyses.
GET raw / FILE = * / missing=omit / VAR = q1 to Q31.
* Enter the desired number of parallel data sets here.
compute ndatsets = 1000.
* Enter the desired percentile here.
compute percent  = 95.
* Enter either
  1 for principal components analysis. or
  2 for principal axis/common factor analysis.
compute kind = 1 .

* Enter either
  1 for normally distributed random data generation parallel analysis. or
  2 for permutations of the raw data set.
compute randtype = 1.

****************** End of user specifications. ******************
compute ncases   = nrow(raw).
compute nvars    = ncol(raw).

* principal components analysis & random normal data generation.
do if (kind = 1 and randtype = 1).
compute nm1 = 1 / (ncases-1).
compute vcv = nm1 * (sscp(raw) - ((t(csum(raw))*csum(raw))/ncases)).
compute d = inv(mdiag(sqrt(diag(vcv)))).
compute realeval = eval(d * vcv * d).
compute evals = make(nvars.ndatsets.-9999).
loop #nds = 1 to ndatsets.
compute x = sqrt(2 * (ln(uniform(ncases.nvars)) * -1) ) &*
          cos(6.283185 * uniform(ncases.nvars) ).
compute vcv = nm1 * (sscp(x) - ((t(csum(x))*csum(x))/ncases)).
compute d = inv(mdiag(sqrt(diag(vcv)))).
compute evals(:.#nds) = eval(d * vcv * d).
end loop.
end if.

* principal components analysis & raw data permutation.
```

```
do if (kind = 1 and randtype = 2).
compute nm1 = 1 / (ncases-1).
compute vcv = nm1 * (sscp(raw) - ((t(csum(raw))*csum(raw))/ncases)).
compute d = inv(mdiag(sqrt(diag(vcv)))).
compute realeval = eval(d * vcv * d).
compute evals = make(nvars.ndatsets.-9999).
loop #nds = 1 to ndatsets.
compute x = raw.
loop #c = 1 to nvars.
loop #r = 1 to (ncases -1).
compute k = trunc( (ncases - #r + 1) * uniform(1.1) + 1 )  + #r - 1.
compute d = x(#r.#c).
compute x(#r.#c) = x(k.#c).
compute x(k.#c) = d.
end loop.
end loop.
compute vcv = nm1 * (sscp(x) - ((t(csum(x))*csum(x))/ncases)).
compute d = inv(mdiag(sqrt(diag(vcv)))).
compute evals(:.#nds) = eval(d * vcv * d).
end loop.
end if.
* PAF/common factor analysis & random normal data generation.
do if (kind = 2 and randtype = 1).
compute nm1 = 1 / (ncases-1).
compute vcv = nm1 * (sscp(raw) - ((t(csum(raw))*csum(raw))/ncases)).
compute d = inv(mdiag(sqrt(diag(vcv)))).
compute cr = (d * vcv * d).
compute smc = 1 - (1 &/ diag(inv(cr)) ).
call setdiag(cr.smc).
compute realeval = eval(cr).
compute evals = make(nvars.ndatsets.-9999).
compute nm1 = 1 / (ncases-1).
loop #nds = 1 to ndatsets.
compute x = sqrt(2 * (ln(uniform(ncases.nvars)) * -1) ) &*
        cos(6.283185 * uniform(ncases.nvars) ).
compute vcv = nm1 * (sscp(x) - ((t(csum(x))*csum(x))/ncases)).
compute d = inv(mdiag(sqrt(diag(vcv)))).
compute r = d * vcv * d.
compute smc = 1 - (1 &/ diag(inv(r)) ).
call setdiag(r.smc).
compute evals(:.#nds) = eval(r).
end loop.
end if.
* PAF/common factor analysis & raw data permutation.
```

```
do if (kind = 2 and randtype = 2).
compute nm1 = 1 / (ncases-1).
compute vcv = nm1 * (sscp(raw) - ((t(csum(raw))*csum(raw))/ncases)).
compute d = inv(mdiag(sqrt(diag(vcv)))).
compute cr = (d * vcv * d).
compute smc = 1 - (1 &/ diag(inv(cr)) ).
call setdiag(cr.smc).
compute realeval = eval(cr).
compute evals = make(nvars.ndatsets.-9999).
compute nm1 = 1 / (ncases-1).
loop #nds = 1 to ndatsets.
compute x = raw.
loop #c = 1 to nvars.
loop #r = 1 to (ncases -1).
compute k = trunc( (ncases - #r + 1) * uniform(1.1) + 1 )  + #r - 1.
compute d = x(#r.#c).
compute x(#r.#c) = x(k.#c).
compute x(k.#c) = d.
end loop.
end loop.
compute vcv = nm1 * (sscp(x) - ((t(csum(x))*csum(x))/ncases)).
compute d = inv(mdiag(sqrt(diag(vcv)))).
compute r = d * vcv * d.
compute smc = 1 - (1 &/ diag(inv(r)) ).
call setdiag(r.smc).
compute evals(:.#nds) = eval(r).
end loop.
end if.
* identifying the eigenvalues corresponding to the desired percentile.
compute num = rnd((percent*ndatsets)/100).
compute results = { t(1:nvars). realeval. t(1:nvars). t(1:nvars) }.
loop #root = 1 to nvars.
compute ranks = rnkorder(evals(#root.:)).
loop #col = 1 to ndatsets.
do if (ranks(1.#col) = num).
compute results(#root.4) = evals(#root.#col).
break.
end if.
end loop.
end loop.
compute results(:.3) = rsum(evals) / ndatsets.
print /title="PARALLEL ANALYSIS:".
do if (kind = 1 and randtype = 1).
print /title="Principal Components & Random Normal Data Generation".
```

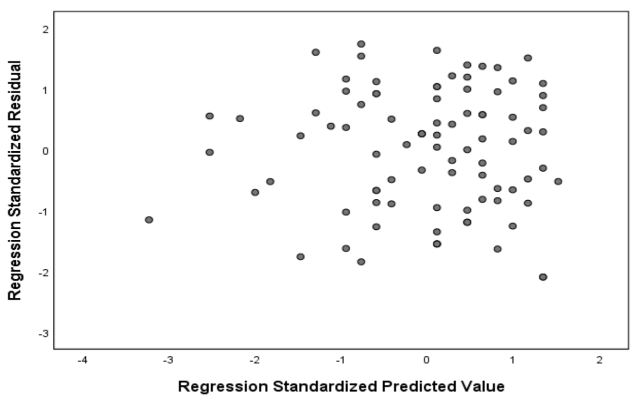
```
else if (kind = 1 and randtype = 2).
print /title="Principal Components & Raw Data Permutation".
else if (kind = 2 and randtype = 1).
print /title="PAF/Common Factor Analysis & Random Normal Data Generation".
else if (kind = 2 and randtype = 2).
print /title="PAF/Common Factor Analysis & Raw Data Permutation".
end if.
compute specifs = {ncases; nvars; ndatsets; percent}.
print specifs /title="Specifications for this Run:"
 /rlabels="Ncases" "Nvars" "Ndatsets" "Percent".
print results
 /title="Raw Data Eigenvalues. & Mean & Percentile Random Data Eigenvalues"
 /clabels="Root" "Raw Data" "Means" "Prcntyle"  /format "f12.6".
do if   (kind = 2).
print / space = 1.
print /title="Warning: Parallel analyses of adjusted correlation matrices".
print /title="eg. with SMCs on the diagonal. tend to indicate more factors".
print /title="than warranted (Buja. A.. & Eyuboglu. N.. 1992. Remarks on parallel".
print /title="analysis. Multivariate Behavioral Research. 27. 509-540.).".
print /title="The eigenvalues for trivial. negligible factors in the real".
print /title="data commonly surpass corresponding random data eigenvalues".
print /title="for the same roots. The eigenvalues from parallel analyses".
print /title="can be used to determine the real data eigenvalues that are".
print /title="beyond chance. but additional procedures should then be used".
print /title="to trim trivial factors.".
print / space = 2.
print /title="Principal components eigenvalues are often used to determine".
print /title="the number of common factors. This is the default in most".
print /title="statistical software packages. and it is the primary practice".
print /title="in the literature. It is also the method used by many factor".
print /title="analysis experts. including Cattell. who often examined".
print /title="principal components eigenvalues in his scree plots to determine".
print /title="the number of common factors. But others believe this common".
print /title="practice is wrong. Principal components eigenvalues are based".
print /title="on all of the variance in correlation matrices. including both".
print /title="the variance that is shared among variables and the variances".
print /title="that are unique to the variables. In contrast. principal".
print /title="axis eigenvalues are based solely on the shared variance".
print /title="among the variables. The two procedures are qualitatively".
print /title="different. Some therefore claim that the eigenvalues from one".
print /title="extraction method should not be used to determine".
print /title="the number of factors for the other extraction method.".
print /title="The issue remains neglected and unsettled.".
end if.
```

```
compute root     = results(:.1).
compute rawdata = results(:.2).
compute percntyl = results(:.4).
save results /outfile= 'screedata.sav' / var=root rawdata means percntyl .
end matrix.
* plots the eigenvalues. by root. for the real/raw data and for the random data.
GET file= 'screedata.sav'.
TSPLOT VARIABLES= rawdata means percntyl /ID= root /NOLOG.
```

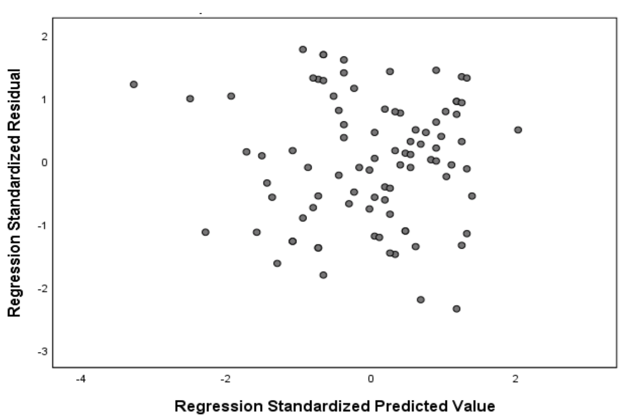
APPENDIX G: RESIDUAL PLOTS OF THE VARIABLES USED IN THE REGRESSION ANALYSIS

In this appendix, the residual plots are generated for three independent variables (innovation strategy, knowledge development and dissemination, and finance mobilization); one moderator (absorptive capacity); control variables (team size, NTBF's age, and the level of innovativeness); and the performance of the NTBFs as an independent variable. The plots use Standardized Residuals (Y-axis) and Standardized Predicted Value (X-axis). Below, the seven residual plots are depicted.

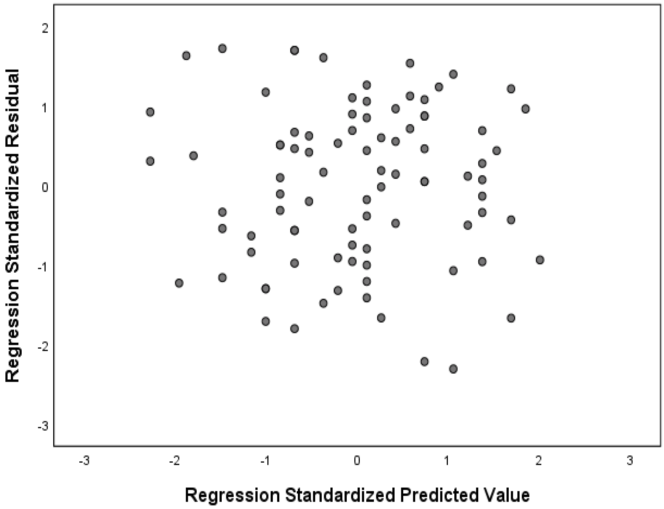
K1: Innovation Strategy on the Performance of the NTBFs



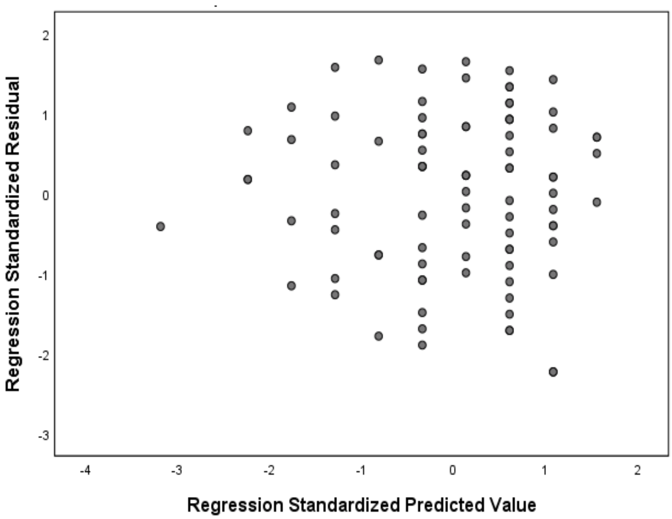
K2: Knowledge development and dissemination on the performance of the NTBFs



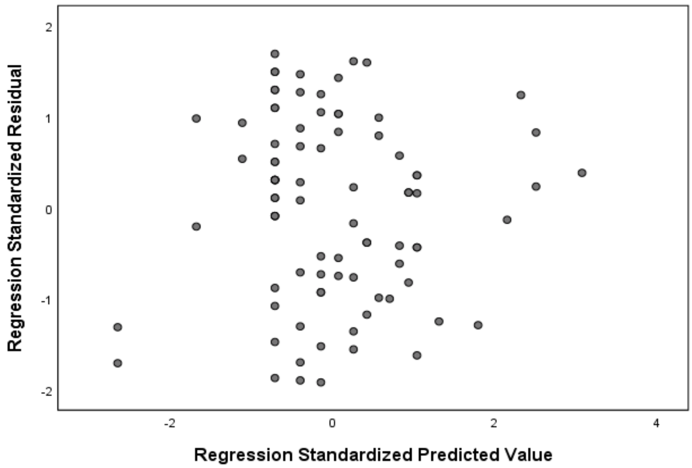
K3: Finance Mobilization on the Performance of the NTBFs



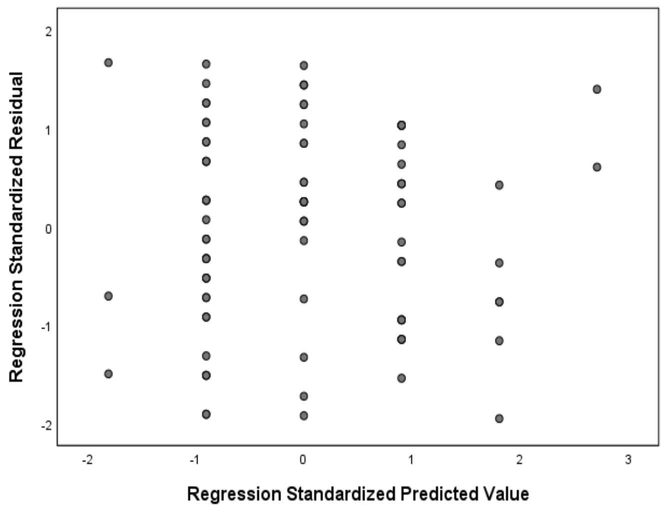
K4: Absorptive Capacity on the Performance of the NTBFs



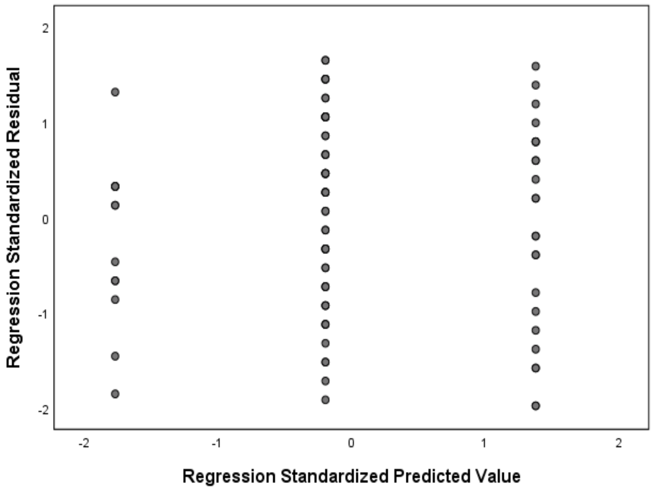
K5: The size of the NTBFs on the Performance of the NTBFs



K6: NTBF's Age on the performance of the NTBFs



K7: The Level of Innovativeness on the Performance of the NTBFs



APPENDIX H: RESULTS OF COMMON METHOD BIAS

Appendix H describes the results of Herman's Single Factor Test associated with common method bias.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9,381	18,393	18,393	9,381	18,393	18,393
2	4,119	8,076	26,469			
3	3,538	6,937	33,406			
4	3,194	6,263	39,669			
5	2,748	5,387	45,057			
6	2,115	4,146	49,203			
7	2,019	3,960	53,163			
8	1,846	3,619	56,782			
9	1,691	3,316	60,098			
10	1,538	3,016	63,114			
11	1,317	2,583	65,697			
12	1,276	2,501	68,198			
13	1,197	2,348	70,546			
14	1,178	2,311	72,857			
15	1,106	2,168	75,025			
16	,952	1,867	76,891			
17	,940	1,842	78,734			
18	,820	1,607	80,341			
19	,791	1,551	81,892			
20	,709	1,390	83,283			
21	,651	1,277	84,560			
22	,638	1,250	85,810			
23	,560	1,099	86,909			
24	,536	1,050	87,959			
25	,525	1,029	88,989			
26	,482	,946	89,935			
27	,459	,899	90,834			
28	,435	,852	91,686			
29	,417	,818	92,504			
30	,368	,722	93,227			
31	,326	,640	93,866			
32	,323	,634	94,500			
33	,308	,604	95,105			

34	,280	,550	95,654			
35	,264	,518	96,172			
36	,240	,471	96,643			
37	,199	,390	97,033			
38	,190	,373	97,405			
39	,176	,346	97,751			
40	,165	,324	98,075			
41	,147	,288	98,363			
42	,137	,268	98,631			
43	,125	,245	98,875			
44	,114	,223	99,098			
45	,093	,183	99,281			
46	,086	,169	99,450			
47	,081	,159	99,609			
48	,065	,127	99,736			
49	,056	,111	99,846			
50	,044	,087	99,933			
51	,034	,067	100,000			

Extraction Method: Principal Component Analysis.

Summary

Currently, the Business Incubator (BI) is a well-known phenomenon. It is well understood as a means to support New Technology-Based Firms (NTBFs), particularly in the early stage when the NTBF is in its development phase. BIs provide supportive services to accelerate their growth. However, there is still a scarcity of investigations and reliable evidence on the effectiveness support by BIs on the performance of NTBFs (see Hackett and Dilts, 2004; Eveleens et al., 2017; van Weele et al., 2017; Lukeš et al., 2019). As a result, BIs attract a considerable amount of attention from scholars around this research gap. In addition, the role of NTBFs' capabilities in making usage of support by BIs is almost neglected. Thus, in our study, we aim to address this gap and develop a model to evaluate the impact of support by BIs on the performances of NTBFs and consider the moderating role of NTBF's capabilities.

Considering the fact that there is a paucity in previous studies on the influence of the supports by BIs on the performance of the NTBFs, we formulate following problem statement (PS) in chapter 1. *How can business incubators support their NTBFs effectively?* Guided by three research questions (RQ1 - RQ3), a seven-stage methodology is applied to find an answer to our PS. Stage 1 reviews a theoretical study and related previous investigations. Stages 2 identifies the supportive activities by university-based business incubators BIs. Stage 3 operationalizes the supportive activities construct of the BIs. Stage 4 validates the construct of the BIs. Stage 5 implements the construct of the BIs. Finally, stages 6 and 7 are part of the usual scientific procedure of analyzing the results, establishing the findings (i.e., discussion), and formulating the conclusion.

Chapter 2 reviews previous investigations and literature related to the context of incubation and NTBFs. The chapter describes four theoretical perspectives (resource-based view, social capital theory, knowledge-based view, and organizational learning theory). They are candidates for further investigations and therefore tentatively listed,

applied and tested. This chapter concluded that resource-based view is an appropriate theoretical perspective to investigate the impact of BIs on the performance of the NTBFs.

Chapter 3 addresses *RQ1*: *What are the main supportive activities offered by BIs that influence the performance of an NTBF?* The answer is based on an explorative study. As a first step, a systematic literature review is conducted to explore the identified supports by BIs in prior investigations. Then, a combination of observations and eleven semi-structured in-depth interviews were conducted with the founders of NTBFs in BIs to explore the supportive activities of the UBIs from the NTBFs' perspectives. The results show that the main supportive activities of BIs are classified into five groups: *(1) access to their networks, (2) growth control, (3) knowledge development and dissemination, (4) finance and administrative mobilization, and (5) creation of exposure.*

Chapter 4 provides a partial answer to *RQ2*: *How can the supportive activities be operationalized in a construct that enables us to measure the impact of the identified supportive activities by BIs on the performance of an NTBF?* In this chapter, we developed our theoretical model which explains the relation between the supports by BIs, the performances of the NTBFs, and their innovation strategy. Meanwhile, the moderating role of NTBFs' capabilities on the relation between the support by BIs and the performance of the NTBFs, is depicted. Subsequently the model is operationalized and the measurement scales for each variable have been addressed.

Chapter 5 presents a conclusive answer to RQ2 by statistically evaluating the validity and reliability of the dimensions of the construct. The procedure includes four-step variable reduction procedure. *First*, the correlation matrix, Kaiser-Meyer-Olkin index and Bartlett's test of Sphericity are conducted to check whether the data is appropriate for the Principal Component Analysis. *Second*, the Principal Component Analysis is performed in order to extract the components from the data. *Third*, Promax Rotation on the independent variables and the Varimax Rotation Method are performed to extract the items with an acceptable validity for further analysis. As a result of these three levels, the validity of the constructs has been checked. *Fourth*, Cronbach's Alpha coefficients and Composite Reliability are calculated to evaluate the reliability of the component solution. The results of this four-step procedure show that innovation strategy, absorptive capacity, knowledge development and dissemination, and finance mobilization retained.

Chapter 6 gives answer to RQ3*: In what way are the identified supportive activities related to (a) the innovation strategy of the NTBFs and consequently to (b) the performance of an NTBF?* To provide an answer to this RQ, we distributed a questionnaire to the Dutch and German NTBFs. Then, through the multiple regression analysis method, we analyze the answers of 96 (co-)founders. The results demonstrate that knowledge development and dissemination have a positive impact on the performance of the NTBFs. However, our data could not support that finance mobilization has impact on the performance of the NTBFs. The findings also show that absorptive capacity can amplify the relation between support by BIs and the performance of the NTBFs.

Chapter 7 provides answers to the three research questions (RQs) and to the problem statement (PS). The answers are based on the results of regression analysis conducted in Chapter 6. From the answers to the RQs, we may conclude that the empirical model provides a clear evidence that knowledge development and dissemination are positively associated with the performances of NTBFs. In addition, the model shows that knowledge development and dissemination are amplified with the effect of absorptive capacity. The obtained results suggest that BIs can provide their supports more effectively via: (1) providing more tailored and customized services on training, coaching, and mentoring; (2) intervening more strongly through the growth process of their NTBFs and help the NTBFs develop their absorptive capacity to identify and utilize knowledge resources; (3) train their NTBFs to enrichen their absorptive capacity to be more independent from incubators and have stronger ability to utilize external knowledge resources both during their incubation process and post-incubation. In the end, this chapter gives (a) the implications for researchers and practitioners, (b) explains the limitations of the research, and (c) provides recommendations for future research.

Samenvatting

Momenteel is de Business Incubator (BI) een bekend fenomeen. Het wordt goed begrepen als een middel om op nieuwe technologie gebaseerde bedrijven (NTBFs) te ondersteunen, vooral in het vroege stadium wanneer de NTBF zich in de ontwikkelingsfase bevindt. BI's bieden ondersteunende diensten om de groei van een NTBF te versnellen. Er is echter nog steeds een schaarste aan onderzoeksresultaten en betrouwbaar bewijs over de effectiviteit van de ondersteuning door BI's in relatie tot de prestaties van NTBF's (zie Hackett en Dilts, 2004; Eveleens et al., 2017; van Weele et al., 2017; Lukeš et al., 2019). Als gevolg hiervan trekken BI's een aanzienlijke hoeveelheid aandacht van wetenschappers rond de onderzoeksvraag: hoe kunnen we de onderzoekskloof dichten? Bovendien wordt de rol van de mogelijkheden van NTBF's bij het benutten van de ondersteuning door BI's niet erg gesteund, sterker nog bijna genegeerd. Daarom proberen we in ons onderzoek deze kloof te dichten door (1) een model te ontwikkelen om de impact van ondersteuning door BI's op de prestaties van NTBF's te evalueren en (2) om de modererende rol van de capaciteiten van NTBF in overweging te nemen.

Gezien het feit dat er in eerdere studies een gebrek is aangetoond aan positieve invloed van de ondersteuningen door BI's op de prestaties van de NTBF's, formuleren we in hoofdstuk 1 de volgende probleemstelling (PS). Hoe kunnen incubators hun NTBF's effectief ondersteunen? Geleid door drie onderzoeksvragen (RQ1-RQ3), wordt een methodologie in zeven fasen toegepast om een adequaat antwoord op onze PS te vinden. Fase 1 geeft een overzicht van een theoretische studie en gerelateerde eerdere onderzoeken. Fase 2 identificeert de ondersteunende activiteiten van BI's van universitaire bedrijfsincubators. Fase 3 operationaliseert de ondersteunende activiteitenconstructie van de UBI's. Fase 4 valideert de constructie van de BI's. Fase 5 implementeert de constructie van de BI's. Ten slotte maken de fasen 6 en 7 deel uit van de gebruikelijke wetenschappelijke procedure om de resultaten te analyseren, de bevindingen vast te stellen (d.w.z. discussie) en de conclusie te formuleren.

Hoofdstuk 2 geeft een overzicht van eerdere onderzoeken en literatuur met betrekking tot de context van incubatie en NTBF's. Het hoofdstuk beschrijft vier theoretische perspectieven (resource-based view, social capital theory, knowledge-based view en organisational learning theory) die in eerdere onderzoeken voornamelijk toegepast werden in eigen beperkte onderzoek. In dit hoofdstuk werd geconcludeerd dat resource-based view een geschikt theoretisch perspectief is om de impact van BI's op de prestaties van de NTBF's te onderzoeken.

Hoofdstuk 3 behandelt *RQ1*: Wat zijn de belangrijkste ondersteunende activiteiten die BI's aanbieden die de prestaties van een NTBF beïnvloeden? Het antwoord is gebaseerd op een verkennend onderzoek. Als eerste stap wordt een systematisch literatuuronderzoek uitgevoerd om de geïdentificeerde ondersteuningen van BI's in eerdere onderzoeken te verkennen. Vervolgens werd een combinatie van observaties en elf semi-gestructureerde diepte-interviews afgenomen met de oprichters van NTBF's in de BI's om de ondersteunende activiteiten van de ubi's te verkennen vanuit het perspectief van de NTBF's. De resultaten laten zien dat de belangrijkste ondersteunende activiteiten van de BI's in vijf groepen zijn ingedeeld: *(1) toegang tot hun netwerken, (2) groeicontrole, (3) kennisontwikkeling en -verspreiding, (4) financiële en administratieve mobilisatie, en (5) het creëren van blootstelling.*

Hoofdstuk 4 geeft een gedeeltelijk antwoord op *RQ2*: Hoe kunnen de ondersteunende activiteiten worden geoperationaliseerd in een constructie die ons in staat stelt de impact te meten van de geïdentificeerde ondersteunende activiteiten door BI's op de prestaties van een NTBF? In dit hoofdstuk hebben we ons theoretische model ontwikkeld dat de relatie verklaart tussen de ondersteuningen door BI's, de prestaties van de NTBF's en hun innovatiestrategie. Ondertussen wordt de modererende rol van de capaciteiten van NTBF's op de relatie tussen de ondersteuning door UBI's en de prestaties van de NTBF's beschreven. Vervolgens is het model geoperationaliseerd en zijn de meetschalen per variabele geadresseerd.

Hoofdstuk 5 presenteert een sluitend antwoord op *RQ2* door de validiteit en betrouwbaarheid van de afmetingen van het construct statistisch te evalueren. De procedure omvat een procedure voor variabele reductie in vier stappen. Eerst worden de correlatiematrix, de Kaiser-Meyer-Olkin-index en Bartlett's sfericiteitstest uitgevoerd om te controleren of de gegevens geschikt zijn voor de Principal Component Analysis. Ten tweede wordt de Principal Component Analysis uitgevoerd om de componenten uit de gegevens te extraheren. Ten derde worden Promax-rotatie op de onafhankelijke variabelen en de Varimax-rotatiemethode uitgevoerd om de items met een aanvaardbare validiteit te extraheren voor verdere analyse. Als resultaat van deze drie niveaus is de validiteit van de constructen gecontroleerd. Ten vierde worden de alfa-coëfficiënten en samengestelde betrouwbaarheid van Cronbach berekend om de betrouwbaarheid van de componentoplossing te evalueren. De resultaten van deze procedure in vier stappen laten zien dat innovatiestrategie, opnamecapaciteit, kennisontwikkeling en -verspreiding en mobilisatie van financiële middelen behouden bleven.

Hoofdstuk 6 geeft antwoord op *RQ3*: Op welke manier zijn de geïdentificeerde ondersteunende activiteiten gerelateerd aan (a) de innovatiestrategie van de NTBF's en bijgevolg (b) de prestatie van een NTBF? Om een definitief antwoord te geven op deze RQ hebben we een vragenlijst uitgedeeld aan de Nederlandse en Duitse NTBF's. Vervolgens analyseren we via de meervoudige regressieanalysemethode de antwoorden van 96 (mede) oprichters. De resultaten laten zien dat kennisontwikkeling en -verspreiding een positieve invloed hebben op de prestaties van de NTBF's. Onze gegevens konden echter niet ondersteunen dat het mobiliseren van financiële middelen invloed heeft op de prestaties van de NTBF's. De bevindingen laten ook zien dat het absorptievermogen de relatie tussen ondersteuning door BI's en de prestaties van de NTBF's kan versterken.

Hoofdstuk 7 geeft antwoord op de drie onderzoeksvragen (RQ's) en op de probleemstelling (PS). De antwoorden zijn gebaseerd op de resultaten van regressieanalyse uitgevoerd in Hoofdstuk 6. Uit de antwoorden op de RQ's kunnen we concluderen dat het empirische model een duidelijk bewijs levert dat kennisontwikkeling en -verspreiding positief geassocieerd zijn met de prestaties van NTBF's. Daarnaast laat het model zien dat kennisontwikkeling en -verspreiding wordt versterkt met het effect van absorptievermogen. De verkregen resultaten suggereren dat BI's hun ondersteuning effectiever kunnen aanbieden door: (1) meer op maat gemaakte en aangepaste diensten te bieden op het gebied van training, coaching en mentoring; (2) sterker ingrijpen door het groeiproces van hun NTBF's en de NTBF's helpen hun absorptievermogen te ontwikkelen om kennisbronnen te identificeren en te gebruiken; (3) hun NTBF's trainen om hun absorptiecapaciteit te verrijken om onafhankelijker te zijn van incubators en een sterker vermogen te hebben om externe kennisbronnen te gebruiken, zowel tijdens hun incubatieproces als na de incubatie. Dit hoofdstuk geeft uiteindelijk (a) de implicaties voor onderzoekers en praktijkmensen, (b) legt de beperkingen van het onderzoek uit en (c) geeft aanbevelingen voor toekomstig onderzoek.

Curriculum Vitae

Negin Samaeemofrad was born in Tehran, Iran on August 1, 1986. She earned her Bachelor's diploma in the field of Industrial Management in 2008 and received her Master's in Technology and Innovation Management in 2012.

Following her graduation, she started to work as an international coordinator in an NGO and an innovation consultant in a consultancy firm in Iran. Then she applied for Ph.D. in Leiden University, the Netherlands, in the field of ICT in Business in the department of Advanced Computer Science. She also obtained a Marie Curie Fellowship and was accepted as an external researcher at Leiden University. While she worked on her Ph.D., she collaborated with different business incubators and accelerators as a start-up trainer and coach. Currently, she is working in Gemeente Den Haag as a data analyst.

List of Publications

Samaeemofrad, N., and van den Herik, H.J. (2020). **A Moderating Role of Absorptive Capacity within Incubation Support.** In the proceedings of the 2020 ICE/ITMC International Virtual Conference, 2020 (IEEE Xplore).

Samaeemofrad, N., and van den Herik, H.J. (2018). **The Effectiveness of Finance Mobilization by Business Incubators on the Performance of NTBFs**. In the proceedings of the 2018 ICE/ITMC International Conference, Stuttgart, Germany 2018 (IEEE Xplore).

Samaeemofrad, N., and van den Herik, H. J. (2018). **The Relation between Support by Business Incubators and Performance of NTBFs**. In the proceedings of the 2018 ICE/ITMC International Conference, Stuttgart, Germany 2018 (IEEE Xplore).

Heere, M., Samaeemofrad, N., and Verburg R. (2017). **Collaboration between University and Practice, Examples and Reflections**, EAWOP Symposium, Dublin, Ireland.

Samaeemofrad, N., van den Herik, H. J., and Verburg, R. (2016). **A New Perspective on Business Incubators.** In the proceedings of the 2016 ICE/ITMC International Conference, Trondheim, Norway 2016 (IEEE Xplore).

Samaeemofrad, N., Dedehayir, O., and Katzy, B.R. (2016) First Chapter of '**Handbooks on Networks in Innovation and Crisis Management; Theory and Practice in a Dynamic and Disruptive Environment'**. (2016). Title: Towards the Typology of Career Paths for Technology and Innovation Management Professionals within Crisis Management Realm.

Samaeemofrad, N., Dedehayir, O., Katzy, B.R., and Verburg, R. (2015). **Towards the Actors' Occupational Movements of Technical Innovation System.** ICE-IEEE Conference 2015, Belfast, Northern Island.

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Soon after that grim incident of professor Katzy's passing away, I was privileged to meet a new promotor, Professor Jaap van den Herik. Without his support and guidance, I would not have been able to complete my research. Words fail to describe his support during my research, which definitely crossed the boundaries of my own ideas on the new research topic. He is not just a supervisor but a real mentor who helped me to develop my skills and transformed me into a dedicated researcher. He mentally supported me to overcome challenges not only in this new research field but also in my life. Not every candidate is so lucky to have a promotor like him. I owe many thanks to Jaap van den Herik for teaching me how to structure and write scientific texts, be accurate in my work, develop my analytical and writing skills, and qualify myself as a researcher and data analyst.

Our team was broadened by my second promotor, Professor Simcha Jong Kon Chin. I would also like to give a special word of thanks to Simcha Jong for providing me with great guidance and constructive feedback throughout my Ph.D. process.

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29. Dennis Reidsma (UT) *Annotations and Subjective Machines - Of Annotators, Embodied Agents, Users, and Other Humans*
30. Wouter van Atteveldt (VU) *Semantic Network Analysis: Techniques for Extracting, Representing and Querying Media Content*
31. Loes Braun (UM) *Pro-Active Medical Information Retrieval*
32. Trung H. Bui (UT) *Toward Affective Dialogue Management using Partially Observable Markov Decision Processes*
33. Frank Terpstra (UvA) *Scientific Workflow Design; theoretical and practical issues*
34. Jeroen de Knijf (UU) *Studies in Frequent Tree Mining*
35. Ben Torben Nielsen (UvT) *Dendritic morphologies: function shapes structure*

2009

1. Rasa Jurgelenaite (RUN) *Symmetric Causal Independence Models*
2. Willem Robert van Hage (VU) *Evaluating Ontology-Alignment Techniques*
3. Hans Stol (UvT) *A Framework for Evidence-based Policy Making Using IT*
4. Josephine Nabukenya (RUN) *Improving the Quality of Organisational Policy Making using Collaboration Engineering*
5. Sietse Overbeek (RUN) *Bridging Supply and Demand for Knowledge Intensive Tasks - Based on Knowledge, Cognition, and Quality*
6. Muhammad Subianto (UU) *Understanding Classification*
7. Ronald Poppe (UT) *Discriminative Vision-Based Recovery and Recognition of Human Motion*
8. Volker Nannen (VU) *Evolutionary Agent-Based Policy Analysis in Dynamic Environments*
9. Benjamin Kanagwa (RUN) *Design, Discovery and Construction of Service-oriented Systems*
10. Jan Wielemaker (UvA) *Logic programming for knowledge-intensive interactive applications*
11. Alexander Boer (UvA) *Legal Theory, Sources of Law & the Semantic* Web
12. Peter Massuthe (TU/e, Humboldt-Universitaet zu Berlin) *Operating Guidelines for Services*
13. Steven de Jong (UM) *Fairness in Multi-Agent Systems*
14. Maksym Korotkiy (VU) *From ontology-enabled services to service-enabled ontologies (making ontologies work in e-science with ONTO-SOA*)
15. Rinke Hoekstra (UvA) *Ontology Representation - Design Patterns and Ontologies that Make Sense*
16. Fritz Reul (UvT) *New Architectures in Computer Chess*
17. Laurens van der Maaten (UvT) *Feature Extraction from Visual Data*
18. Fabian Groffen (CWI) *Armada, An Evolving Database System*
19. Valentin Robu (CWI) *Modeling Preferences, Strategic Reasoning and Collaboration in Agent-Mediated Electronic Markets*
20. Bob van der Vecht (UU) *Adjustable Autonomy: Controling Influences on Decision Making*
21. Stijn Vanderlooy (UM) *Ranking and Reliable Classification*
22. Pavel Serdyukov (UT) *Search For Expertise: Going beyond direct evidence*
23. Peter Hofgesang (VU) *Modelling Web Usage in a Changing Environment*
24. Annerieke Heuvelink (VU) *Cognitive Models for Training Simulations*
25. Alex van Ballegooij (CWI) *"RAM: Array Database Management through Relational Mapping"*
26. Fernando Koch (UU) *An Agent-Based Model for the Development of Intelligent Mobile Services*
27. Christian Glahn (OU) *Contextual Support of social Engagement and Reflection on the Web*
28. Sander Evers (UT) *Sensor Data Management with Probabilistic Models*

29. Stanislav Pokraev (UT) *Model-Driven Semantic Integration of Service-Oriented Applications*
30. Marcin Zukowski (CWI) *Balancing vectorized query execution with bandwidth-optimized storage*
31. Sofiya Katrenko (UvA) *A Closer Look at Learning Relations from Text*
32. Rik Farenhorst (VU) and Remco de Boer (VU) *Architectural Knowledge Management: Supporting Architects and Auditors*
33. Khiet Truong (UT) *How Does Real Affect Affect Affect Recognition In Speech?*
34. Inge van de Weerd (UU) *Advancing in Software Product Management: An Incremental Method Engineering Approach*
35. Wouter Koelewijn (UL) *Privacy en Politiegegevens; Over geautomatiseerde normatieve informatie-uitwisseling*
36. Marco Kalz (OU) *Placement Support for Learners in Learning Networks*
37. Hendrik Drachsler (OU) *Navigation Support for Learners in Informal Learning Networks*
38. Riina Vuorikari (OU) *Tags and self-organisation: a metadata ecology for learning resources in a multilingual context*
39. Christian Stahl (TU/e, Humboldt-Universitaet zu Berlin) *Service Substitution* -- *A Behavioral Approach Based on Petri Nets*
40. Stephan Raaijmakers (UvT) *Multinomial Language Learning: Investigations into the Geometry of Language*
41. Igor Berezhnyy (UvT) *Digital Analysis of Paintings*
42. Toine Bogers (UvT) *Recommender Systems for Social Bookmarking*
43. Virginia Nunes Leal Franqueira (UT) *Finding Multi-step Attacks in Computer Networks using Heuristic Search and Mobile Ambients*
44. Roberto Santana Tapia (UT) *Assessing Business-IT Alignment in Networked Organizations*
45. Jilles Vreeken (UU) *Making Pattern Mining Useful*
46. Loredana Afanasiev (UvA) *Querying XML: Benchmarks and Recursion*

2010

1. Matthijs van Leeuwen (UU) *Patterns that Matter*
2. Ingo Wassink (UT) *Work flows in Life Science*
3. Joost Geurts (CWI) *A Document Engineering Model and Processing Framework for Multimedia documents*
4. Olga Kulyk (UT) *Do You Know What I Know? Situational Awareness of Co-located Teams in Multidisplay Environments*
5. Claudia Hauff (UT) *Predicting the Effectiveness of Queries and Retrieval Systems*
6. Sander Bakkes (UvT) *Rapid Adaptation of Video Game AI*
7. Wim Fikkert (UT) *Gesture interaction at a Distance*

8. Krzysztof Siewicz (UL) *Towards an Improved Regulatory Framework of Free Software. Protecting user freedoms in a world of software communities and eGovernments*
9. Hugo Kielman (UL) *A Politiele gegevensverwerking en Privacy, Naar een effectieve waarborging*
10. Rebecca Ong (UL) *Mobile Communication and Protection of Children*
11. Adriaan Ter Mors (TUD) *The world according to MARP: Multi-Agent Route Planning*
12. Susan van den Braak (UU) *Sensemaking software for crime analysis*
13. Gianluigi Folino (RUN) *High Performance Data Mining using Bio-inspired techniques*
14. Sander van Splunter (VU) *Automated Web Service Reconfiguration*
15. Lianne Bodenstaff (UT) *Managing Dependency Relations in Inter-Organizational Models*
16. Sicco Verwer (TUD) *Efficient Identification of Timed Automata, theory and practice*
17. Spyros Kotoulas (VU) *Scalable Discovery of Networked Resources: Algorithms, Infrastructure, Applications*
18. Charlotte Gerritsen (VU) *Caught in the Act: Investigating Crime by Agent-Based Simulation*
19. Henriette Cramer (UvA) *People's Responses to Autonomous and Adaptive Systems*
20. Ivo Swartjes (UT) *Whose Story Is It Anyway? How Improv Informs Agency and Authorship of Emergent Narrative*
21. Harold van Heerde (UT) *Privacy-aware data management by means of data degradation*
22. Michiel Hildebrand (CWI) *End-user Support for Access to\\ Heterogeneous Linked Data*
23. Bas Steunebrink (UU) *The Logical Structure of Emotions*
24. Dmytro Tykhonov (TUD) *Designing Generic and Efficient Negotiation Strategies*
25. Zulfiqar Ali Memon (VU) *Modelling Human-Awareness for Ambient Agents: A Human Mindreading Perspective*
26. Ying Zhang (CWI) *XRPC: Efficient Distributed Query Processing on Heterogeneous XQuery Engines*
27. Marten Voulon (UL) *Automatisch contracteren*
28. Arne Koopman (UU) *Characteristic Relational Patterns*
29. Stratos Idreos(CWI) *Database Cracking: Towards Auto-tuning Database Kernels*
30. Marieke van Erp (UvT) *Accessing Natural History - Discoveries in data cleaning, structuring, and retrieval*
31. Victor de Boer (UvA) *Ontology Enrichment from Heterogeneous Sources on the Web*
32. Marcel Hiel (UvT) *An Adaptive Service Oriented Architecture: Automatically solving Interoperability Problems*
33. Robin Aly (UT) *Modeling Representation Uncertainty in Concept-Based Multimedia Retrieval*
34. Teduh Dirgahayu (UT) *Interaction Design in Service Compositions*

35. Dolf Trieschnigg (UT) *Proof of Concept: Concept-based Biomedical Information Retrieval*
36. Jose Janssen (OU) *Paving the Way for Lifelong Learning; Facilitating competence development through a learning path specification*
37. Niels Lohmann (TU/e) *Correctness of services and their composition*
38. Dirk Fahland (TU/e) *From Scenarios to components*
39. Ghazanfar Farooq Siddiqui (VU) *Integrative modeling of emotions in virtual agents*
40. Mark van Assem (VU) *Converting and Integrating Vocabularies for the Semantic Web*
41. Guillaume Chaslot (UM) *Monte-Carlo Tree Search*
42. Sybren de Kinderen (VU) *Needs-driven service bundling in a multi-supplier setting - the computational e3-service approach*
43. Peter van Kranenburg (UU) *A Computational Approach to Content-Based Retrieval of Folk Song Melodies*
44. Pieter Bellekens (TU/e) *An Approach towards Context-sensitive and User-adapted Access to Heterogeneous Data Sources, Illustrated in the Television Domain*
45. Vasilios Andrikopoulos (UvT) *A theory and model for the evolution of software services*
46. Vincent Pijpers (VU) *e3alignment: Exploring Inter-Organizational Business-ICT Alignment*
47. Chen Li (UT) *Mining Process Model Variants: Challenges, Techniques, Examples*
48. Withdrawn
49. Jahn-Takeshi Saito (UM) *Solving difficult game positions*
50. Bouke Huurnink (UvA) *Search in Audiovisual Broadcast Archives*
51. Alia Khairia Amin (CWI) *Understanding and supporting information seeking tasks in multiple sources*
52. Peter-Paul van Maanen (VU) *Adaptive Support for Human-Computer Teams: Exploring the Use of Cognitive Models of Trust and Attention*
53. Edgar Meij (UvA) *Combining Concepts and Language Models for Information Access*

2011

1. Botond Cseke (RUN) *Variational Algorithms for Bayesian Inference in Latent Gaussian Models*
2. Nick Tinnemeier (UU) *Organizing Agent Organizations. Syntax and Operational Semantics of an Organization-Oriented Programming Language*
3. Jan Martijn van der Werf (TU/e) *Compositional Design and Verification of Component-Based Information Systems*
4. Hado van Hasselt (UU) *Insights in Reinforcement Learning; Formal analysis and empirical evaluation of temporal-difference learning algorithms*
5. Base van der Raadt (VU) *Enterprise Architecture Coming of Age - Increasing the Performance of an Emerging Discipline*

6. Yiwen Wang (TU/e) *Semantically-Enhanced Recommendations in Cultural Heritage*
7. Yujia Cao (UT) *Multimodal Information Presentation for High Load Human Computer Interaction*
8. Nieske Vergunst (UU) *BDI-based Generation of Robust Task-Oriented Dialogues*
9. Tim de Jong (OU) *Contextualised Mobile Media for Learning*
10. Bart Bogaert (UvT) *Cloud Content Contention*
11. Dhaval Vyas (UT) *Designing for Awareness: An Experience-focused HCI Perspective*
12. Carmen Bratosin (TU/e) *Grid Architecture for Distributed Process Mining*
13. Xiaoyu Mao (UvT) *Airport under Control. Multiagent Scheduling for Airport Ground Handling*
14. Milan Lovric (EUR) *Behavioral Finance and Agent-Based Artificial Markets*
15. Marijn Koolen (UvA) *The Meaning of Structure: the Value of Link Evidence for Information* Retrieval
16. Maarten Schadd (UM) *Selective Search in Games of Different Complexity*
17. Jiyin He (UvA) *Exploring Topic Structure: Coherence, Diversity and Relatedness*
18. Mark Ponsen (UM) *Strategic Decision-Making in complex games*
19. Ellen Rusman (OU) *The Mind's Eye on Personal Profiles*
20. Qing Gu (VU) *Guiding service-oriented software engineering - A view-based approach*
21. Linda Terlouw (TUD) *Modularization and Specification of Service-Oriented Systems*
22. Junte Zhang (UvA) *System Evaluation of Archival Description and Access*
23. Wouter Weerkamp (UvA) *Finding People and their Utterances in Social Media*
24. Herwin van Welbergen (UT) *Behavior Generation for Interpersonal Coordination with Virtual Humans On Specifying, Scheduling and Realizing Multimodal Virtual Human Behavior*
25. Syed Waqar ul Qounain Jaffry (VU) *Analysis and Validation of Models for Trust Dynamics*
26. Matthijs Aart Pontier (VU) *Virtual Agents for Human Communication - Emotion Regulation and Involvement-Distance Trade-Offs in Embodied Conversational Agents and Robots*
27. Aniel Bhulai (VU) *Dynamic website optimization through autonomous management of design patterns*
28. Rianne Kaptein (UvA) *Effective Focused Retrieval by Exploiting Query Context and Document Structur*e
29. Faisal Kamiran (TU/e) *Discrimination-aware* Classification
30. Egon van den Broek (UT) *Affective Signal Processing (ASP): Unraveling the mystery of emotions*
31. Ludo Waltman (EUR) *Computational and Game-Theoretic Approaches for Modeling Bounded Rationality*

32. Nees-Jan van Eck (EUR) *Methodological Advances in Bibliometric Mapping of Science*
33. Tom van der Weide (UU) *Arguing to Motivate Decisions*
34. Paolo Turrini (UU) *Strategic Reasoning in Interdependence: Logical and Game-theoretical Investigations*
35. Maaike Harbers (UU) *Explaining Agent Behavior in Virtual Training*
36. Erik van der Spek (UU) *Experiments in serious game design: a cognitive approach*
37. Adriana Burlutiu (RUN) *Machine Learning for Pairwise Data, Applications for Preference Learning and Supervised Network Inference*
38. Nyree Lemmens (UM) *Bee-inspired Distributed Optimization*
39. Joost Westra (UU) *Organizing Adaptation using Agents in Serious Games*
40. Viktor Clerc (VU) *Architectural Knowledge Management in Global Software Development*
41. Luan Ibraimi (UT) *Cryptographically Enforced Distributed Data Access Control*
42. Michal Sindlar (UU) *Explaining Behavior through Mental State Attribution*
43. Henk van der Schuur (UU) *Process Improvement through Software Operation Knowledge*
44. Boris Reuderink (UT) *Robust Brain-Computer Interfaces*
45. Herman Stehouwer (UvT) *Statistical Language Models for Alternative Sequence Selection*
46. Beibei Hu (TUD) *Towards Contextualized Information Delivery: A Rule-based Architecture for the Domain of Mobile Police Work*
47. Azizi Bin Ab Aziz (VU) *Exploring Computational Models for Intelligent Support of Persons with Depression*
48. Mark Ter Maat (UT) *Response Selection and Turn-taking for a Sensitive Artificial Listening Agent*
49. Andreea Niculescu (UT) *Conversational interfaces for task-oriented spoken dialogues: design aspects influencing interaction quality*

2012

1. Terry Kakeeto (UvT) *Relationship Marketing for SMEs in Uganda*
2. Muhammad Umair (VU) *Adaptivity, emotion, and Rationality in Human and Ambient Agent Models*
3. Adam Vanya (VU) *Supporting Architecture Evolution by Mining Software Repositories*
4. Jurriaan Souer (UU) *Development of Content Management System-based Web Applications*
5. Marijn Plomp (UU) *Maturing Interorganisational Information Systems*
6. Wolfgang Reinhardt (OU) *Awareness Support for Knowledge Workers in Research Networks*
7. Rianne van Lambalgen (VU) *When the Going Gets Tough: Exploring Agent-based Models of Human Performance under Demanding Conditions*
8. Gerben de Vries (UvA) *Kernel Methods for Vessel Trajectories*
9. Ricardo Neisse (UT) *Trust and Privacy Management Support for Context-Aware Service*

Platforms

10. David Smits (TU/e) *Towards a Generic Distributed Adaptive Hypermedia Environment*
11. J.C.B. Rantham Prabhakara (TU/e) *Process Mining in the Large: Preprocessing, Discovery, and Diagnostics*
12. Kees van der Sluijs (TU/e) *Model Driven Design and Data Integration in Semantic Web Information Systems*
13. Suleman Shahid (UvT) *Fun and Face: Exploring non-verbal expressions of emotion during playful interactions*
14. Evgeny Knutov (TU/e) *Generic Adaptation Framework for Unifying Adaptive Web-based Systems*
15. Natalie van der Wal (VU) *Social Agents. Agent-Based Modelling of Integrated Internal and Social Dynamics of Cognitive and Affective Processes.*
16. Fiemke Both (VU) *Helping people by understanding them - Ambient Agents supporting task execution and depression treatment*
17. Amal Elgammal (UvT) *Towards a Comprehensive Framework for Business Process Compliance*
18. Eltjo Poort (VU) *Improving Solution Architecting Practices*
19. Helen Schonenberg (TU/e) *What's Next? Operational Support for Business Process Execution*
20. Ali Bahramisharif (RUN) *Covert Visual Spatial Attention, a Robust Paradigm for Brain-Computer Interfacing*
21. Roberto Cornacchia (TUD) *Querying Sparse Matrices for Information Retrieval*
22. Thijs Vis (UvT) *Intelligence, politie en veiligheidsdienst: verenigbare grootheden?*
23. Christian Muehl (UT) *Toward Affective Brain-Computer Interfaces: Exploring the Neurophysiology of Affect during Human Media Interaction*
24. Laurens van der Werff (UT) *Evaluation of Noisy Transcripts for Spoken Document Retrieval*
25. Silja Eckartz (UT) *Managing the Business Case Development in Inter-Organizational IT Projects: A Methodology and its Application*
26. Emile de Maat (UvA) *Making Sense of Legal Text*
27. Hayrettin Gurkok (UT) *Mind the Sheep! User Experience Evaluation & Brain-Computer Interface Games*
28. Nancy Pascall (UvT) *Engendering Technology Empowering Women*
29. Almer Tigelaar (UT) *Peer-to-Peer Information Retrieval*
30. Alina Pommeranz (TUD) *Designing Human-Centered Systems for Reflective Decision Making*
31. Emily Bagarukayo (RUN) *A Learning by Construction Approach for Higher Order Cognitive*

Skills Improvement, Building Capacity and Infrastructure

32. Wietske Visser (TUD) *Qualitative multi-criteria preference representation and reasoning*
33. Rory Sie (OU) *Coalitions in Cooperation Networks (COCOON)*
34. Pavol Jancura (RUN) *Evolutionary analysis in PPI networks and applications*
35. Evert Haasdijk (VU) *Never Too Old To Learn -- On-line Evolution of Controllers in Swarm- and Modular Robotics*
36. Denis Ssebugwawo (RUN) *Analysis and Evaluation of Collaborative Modeling Processes*
37. Agnes Nakakawa (RUN) *A Collaboration Process for Enterprise Architecture Creation*
38. Selmar Smit (VU) *Parameter Tuning and Scientific Testing in Evolutionary Algorithms*
39. Hassan Fatemi (UT) *Risk-aware design of value and coordination networks*
40. Agus Gunawan (UvT) *Information Access for SMEs in Indonesia*
41. Sebastian Kelle (OU) *Game Design Patterns for Learning*
42. Dominique Verpoorten (OU) *Reflection Amplifiers in self-regulated Learning*
43. Withdrawn
44. Anna Tordai (VU) *On Combining Alignment Techniques*
45. Benedikt Kratz (UvT) *A Model and Language for Business-aware Transactions*
46. Simon Carter (UvA) *Exploration and Exploitation of Multilingual Data for Statistical Machine Translation*
47. Manos Tsagkias (UvA) *Mining Social Media: Tracking Content and Predicting Behavior*
48. Jorn Bakker (TU/e) *Handling Abrupt Changes in Evolving Time-series Data*
49. Michael Kaisers (UM) *Learning against Learning - Evolutionary dynamics of reinforcement learning algorithms in strategic interactions*
50. Steven van Kervel (TUD) *Ontologogy driven Enterprise Information Systems Engineering*
51. Jeroen de Jong (TUD) *Heuristics in Dynamic Sceduling; a practical framework with a case study in elevator dispatching*

2013

1. Viorel Milea (EUR) *News Analytics for Financial Decision Support*
2. Erietta Liarou (CWI) *MonetDB/DataCell: Leveraging the Column-store Database Technology for Efficient and Scalable Stream Processing*
3. Szymon Klarman (VU) *Reasoning with Contexts in Description Logics*
4. Chetan Yadati (TUD) *Coordinating autonomous planning and scheduling*
5. Dulce Pumareja (UT) *Groupware Requirements Evolutions Patterns*
6. Romulo Goncalves (CWI) *The Data Cyclotron: Juggling Data and Queries for a Data Warehouse Audience*
7. Giel van Lankveld (UvT) *Quantifying Individual Player Differences*
8. Robbert-Jan Merk (VU) *Making enemies: cognitive modeling for opponent agents in fighter*

pilot simulators

9. Fabio Gori (RUN) *Metagenomic Data Analysis: Computational Methods and Applications*
10. Jeewanie Jayasinghe Arachchige (UvT) *A Unified Modeling Framework for Service Design*
11. Evangelos Pournaras (TUD) *Multi-level Reconfigurable Self-organization in Overlay Services*
12. Marian Razavian (VU) *Knowledge-driven Migration to Services*
13. Mohammad Safiri (UT) *Service Tailoring: User-centric creation of integrated IT-based homecare services to support independent living of elderly*
14. Jafar Tanha (UvA) *Ensemble Approaches to Semi-Supervised Learning Learning*
15. Daniel Hennes (UM) *Multiagent Learning - Dynamic Games and Applications*
16. Eric Kok (UU) *Exploring the practical benefits of argumentation in multi-agent deliberation*
17. Koen Kok (VU) *The PowerMatcher: Smart Coordination for the Smart Electricity Grid*
18. Jeroen Janssens (UvT) *Outlier Selection and One-Class Classification*
19. Renze Steenhuizen (TUD) *Coordinated Multi-Agent Planning and Scheduling*
20. Katja Hofmann (UvA) *Fast and Reliable Online Learning to Rank for Information Retrieval*
21. Sander Wubben (UvT) *Text-to-text generation by monolingual machine translation*
22. Tom Claassen (RUN) *Causal Discovery and Logic*
23. Patricio de Alencar Silva (UvT) *Value Activity Monitoring*
24. Haitham Bou Ammar (UM) *Automated Transfer in Reinforcement Learning*
25. Agnieszka Anna Latoszek-Berendsen (UM) *Intention-based Decision Support. A new way of representing and implementing clinical guidelines in a Decision Support System*
26. Alireza Zarghami (UT) *Architectural Support for Dynamic Homecare Service Provisioning*
27. Mohammad Huq (UT) *Inference-based Framework Managing Data Provenance*
28. Frans van der Sluis (UT) *When Complexity becomes Interesting: An Inquiry into the Information eXperience*
29. Iwan de Kok (UT) *Listening Heads*
30. Joyce Nakatumba (TU/e) *Resource-Aware Business Process Management: Analysis and Support*
31. Dinh Khoa Nguyen (UvT) *Blueprint Model and Language for Engineering Cloud Applications*
32. Kamakshi Rajagopal (OU) *Networking For Learning; The role of Networking in a Lifelong Learner's Professional Development*
33. Qi Gao (TUD) *User Modeling and Personalization in the Microblogging Sphere*
34. Kien Tjin-Kam-Jet (UT) *Distributed Deep Web Search*
35. Abdallah El Ali (UvA) *Minimal Mobile Human Computer Interaction*
36. Than Lam Hoang (TU/e) *Pattern Mining in Data Streams*

37. Dirk Börner (OU) *Ambient Learning Displays*
38. Eelco den Heijer (VU) *Autonomous Evolutionary Art*
39. Joop de Jong (TUD) *A Method for Enterprise Ontology based Design of Enterprise Information Systems*
40. Pim Nijssen (UM) *Monte-Carlo Tree Search for Multi-Player Games*
41. Jochem Liem (UvA) *Supporting the Conceptual Modelling of Dynamic Systems: A Knowledge Engineering Perspective on Qualitative Reasoning*
42. Léon Planken (TUD) *Algorithms for Simple Temporal Reasoning*
43. Marc Bron (UvA) *Exploration and Contextualization through Interaction and Concepts*

2014

1. Nicola Barile (UU) *Studies in Learning Monotone Models from Data*
2. Fiona Tuliyano (RUN) *Combining System Dynamics with a Domain Modeling Method*
3. Sergio Raul Duarte Torres (UT) *Information Retrieval for Children: Search Behavior and Solutions*
4. Hanna Jochmann-Mannak (UT) *Websites for children: search strategies and interface design - Three studies on children's search performance and evaluation*
5. Jurriaan van Reijsen (UU) *Knowledge Perspectives on Advancing Dynamic Capability*
6. Damian Tamburri (VU) *Supporting Networked Software Development*
7. Arya Adriansyah (TU/e) *Aligning Observed and Modeled Behavior*
8. Samur Araujo (TUD) *Data Integration over Distributed and Heterogeneous Data Endpoints*
9. Philip Jackson (UvT) *Toward Human-Level Artificial Intelligence: Representation and Computation of Meaning in Natural Language*
10. Ivan Salvador Razo Zapata (VU) *Service Value Networks*
11. Janneke van der Zwaan (TUD) *An Empathic Virtual Buddy for Social Support*
12. Willem van Willigen (VU) *Look Ma, No Hands: Aspects of Autonomous Vehicle Control*
13. Arlette van Wissen (VU) *Agent-Based Support for Behavior Change: Models and Applications in Health and Safety Domains*
14. Yangyang Shi (TUD) *Language Models With Meta-information*
15. Natalya Mogles (VU) *Agent-Based Analysis and Support of Human Functioning in Complex Socio-Technical Systems: Applications in Safety and Healthcare*
16. Krystyna Milian (VU) *Supporting trial recruitment and design by automatically interpreting eligibility criteria*
17. Kathrin Dentler (VU) *Computing healthcare quality indicators automatically: Secondary Use of Patient Data and Semantic Interoperability*
18. Mattijs Ghijsen (UvA) *Methods and Models for the Design and Study of Dynamic Agent Organizations*

19. Vinicius Ramos (TU/e) *Adaptive Hypermedia Courses: Qualitative and Quantitative Evaluation and Tool Support*
20. Mena Habib (UT) *Named Entity Extraction and Disambiguation for Informal Text: The Missing Link*
21. Kassidy Clark (TUD) *Negotiation and Monitoring in Open Environments*
22. Marieke Peeters (UU) *Personalized Educational Games - Developing agent-supported scenario-based training*
23. Eleftherios Sidirourgos (UvA/CWI) *Space Efficient Indexes for the Big Data* Era
24. Davide Ceolin (VU) *Trusting Semi-structured Web Data*
25. Martijn Lappenschaar (RUN) *New network models for the analysis of disease interaction*
26. Tim Baarslag (TUD) *What to Bid and When to Stop*
27. Rui Jorge Almeida (EUR) *Conditional Density Models Integrating Fuzzy and Probabilistic Representations of Uncertainty*
28. Anna Chmielowiec (VU) *Decentralized k-Clique Matching*
29. Jaap Kabbedijk (UU) *Variability in Multi-Tenant Enterprise Software*
30. Peter de Cock (UvT) *Anticipating Criminal Behaviour*
31. Leo van Moergestel (UU) *Agent Technology in Agile Multiparallel Manufacturing and Product* Support
32. Naser Ayat (UvA) *On Entity Resolution in Probabilistic Data*
33. Tesfa Tegegne (RUN) *Service Discovery in eHealth*
34. Christina Manteli (VU) *The Effect of Governance in Global Software Development: Analyzing Transactive Memory Systems*.
35. Joost van Ooijen (UU) *Cognitive Agents in Virtual Worlds: A Middleware Design Approach*
36. Joos Buijs (TU/e) *Flexible Evolutionary Algorithms for Mining Structured Process Models*
37. Maral Dadvar (UT) *Experts and Machines United Against Cyberbullying*
38. Danny Plass-Oude Bos (UT) *Making brain-computer interfaces better: improving usability through post-processing*
39. Jasmina Maric (UvT) *Web Communities, Immigration, and Social Capital*
40. Walter Omona (RUN) *A Framework for Knowledge Management Using ICT in Higher Education*
41. Frederic Hogenboom (EUR) Automated Detection of Financial Events in News Text
42. Carsten Eijckhof (CWI/TUD) *Contextual Multidimensional Relevance Models*
43. Kevin Vlaanderen (UU) *Supporting Process Improvement using Method Increments*
44. Paulien Meesters (UvT) *Intelligent Blauw. Met als ondertitel: Intelligence-gestuurde politiezorg in gebiedsgebonden eenheden*
45. Birgit Schmitz (OU) *Mobile Games for Learning: A Pattern-Based Approach*

46. Ke Tao (TUD) *Social Web Data Analytics: Relevance, Redundancy, Diversity*
47. Shangsong Liang (UvA) *Fusion and Diversification in Information Retrieval*

2015

1. Niels Netten (UvA) *Machine Learning for Relevance of Information in Crisis Response*
2. Faiza Bukhsh (UvT) *Smart auditing: Innovative Compliance Checking in Customs Controls*
3. Twan van Laarhoven (RUN) *Machine learning for network data*
4. Howard Spoelstra (OU) *Collaborations in Open Learning Environments*
5. Christoph Bösch (UT) *Cryptographically Enforced Search Pattern Hiding*
6. Farideh Heidari (TUD) *Business Process Quality Computation - Computing Non-Functional Requirements to Improve Business Processes*
7. Maria-Hendrike Peetz (UvA) *Time-Aware Online Reputation Analysis*
8. Jie Jiang (TUD) *Organizational Compliance: An agent-based model for designing and evaluating organizational interactions*
9. Randy Klaassen (UT) *HCI Perspectives on Behavior Change Support Systems*
10. Henry Hermans (OU) *OpenU: design of an integrated system to support lifelong learning*
11. Yongming Luo (TU/e) *Designing algorithms for big graph datasets: A study of computing bisimulation and joins*
12. Julie M. Birkholz (VU) *Modi Operandi of Social Network Dynamics: The Effect of Context on Scientific Collaboration Networks*
13. Giuseppe Procaccianti (VU) *Energy-Efficient Software*
14. Bart van Straalen (UT) *A cognitive approach to modeling bad news conversations*
15. Klaas Andries de Graaf (VU) *Ontology-based Software Architecture Documentation*
16. Changyun Wei (UT) *Cognitive Coordination for Cooperative Multi-Robot Teamwork*
17. André van Cleeff (UT) *Physical and Digital Security Mechanisms: Properties, Combinations and Trade-offs*
18. Holger Pirk (CWI) *Waste Not, Want Not! - Managing Relational Data in Asymmetric Memories*
19. Bernardo Tabuenca (OU) *Ubiquitous Technology for Lifelong Learners*
20. Loïs Vanhée (UU) *Using Culture and Values to Support Flexible Coordination*
21. Sibren Fetter (OU) *Using Peer-Support to Expand and Stabilize Online Learning*
22. Zhemin Zhu (UT) *Co-occurrence Rate Networks*
23. Luit Gazendam (VU) *Cataloguer Support in Cultural Heritage*
24. Richard Berendsen (UvA) *Finding People, Papers, and Posts: Vertical Search Algorithms and Evaluation*
25. Steven Woudenberg (UU) *Bayesian Tools for Early Disease Detection*
26. Alexander Hogenboom (EUR) *Sentiment Analysis of Text Guided by Semantics and Structure*

27. Sándor Héman (CWI) *Updating compressed colomn stores*
28. Janet Bagorogoza (UvT) *KNOWLEDGE MANAGEMENT AND HIGH PERFORMANCE; The Uganda Financial Institutions Model for HPO*
29. Hendrik Baier (UM) *Monte-Carlo Tree Search Enhancements for One-Player and Two-Player Domains*
30. Kiavash Bahreini (OU) Real-time Multimodal Emotion Recognition in E-Learning
31. Yakup Koç (TUD) *On the robustness of Power* Grids
32. Jerome Gard (UL) *Corporate Venture Management in SMEs*
33. Frederik Schadd (TUD) *Ontology Mapping with Auxiliary Resources*
34. Victor de Graaf (UT) *Gesocial Recommender Systems*
35. Jungxao Xu (TUD) *Affective Body Language of Humanoid Robots: Perception and Effects in Human Robot Interaction*

2016

1. Syed Saiden Abbas (RUN) *Recognition of Shapes by Humans and Machines*
2. Michiel Christiaan Meulendijk (UU) *Optimizing medication reviews through decision support: prescribing a better pill to swallow*
3. Maya Sappelli (RUN) *Knowledge Work in Context: User Centered Knowledge Worker Support*
4. Laurens Rietveld (VU) *Publishing and Consuming Linked Data*
5. Evgeny Sherkhonov (UvA) *Expanded Acyclic Queries: Containment and an Application in Explaining Missing Answers*
6. Michel Wilson (TUD) *Robust scheduling in an uncertain environment*
7. Jeroen de Man (VU) *Measuring and modeling negative emotions for virtual training*
8. Matje van de Camp (UvT) *A Link to the Past: Constructing Historical Social Networks from Unstructured Data*
9. Archana Nottamkandath (VU) *Trusting Crowdsourced Information on Cultural Artefacts*
10. George Karafotias (VU) *Parameter Control for Evolutionary Algorithms*
11. Anne Schuth (UvA) *Search Engines that Learn from Their Users*
12. Max Knobbout (UU) *Logics for Modelling and Verifying Normative Multi-Agent Systems*
13. Nana Baah Gyan (VU) *The Web, Speech Technologies and Rural Development in West Africa - An ICT4D Approach*
14. Ravi Khadka (UU) *Revisiting Legacy Software System Modernization*
15. Steffen Michels (RUN) *Hybrid Probabilistic Logics - Theoretical Aspects, Algorithms and Experiments*
16. Guangliang Li (UvA) *Socially Intelligent Autonomous Agents that Learn from Human Reward*

17. Berend Weel (VU) *Towards Embodied Evolution of Robot Organisms*
18. Albert Meroño Peñuela (VU) *Refining Statistical Data on the Web*
19. Julia Efremova (TU/e) *Mining Social Structures from Genealogical Data*
20. Daan Odijk (UvA) *Context & Semantics in News & Web Search*
21. Alejandro Moreno Celleri (UT) *From Traditional to Interactive Playspaces: Automatic Analysis of Player Behavior in the Interactive Tag Playground*
22. Grace Lewis (VU) *Software Architecture Strategies for Cyber-Foraging Systems*
23. Fei Cai (UvA) *Query Auto Completion in Information Retrieval*
24. Brend Wanders (UT) *Repurposing and Probabilistic Integration of Data; An Iterative and data model independent approach*
25. Julia Kiseleva (TU/e) *Using Contextual Information to Understand Searching and Browsing Behavior*
26. Dilhan Thilakarathne (VU) *In or Out of Control: Exploring Computational Models to Study the Role of Human Awareness and Control in Behavioural Choices, with Applications in Aviation and Energy Management Domains*
27. Wen Li (TUD) *Understanding Geo-spatial Information on Social Media*
28. Mingxin Zhang (TUD) *Large-scale Agent-based Social Simulation - A study on epidemic prediction and control*
29. Nicolas Höning (TUD) *Peak reduction in decentralised electricity systems -Markets and prices for flexible planning*
30. Ruud Mattheij (UvT) *The Eyes Have It*
31. Mohammad Khelghati (UT) *Deep web content monitoring*
32. Eelco Vriezekolk (UT) *Assessing Telecommunication Service Availability Risks for Crisis Organisations*
33. Peter Bloem (UvA) *Single Sample Statistics, exercises in learning from just one example*
34. Dennis Schunselaar (TU/e) *Configurable Process Trees: Elicitation, Analysis, and Enactment*
35. Zhaochun Ren (UvA) *Monitoring Social Media: Summarization, Classification and Recommendation*
36. Daphne Karreman (UT) *Beyond R2D2: The design of nonverbal interaction behavior optimized for robot-specific morphologies*
37. Giovanni Sileno (UvA) *Aligning Law and Action - a conceptual and computational inquiry*
38. Andrea Minuto (UT) *MATERIALS THAT MATTER - Smart Materials meet Art & Interaction Design*
39. Merijn Bruijnes (UT) *Believable Suspect Agents; Response and Interpersonal Style Selection for an Artificial Suspect*

40. Christian Detweiler (TUD) *Accounting for Values in Design*
41. Thomas King (TUD) *Governing Governance: A Formal Framework for Analysing Institutional Design and Enactment Governance*
42. Spyros Martzoukos (UvA) *Combinatorial and Compositional Aspects of Bilingual Aligned Corpora*
43. Saskia Koldijk (RUN) *Context-Aware Support for Stress Self-Management: From Theory to Practice*
44. Thibault Sellam (UvA) Automatic Assistants for Database Exploration
45. Bram van de Laar (UT) *Experiencing Brain-Computer Interface Control*
46. Jorge Gallego Perez (UT) *Robots to Make you Happy*
47. Christina Weber (UL) *Real-time foresight - Preparedness for dynamic innovation networks*
48. Tanja Buttler (TUD) *Collecting Lessons Learned*
49. Gleb Polevoy (TUD) *Participation and Interaction in Projects. A Game-Theoretic Analysis*
50. Yan Wang (UvT) *The Bridge of Dreams: Towards a Method for Operational Performance Alignment in IT-enabled Service Supply Chains*

2017

1. Jan-Jaap Oerlemans (UL) *Investigating Cybercrime*
2. Sjoerd Timmer (UU) *Designing and Understanding Forensic Bayesian Networks using Argumentation*
3. Daniël Harold Telgen (UU) *Grid Manufacturing; A Cyber-Physical Approach with Autonomous Products and Reconfigurable Manufacturing Machines*
4. Mrunal Gawade (CWI) *Multi-Core Parallelism In A Column-Store*
5. Mahdieh Shadi (UvA) *Collaboration Behavior*
6. Damir Vandic (EUR) *Intelligent Information Systems for Web Product Search*
7. Roel Bertens (UU) *Insight in Information: from Abstract to Anomaly*
8. Rob Konijn (VU) *Detecting Interesting Differences:Data Mining in Health Insurance Data using Outlier Detection and Subgroup Discovery*
9. Dong Nguyen (UT) *Text as Social and Cultural Data: A Computational Perspective on Variation in Text*
10. Robby van Delden (UT) (Steering) *Interactive Play Behavior*
11. Florian Kunneman (RUN) *Modelling patterns of time and emotion in Twitter #anticipointment*
12. Sander Leemans (TU/e) *Robust Process Mining with Guarantees*
13. Gijs Huisman (UT) *Social Touch Technology - Extending the reach of social touch through haptic technology*
14. Shoshannah Tekofsky (UvT) *You Are Who You Play You Are: Modelling Player Traits from*

Video Game Behavior

15. Peter Berck, Radboud University (RUN) *Memory-Based Text Correction*
16. Aleksandr Chuklin (UvA) *Understanding and Modeling Users of Modern Search Engines*
17. Daniel Dimov (UL) *Crowdsourced Online Dispute Resolution*
18. Ridho Reinanda (UvA) *Entity Associations for Search*
19. Jeroen Vuurens (TUD) *Proximity of Terms, Texts and Semantic Vectors in Information Retrieval*
20. Mohammadbashir Sedighi (TUD) *Fostering Engagement in Knowledge Sharing: The Role of Perceived Benefits, Costs and Visibility*
21. Jeroen Linssen (UT) *Meta Matters in Interactive Storytelling and Serious Gaming (A Play on Worlds)*
22. Sara Magliacane (VU) *Logics for causal inference under uncertainty*
23. David Graus (UvA) *Entities of Interest--- Discovery in Digital Traces*
24. Chang Wang (TUD) *Use of Affordances for Efficient Robot Learning*
25. Veruska Zamborlini (VU) *Knowledge Representation for Clinical Guidelines, with applications to Multimorbidity Analysis and Literature Search*
26. Merel Jung (UT) *Socially intelligent robots that understand and respond to human touch*
27. Michiel Joosse (UT) *Investigating Positioning and Gaze Behaviors of Social Robots: People's Preferences, Perceptions and Behaviors*
28. John Klein (VU) *Architecture Practices for Complex Contexts*
29. Adel Alhuraibi (UvT) *From IT-BusinessStrategic Alignment to Performance: A Moderated Mediation Model of Social Innovation, and Enterprise Governance of IT*
30. Wilma Latuny (UvT) *The Power of Facial Expressions*
31. Ben Ruijl (UL) *Advances in computational methods for QFT calculations*
32. Thaer Samar (RUN) *Access to and Retrievability of Content in Web Archives*
33. Brigit van Loggem (OU) *Towards a Design Rationale for Software Documentation: A Model of Computer-Mediated Activity*
34. Maren Scheffel (OU) *The Evaluation Framework for Learning Analytics*
35. Martine de Vos (VU) *Interpreting natural science spreadsheets*
36. Yuanhao Guo (UL) *Shape Analysis for Phenotype Characterisation from High-throughput Imaging*
37. Alejandro Montes Garcia (TU/e) *WiBAF: A Within Browser Adaptation Framework that Enables Control over Privacy*
38. Alex Kayal (TUD) *Normative Social Applications*
39. Sara Ahmadi (RUN) *Exploiting properties of the human auditory system and compressive sensing methods to increase noise robustness in ASR*

40. Altaf Hussain Abro (VU) *Steer your Mind: Computational Exploration of Human Control in Relation to Emotions, Desires and Social Support For applications in human-aware support systems"*
41. Adnan Manzoor (VU) *Minding a Healthy Lifestyle: An Exploration of Mental Processes and a Smart Environment to Provide Support for a Healthy Lifestyle*
42. Elena Sokolova (RUN) *Causal discovery from mixed and missing data with applications on ADHD datasets*
43. Maaike de Boer (RUN) *Semantic Mapping in Video Retrieval*
44. Garm Lucassen (UU) *Understanding User Stories - Computational Linguistics in Agile Requirements Engineering*
45. Bas Testerink (UU) *Decentralized Runtime Norm Enforcement*
46. Jan Schneider (OU) *Sensor-based Learning Support*
47. Yie Yang (TUD) *Crowd Knowledge Creation Acceleration*
48. Angel Suarez (OU) *Collaborative inquiry-based learning*

2018

1. Han van der Aa (VU) *Comparing and Aligning Process Representations*
2. Felix Mannhardt (TU/e) *Multi-perspective Process Mining*
3. Steven Bosems (UT) *Causal Models For Well-Being: Knowledge Modeling, Model-Driven Development of Context-Aware Applications, and Behavior Prediction*
4. Jordan Janeiro (TUD) *Flexible Coordination Support for Diagnosis Teams in Data-Centric Engineering Tasks*
5. Hugo Huurdeman (UvA) *Supporting the Complex Dynamics of the Information Seeking Process*
6. Dan Ionita (UT) *Model-Driven Information Security Risk Assessment of Socio-Technical Systems*
7. Jieting Luo (UU) *A formal account of opportunism in multi-agent systems*
8. Rick Smetsers (RUN) *Advances in Model Learning for Software Systems*
9. Xu Xie (TUD) *Data Assimilation in Discrete Event Simulations*
10. Julienka Mollee (VU) *Moving forward: supporting physical activity behavior change through intelligent technology*
11. Mahdi Sargolzaei (UvA) *Enabling Framework for Service-oriented Collaborative Networks*
12. Xixi Lu (TU/e) *Using behavioral context in process mining*
13. Seyed Amin Tabatabaei (VU) *Using behavioral context in process mining: Exploring the added value of computational models for increasing the use of renewable energy in the residential sector*
14. Bart Joosten (UvT) *Detecting Social Signals with Spatiotemporal Gabor Filters*

15. Naser Davarzani (UM) *Biomarker discovery in heart failure*
16. Jaebok Kim (UT) *Automatic recognition of engagement and emotion in a group of* children
17. Jianpeng Zhang (TU/e) *On Graph Sample Clustering*
18. Henriette Nakad (UL) *De Notaris en Private Rechtspraak*
19. Minh Duc Pham (VU) *Emergent relational schemas for RDF*
20. Manxia Liu (RUN) *Time and Bayesian Networks*
21. Aad Slootmaker (OU) *EMERGO: a generic platform for authoring and playing scenario-based serious games*
22. Eric Fernandes de Mello Araújo (VU) *Contagious: Modeling the Spread of Behaviours, Perceptions and Emotions in Social Networks*
23. Kim Schouten (EUR) *Semantics-driven Aspect-Based Sentiment Analysis*
24. Jered Vroon (UT) *Responsive Social Positioning Behaviour for Semi-Autonomous Telepresence Robots*
25. Riste Gligorov (VU) *Serious Games in Audio-Visual Collections*
26. Roelof de Vries (UT) *Theory-Based And Tailor-Made: Motivational Messages for Behavior Change Technology*
27. Maikel Leemans (TU/e) *Hierarchical Process Mining for Scalable Software Analysis*
28. Christian Willemse (UT) *Social Touch Technologies: How they feel and how they make you feel*
29. Yu Gu (UvT) *Emotion Recognition from Mandarin Speech*
30. Wouter Beek (VU) *The “K” in "semantic web" stands for “knowledge”: scaling semantics to the web*

2019

1. Rob van Eijk (UL) *Web privacy measurement in real-time bidding systems. A graph-based approach to RTB system classification*
2. Emmanuelle Beauxis- Aussalet (CWI, UU) *Statistics and Visualizations for Assessing Class Size Uncertainty*
3. Eduardo Gonzalez Lopez de Murillas (TU/e) *Process Mining on Databases: Extracting Event Data from Real Life Data Sources*
4. Ridho Rahmadi (RUN) *Finding stable causal structures from clinical data*
5. Sebastiaan van Zelst (TU/e) *Process Mining with Streaming Data*
6. Chris Dijkshoorn (VU) *Nichesourcing for Improving Access to Linked Cultural Heritage Datasets*
7. Soude Fazeli (TUD) *Recommender Systems in Social Learning Platforms*
8. Frits de Nijs (TUD) *Resource-constrained Multi-agent Markov Decision Processes*
9. Fahimeh Alizadeh Moghaddam (UvA) *Self-adaptation for energy efficiency in software*

systems

10. Qing Chuan Ye (EUR) *Multi-objective Optimization Methods for Allocation and Prediction*
11. Yue Zhao (TUD) *Learning Analytics Technology to Understand Learner Behavioral Engagement in MOOCs*
12. Jacqueline Heinerman (VU) *Better Together*
13. Guanliang Chen (TUD) *MOOC Analytics: Learner Modeling and Content Generation*
14. Daniel Davis (TUD) *Large-Scale Learning Analytics: Modeling Learner Behavior & Improving Learning Outcomes in Massive Open Online Courses*
15. Erwin Walraven (TUD) *Planning under Uncertainty in Constrained and Partially Observable Environments*
16. Guangming Li (TU/e) *Process Mining based on Object-Centric Behavioral Constraint (OCBC) Models*
17. Ali Hurriyetoglu (RUN) *Extracting actionable information from microtexts*
18. Gerard Wagenaar (UU) *Artefacts in Agile Team Communication*
19. Vincent Koeman (TUD) *Tools for Developing Cognitive Agents*
20. Chide Groenouwe (UU) *Fostering technically augmented human collective intelligence*
21. Cong Liu (TU/e) *Software Data Analytics: Architectural Model Discovery and Design Pattern Dete*ction
22. Martin van den Berg (VU) *Improving IT Decisions with Enterprise Architecture*
23. Qin Liu (TUD) *Intelligent Control Systems: Learning, Interpreting, Verification*
24. Anca Dumitrache (VU) *Truth in Disagreement- Crowdsourcing Labeled Data for Natural Language Processing*
25. Emiel van Miltenburg (UvT) *Pragmatic factors in (automatic) image description*
26. Prince Singh (UT) *An Integration Platform for Synchromodal Transport*
27. Alessandra Antonaci (OU) *The Gamification Design Process applied to (Massive) Open Online Courses*
28. Esther Kuindersma (UL) *Cleared for take-off: Game-based learning to prepare airline pilots for critical situations*
29. Daniel Formolo (VU) *Using virtual agents for simulation and training of social skills in safety-critical circumstances*
30. Vahid Yazdanpanah (UT) *Multiagent Industrial Symbiosis Systems*
31. Milan Jelisavcic (VU) *Alive and Kicking: Baby Steps in Robotics*
32. Chiara Sironi (UM) *Monte-Carlo Tree Search for Artificial General Intelligence in Games*
33. Anil Yaman (TU/e) *Evolution of Biologically Inspired Learning in Artificial Neural Networks*
34. Negar Ahmadi (TU/e) *EEG Microstate and Functional Brain Network Features for Classification of Epilepsy and PNES*

35. Lisa Facey-Shaw (OU) *Gamification with digital badges in learning programming*
36. Kevin Ackermans (OU) *Designing Video-Enhanced Rubrics to Master Complex Skills*
37. Jian Fang (TUD) *Database Acceleration on FPGAs*
38. Akos Kadar (OU) *Learning visually grounded and multilingual representations*

2020

1. Armon Toubman (UL) *Calculated Moves: Generating Air Combat Behaviour*
2. Marcos de Paula Bueno (UL) *Unraveling Temporal Processes using Probabilistic Graphical Models*
3. Mostafa Deghani (UvA) *Learning with Imperfect Supervision for Language Understanding*
4. Maarten van Gompel (RUN) *Context as Linguistic Bridges*
5. Yulong Pei (TU/e) *On local and global structure mining*
6. Preethu Rose Anish (UT) *Stimulation Architectural Thinking during Requirements Elicitation - An Approach and Tool Support*
7. Wim van der Vegt (OU) *Towards a software architecture for reusable game components*
8. Ali Mirsoleimani (UL) *Structured Parallel Programming for Monte Carlo Tree Search*
9. Myriam Traub (UU) *Measuring Tool Bias & Improving Data Quality for Digital Humanities Research*
10. Alifah Syamsiyah (TU/e) *In-database Preprocessing for Process Mining*
11. Sepideh Mesbah (TUD) *Semantic-Enhanced Training Data AugmentationMethods for Long-Tail Entity Recognition Models*
12. Ward van Breda (VU) *Predictive Modeling in E-Mental Health: Exploring Applicability in Personalised Depression Treatment*
13. Marco Virgolin (CWI) *Design and Application of Gene-pool Optimal Mixing Evolutionary Algorithms for Genetic Programming*
14. Mark Raasveldt (CWI/UL) *Integrating Analytics with Relational Databases*
15. Konstantinos Georgiadis (OU) *Smart CAT: Machine Learning for Configurable Assessments in Serious Games*
16. Ilona Wilmont (RUN) *Cognitive Aspects of Conceptual Modelling*
17. Daniele Di Mitri (OU) *The Multimodal Tutor: Adaptive Feedback from Multimodal Experiences*
18. Georgios Methenitis (TUD) *Agent Interactions & Mechanisms in Markets with Uncertainties: Electricity Markets in Renewable Energy Systems*
19. Guido van Capelleveen (UT) *Industrial Symbiosis Recommender Systems*
20. Albert Hankel (VU) *Embedding Green ICT Maturity in Organisations*
21. Karine da Silva Miras de Araujo (VU) *Where is the robot?: Life as it could be*
22. Maryam Masoud Khamis (RUN) *Understanding complex systems implementation through a*

modeling approach: the case of e-government in Zanzibar

23. Rianne Conijn (UT) *The Keys to Writing: A writing analytics approach to studying writing processes using keystroke logging*
24. Lenin da Nobrega Medeiros (VU/RUN) *How are you feeling, human? Towards emotionally supportive chatbots*
25. Xin Du (TU/e) *The Uncertainty in Exceptional Model Mining*
26. Krzysztof Leszek Sadowski (UU) *GAMBIT: Genetic Algorithm for Model-Based mixed-Integer opTimization*
27. Ekaterina Muravyeva (TUD) *Personal data and informed consent in an educational context*
28. Bibeg Limbu (TUD) *Multimodal interaction for deliberate practice: Training complex skills with augmented reality*
29. Ioan Gabriel Bucur (RUN) *Being Bayesian about Causal Inference*
30. Bob Zadok Blok (UL) *Creatief, Creatieve, Creatiefst*
31. Gongjin Lan (VU) *Learning better -- From Baby to Better*
32. Jason Rhuggenaath (TU/e) *Revenue management in online markets: pricing and online advertising*
33. Rick Gilsing (TU/e) *Supporting service-dominant business model evaluation in the context of business model innovation*
34. Anna Bon (MU) *Intervention or Collaboration? Redesigning Information and Communication Technologies for Development*
35. Siamak Farshidi (UU) *Multi-Criteria Decision-Making in Software Production*

2021

1. Francisco Xavier Dos Santos Fonseca (TUD) *Location-based Games for Social Interaction in Public Space*
2. Rijk Mercuur (TUD) *Simulating Human Routines: Integrating Social Practice Theory in Agent-Based Models*
3. Seyyed Hadi Hashemi (UvA) *Modeling Users Interacting with Smart Devices*
4. Ioana Jivet (OU) *The Dashboard That Loved Me: Designing adaptive learning analytics for self-regulated learning*
5. Davide Dell’Anna (UU) *Data-Driven Supervision of Autonomous Systems*
6. Daniel Davison (UT) *“Hey robot, what do you think?” How children learn with a social robot*
7. Armel Lefebvre (UU) *Research data management for open science*
8. Nardie Fanchamps (OU) *The Influence of Sense-Reason-Act Programming on Computational Thinking*
9. Cristina Zaga (UT) *The Design of Robothings. Non-Anthropomorphic and Non-Verbal*

Robots to Promote Children's Collaboration Through Play

10. Quinten Meertens (UvA) *Misclassification Bias in Statistical Learning*
11. Anne van Rossum (UL) *Nonparametric Bayesian Methods in Robotic Vision*
12. Lei Pi (UL) *External Knowledge Absorption in Chinese SMEs*
13. Bob R. Schadenberg (UT) *Robots for Autistic Children: Understanding and Facilitating Predictability for Engagement in Learning*
14. Negin Samaeemofrad (UL) *Business Incubators: The Impact of Their Support*