Are University Business Incubators Overprotective Parents?

A Knowledge as a Resource-Based Perspective on Growth of Academic Spinoffs using an Open Innovation and Absorptive Capacity Framework

MIHIR TANDON

TU Delft

Are University Business Incubators Overprotective Parents? A Knowledge as a Resource-Based Perspective on Growth of Academic Spinoffs using an Open Innovation and Absorptive Capacity Framework.

Master thesis submitted to Delft University of Technology

in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE

in **Management of Technology**

Faculty of Technology, Policy and Management

by

Mihir Tandon

Student number: 4628292

To be defended in public on 18th December 2019 at 1:00 PM

Graduation committee

Chairperson	: Dr.R.M (Robert) Verburg, Associate Professor, Economics of Technology and Innovation
First Supervisor	: Dr.ing. V.E. (Victor Scholten), Assistant Professor, Delft Center for Entrepreneurship
Second Supervisor	: Dr.R.M (Robert Verburg), Economics of Technology and Innovation

An electronic version of this thesis is available at http://repository.tudelft.nl/

TU Delft

DCE TU Delft

Dedicated to Maa, Papa & Shubhangi

Executive Summary

University business incubators are a global rising phenomenon and have an imprint on the genetics of high technology based academic spin-offs and are central the triple-helix model of innovation systems for academia-industry-policy.

Research focused on Regional Innovation System of Delft suggest that the high technology based start-ups face challenges in their growth up to a time period as long as four years due to resource based obstacles and this can be a factor affecting the mortality rate of start-ups in the regions

Although University business incubators are a powerhouse of open innovation and support permeable firm boundaries for external knowledge, organizations cannot enjoy competitive advantage just by the virtue of being exposed to it but have to acquire, assimilate (*Potential Absorptive Capacity*), transform and exploit (*Realized Absorptive Capacity*) knowledge as a resource. Relatively less is known about how does the incubator support help the start-ups to develop their dynamic capabilities and the possible implications of this parent-spin-off relationship on their growth after graduation from that incubator and removal of the incubator support.

Thus, to address this research gap, this research study attempts to find an answer to the following research question:

- **"What are the implications of a university incubator's support to academic start-ups to implement open-innovation & develop dynamic capabilities on the growth of academic start-ups?"**

The focus of the study is YES! Delft, the university business incubator of highest ranking technical university of the Netherlands -Delft University of Technology, supports high technology based start-ups from ideation to product commercialisation .

An extensive literature review (Chapter-2) was conducted to build a conceptual model operationalised to obtain an Open Innovation-Absorptive Capacity based framework to answer the research question. The data used for analyses is collected from *Delft Center for Entrepreneurship* and analysis was done for 67 academic start-ups in aggregate form. With the help of data responses to questionnaires the conceptual model has been operationalised to form a hierarchical model in which the higher order consists of dimensions of Absorptive Capacity (Potential Absorptive Capacity and Realized Absorptive Capacity) while the lower order consists of the underlying managerial actions of open innovation and the final outcome is 'Competitive Advantage' measured using three constructs- *Innovation, Strategic Flexibility* and *Product Development Related Performance* (Chapter-3). The preliminary data analyses was done using the software IBM SPSS 3.0 and the data analyses for PLS-SEM using the software SmartPLS 3.0 (Chapter 4).

The empirical results from hypothesis testing using PLS-SEM are then interpreted to answer the three sub-research questions The answers to ***SQ-1 How do the managerial processes of implementing open innovation affect the dynamic capabilities of the firm?*** are found by observing the results of the lower-order of the developed hierarchical model and gives us insight into how the dimensions of absorptive capacity of the academic start-ups are developed due to the underlying managerial actions implement open-innovation.

The answers to SQ-2 How do experiences of academic start-ups in university incubators influence their growth? gives us insights into the

interaction between absorptive capacity dimensions. Potential Absorptive Capacity has a *statistically significant relationship* with Realized Absorptive Capacity, thus, Potential Absorptive Capacity is proved to be an antecedent that drives Realized Absorptive Capacity suggesting path dependency and accumulation of absorptive capacity as a dynamic capability with the learning experience.

Lastly, the ***SQ-3 How do the internal capabilities of the academic start-ups in university incubators help them achieve competitive advantage?*** gives insights into the higher-order of the hierarchical model and the outcome variables of competitive advantage- Innovation, Strategic Flexibility and Product Development Related Performance.

For the relationship between Absorptive Capacity and Innovation, both the dimensions of absorptive capacity- Potential Absorptive Capacity and Realized Absorptive had shown *insignificant relationship* with Innovation.

The relationship between Absorptive Capacity and Strategic Flexibility for Potential ACAP, there was a *positive and significant relationship* with Acquisition Capacity but not with Assimilation Capacity. For Realized Absorptive Capacity, Transformation Capacity had *insignificant relationship* but Exploitation Capacity had a *significant relationship* with Strategic Flexibility.

The relationship between the dimensions of Absorptive Capacity and Product Development Related performance showed that Assimilation Capacity had a *highly significant and strongly correlated relationship* while Acquisition Capacity, Transformation Capacity and Exploitation Capacity had an *insignificant* relationship.

The interpretation of answers to the sub-research questions are used to find their implications on navigating the critical junctures in academic start up growth - *Opportunity Recognition, Entrepreneurial Commitment, Credibility and Sustainable Returns* for answering the main research question (Chapter 5).

The study contributes to the literature of 'Open Innovation' and 'Absorptive Capacity'. Additionally, the results are a contribution to theory of growth of start-ups from knowledge as a resource based view of the firm. The study hopes to contribute the following implications for the practitioners

- Suggestions to understand how the managerial processes to implement open innovation help develop potential and realized absorptive capacity and implications of simplified learning mechanisms for their growth.

- Suggestions to policy makers and incubator managers to understand the growth process from a non-pecuniary perspective that can facilitate higher organisational efficiency of the start-ups

Keywords: *regional innovation systems, triple-helix, incubator support, academic start-ups, absorptive capacity, open innovation, dynamic capabilities, knowledge-based view, competitive advantage, growth of academic start-ups, strategy management, entrepreneurship, PLS-SEM*

This page is intentionally left blank.

Acknowledgments

This thesis project is the final step towards the completion of my Masters of Science in Management of Technology program and an extraordinary journey which has completely changed me to be a better person. Each day at TU Delft greets you with a surprise. Some days are filled with incredible success stories while some days can be rough and challenging. However both the experiences are equally important to polish your personal growth and learning invaluable lessons of life and makes you feel proud of every single credit on the grade sheet, truly earned. This accomplishment is not possible without the help of numerous people who have motivated and supported me to reach to this point.

I would like to express my gratitude to my Thesis Graduation Committee: *Dr Robert Verburg* and *Dr Victor Scholten* for their guidance and help to finish this graduation research project. I would like to thank Dr Robert for allowing me to start the project. His critical insights during the first Kick-Off meeting gave me a sense of direction and additional insights to the research topic. Robert's lectures on Knowledge Processes and Knowledge Management were my initial source of motivation to follow this field of research. I have learnt immensely and feel extremely fortunate to have been a student of Dr Robert Verburg.

It is incredibly hard for me to condense my gratitude for Dr Victor Scholten in the limited space here. I am immensely grateful to have Dr Victor Scholten as my first supervisor, without whom I would have reached nowhere. I would like to thank Victor for his time for numerous meetings with insightful discussions, complete liberty to explore my research project and having lots of patience with me at times when I had gone astray. I would remember entering your office with lot of difficulties and stress but I would return every time with a solution and a boosted motivation. You have been extremely approachable and never turned down a request for help, for which I shall be forever grateful. The person without whom I couldn't have imagined the possibility of this accomplishment is *Drs Marja Brand*. Marja's support has been extremely crucial in my graduation process. Marja helped me get my project back on track and have always welcomed me and my problems with all her concern and patience. Thank you Marja, I will always cherish your assis-

tance and motivating words. I would also like to thank all the lectures of my masters program who have helped me prepare to be a young professional.

I am grateful to all the friends, the best minds from all over the world, I made during my studies here, it is impossible to mention them all here but thanks to the 'Mandatory Group': *Akhil, Astrid Bram, Milan, Efrain, Elisa, Lianne, Manuela, Renita, Vimal, Zarife, Lina, Ifa, Amalia, Andres, Tanya.* Each person has been an incredible support during various phases of my study, special thanks to *Elsa Rodriguez* and *Rahul Prasad* for the help in thesis. I would like to specially thank *Pratik Mishra, Sparsh Sharma, Ajith Meera, Malvika Dixit, Mary Karamanou, Ayesha Rahman, Agnelo Iasanth, Aravindakshan Ramesh, Mruthunjaya Katrahally, Abhishek Gupta and Kunal Shetty* for all the good breaks from studies and support during the frustrating moments. I would like to thank the 'Padhe Likhe Log' group- *Siddharth Rasya, Annette* and *Kunal Datta* for their concern and good home cooked food. I would like to immensely thank *Arjun Narayanan*, who has been a constant motivation since my Chennai days. To my support system from India which is kilometers away yet super strong. My family: all the members of The 'RK Tandon family' group and 'Sushyam'. Thanks to my uncle and aunts- *Milan & Anubha Tandon, Manisha& Anshumali Tandon, Yashil & Richa Tandon, Kapil & Shalini Malhotra.* My grandparents: *Dadda-Baba, Nani-Nana* who with their unconditional love and support are waiting for me to come home with the degree and are ever so patient. Special thanks to all my cousins *Madhav & Amogh Tandon, Devansh & Bhavini Malhotra, Aryaman & Aishwarya Tandon*. The biggest thanks goes to the support of my brother, *Arush Tandon* and my lovely sister-in-law, *Avni Kapoor*. I have been away from home for very long and hope to spend time with you all now.Yes, yes yoda, thank you too. To my sisters –*Shubhangi & Saumya Tandon*, who are ever so concerned for me and want me to achieve the best things in life and whom I love the most.

Last but definitely not the least, my parents *Archana* and *Vivek Tandon*. All this is because of you, your unconditional love, support, sacrifices and trust in me. Papa and Maa, this thesis marks the end of the lifelong support for my education and my future that you both have given to me, right from St Judes to TU Delft. Your selfless love to support my ambitions is the reason I could come so far. Times were hard here, but Maa your faith in me and Papa's undying entrepreneurial spirit and fulfilling your promises no matter what helped me keep going & brave all the challenges. I dedicate this thesis to you both. I hope reading this makes you proud. I promise this thesis is finished now and I am coming home.

I wish you all enjoy reading this document,

To the conclusion of a journey and to the start of a new,
Mihir Tandon
Delft, December 2019

Contents

List of figures

This page is intentionally left blank.

List of Tables

This page is intentionally left blank.

List of Abbreviations

ACAP	*Absorptive Capacity*
AVE	*Average Variance Extracted*
CB-SEM	*Covariance Based SEM*
DV	*Dependent Variable*
IV	*Independent Variable*
KBV	*Knowledge Based View*
NIS	*National Innovation System*
NTBF	*New Technology Based Firm*
PACAP	*Potential Absorptive Capacity*
PLS	*Partial Least Square*
RQ	*Research Question*
R& D	*Research and Development*
RACAP	*Realized Absorptive Capacity*
RBV	*Resource Based View*
RIS	*Regional Innovation System*
SEM	*Structural Equation Modelling*
SECI	*Socialisation Externalization Combination Internalisation*
SME	*Small and Medium Enterprise*
SQ	*Sub-Research Question*
TOL	*Tolerance Factor*
USO	*University Spin-off*
VIF	*Variance Inflation Factor*
VRIN	*Valuable Rare Imperfectly-Imitable Non-Substitutable*
YES!Delft	*Young Entrepreneurs Society! Delft*

1

Introduction

"The atomic bomb, inertially guided missiles and submarines, computer-based defence of North America, the race to the moon, and the complex of high-technology companies lining Route 128 outside of Boston are phenomenon that became prominent in the postwar years. This was a time marked by a plethora of scientific and technological advances. World War II had defined technology as the critical element upon which survival of the nation rested. That war brought scientists from the shelter of their labs into the confidence of those in the highest levels of government. And in the postwar years their power and their products and by-products began to shape society, the economy, and the industrial landscape."

(Edward B.Roberts [1991], page 32)

1.1 General Introduction

Academic Spin-offs are crucial for the economic development of any National or Regional Innovation Systems. The modern age academic spin-offs find their nurture, launch and support system at university business incubators. University incubators are bound to have an imprint on the genetics of the firm and affect the stages of growth in their life-cycle, specifically in the terms of dynamic capabilities that they develop over time through routines and actions. While the academic spin-off and knowledge commercialization ecosystem of high-technology based start-ups with origins from the likes of MIT & Stanford has been extensively researched, there becomes a need of studying the growth of academic spin-off in other emerging regional innovation systems. This thesis aims to investigate the growth of academic spin-offs in the university incubator of the Delft University of Technology, Yes! Delft, which is an essential establishment to promote economic development and commercialisation of scientific knowledge in the regional innovation system of Delft. This chapter introduces the study research conducted for this thesis. The chapter highlights the importance of studying the growth of academic start-ups in a knowledge-based economy and establishes research objectives and research questions for the thesis research.

This chapter is divided into two parts:

1. *Part I: Section 1.2 to 16* : This part focuses on the detailed history and definition of academic spin-offs, development of university incubator, introduction to working definitions of the main concepts and the background of the study. This section is the contribution to Master Annotation Entrepreneurship Program additional work. Readers interested in the motivation and problem identification of the study can directly skip to Part II (section 1.7 onwards), however to avoid repetition of content, important definitions and background to the study is discussed in this section itself

2. *Part II: Section 1.7 to 1.12*: The second part of the chapter discusses the identified problems, sets the research goals and introduces the research question. This section also discusses the relevance of the study.

Part I

1.2 The Importance of Studying Growth of Academic Start-ups in University Incubators

Knowledge as Economy Driver: Knowledge is recognized as an important strategic asset and a resource to achieve competitive advantage. This is because we are experiencing times of a knowledge-based economy as suggested by Carrillo [2015] and discussed in Table 1.2.1

	Production	Input	Agent	Output
Physical Era	Hunting-Gathering	Land	Human&Animal	Game, fish, natural goods
	Agriculture	Water, Seeds	Human&Animal	Agricultural goods
	Extractive	Natural Deposits	Human&Animal	Stones, metals, minerals
	Industrial	Raw Material	Human&Animal	Industrial Products
Knowledge Era	Knowledge based production	Knowledge input	Rationality, emotion	Knowledge output and services

Table 1.2.1: Knowledge Based Era [Carrillo, 2015]

Politicians and university managers are increasingly understanding the strategic importance of the role of universities and scientific research in the new era 'knowledge-based capitalism' and are trying to commercialize it through university incubators. This is evident from the European Commission's 2020 plan to boost entrepreneurship.

According to the European Commission, *"This Action Plan is a blueprint for decisive joint action to unleash Europe's entrepreneurial potential, to remove existing obstacles and to revolutionise the culture of entrepreneurship in Europe. It aims to ease the creation of new businesses and to create a much more supportive environment for existing entrepreneurs to thrive and grow.*
It proposes three areas for immediate intervention:

1. Entrepreneurial education and training to support growth and business creation
2. Strengthening framework conditions for entrepreneurs by removing existing structural barriers and supporting them in crucial phases of the business life-cycle,
3. Dynamising the culture of entrepreneurship in Europe: nurturing the new generation of entrepreneurs." ([EuropeanCommission, 2013], page 5)

Acting on this plan, the European Commission's Horizon 2020 initiative pledges to contribute more than 80.000 million (80 billion) euros in bringing science to market through *Research, Development* and *Innovation* in order to boost the economic development of national and regional innovation systems ([EUHorizon2020, nd]). The university incubators, like the one closely studied in this thesis, Yes!Delft; host academic start-ups or academic spin-offs which can be seen as a locus of regional innovation systems. Small and Medium Enterprises are characterized by resource deficiencies, but start-ups in university incubators have an advantage of added resource support, primarily being knowledge.

The Innovation and Business Ecosystem in the Netherlands

The Netherlands can be seen as very active in recognizing and producing *knowledge* as a resource. The graphical figure 1.2.2 illustrates that the OECD scorecard ranks the Netherlands' as the second-highest quality and quantity-wise producer of scientific research. The percentage of the total top-cited publications, where the Dutch score of 35% share stands second to Switzerland's score of 24 %. This is an indication that the Netherlands has a high scientific output but still have few challenges to improve the quality of scientific output.

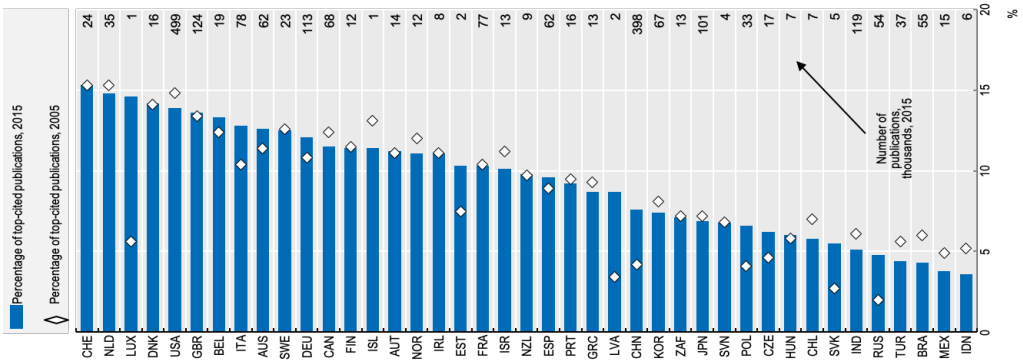


Figure 1.2.1: Overview of Scientific Production in the Netherlands

The Netherlands has a very high focus on research and development for business. In 2015, the Netherlands' innovation R&D for business support had a reliance of as high as 88,1% on direct tax funding and tax incentives on R&D which is a change from 69,4 % in 2006 (OECD [2014]).

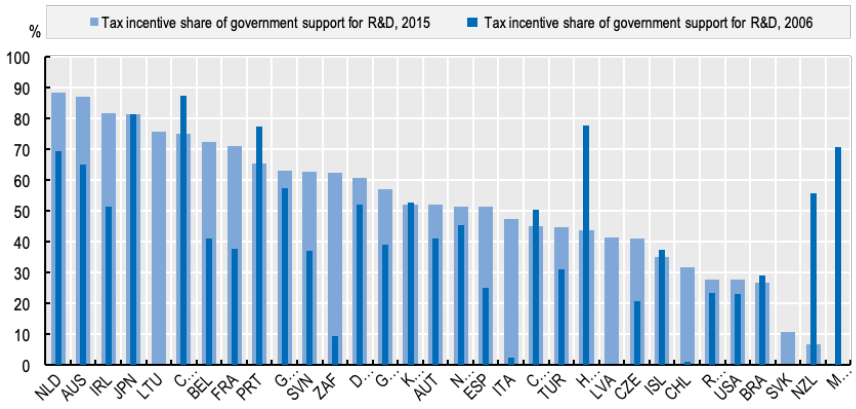


Figure 1.2.2: Overview of R&D investment for business in the Netherlands

1.3 Introduction to Academic Spin-offs, University Incubators and Innovation Systems

1.3.1 Academic Spin-off

The unit of analysis of this research is 'Academic Spin-off' [1] in the university incubator of the Delft University of Technology, so before understanding this form of organization empirically, it becomes important to define it (academic spin-off) in the introduction itself. To understand Academic-Spin off, we need to understand what is a spin-off first. Cooper [1973] studied a group of New-Technology Based Firms (NTBF) active from the 1960s in San Francisco and terms these firms as spin-offs because they have originated from a parent organisation. Edward B. Roberts in his research titled "Entrepreneurs in High Technology –Lessons from MIT and beyond" give us one of the earliest insights to "Academic Spin-off" as a distinctive form of organization with its distinct characteristics, growth patterns and organizational structure. It studies the positive influence of the Massachusetts Institute of Technology [MIT] on the regional development of new high technology-based firms. It argues that new technology-based firms are brought into existence by engineers and scientists who decide to become entrepreneurs by developing or adopting the technological bases for their new firms and investing or raising the financial resources required to make it happen ([Roberts, 1991]) and these new firms are called *spin-offs*.

According to Pattnaik and Pandey [2014], an *'Academic Spin-off'* is an organisation having the following characteristics

1. the parent organisation from which the innovation emerges is a university or academic

[1] Note-The term Academic Spin-off has been used interchangeably with the term *Academic Start-Up* in some parts of this document, for the purpose of this thesis study both terms have the same working definition

institute

2. it is a separate legal entity and not controlled by the university

3. it exploits knowledge from academic activities

4. it aims at profit generation by the commercialization of technology (Pattnaik and Pandey [2014], page 45)

1.3.2 Systems of Innovation & Rise of Entrepreneurial Science

In the previous section we understood what is meant by an Academic Spin-off in this study, in this section, we understand what is a university incubator, for this purpose, it becomes essential to learn the rise of entrepreneurial science that motivated university and research centres to commercialize knowledge.

Drawing inspiration from 'general systems theory' of natural sciences, Edquist [2006] introduces the concept of system in business and management sciences as consisting of two constituents : components and relations among them, having a function to perform or achieve something and it can be possible to distinguish boundaries of the system and also their extent (Edquist, 2006, page 5). This leads Edquist [2006] to the definition of *System of Innovation* as "determinants of the innovation process, that is the important economic, social, political, organizational, institutional factors that influence the development, diffusion and use of innovations". Systems of Innovation is the study of emerging innovation trends in an economy. Here *Innovation* is defined as new creations of economic significance. Systems of innovation are generally categorized on geographic dimensions - *national, regional and international.* This masters thesis focuses on university incubator, which can be seen as a component of a regional innovation system. Here region is defined as a meso-political level unit set between national and local levels of government. Universities serve as a natural innovation system in a regional innovation landscape ([Etzkowitz, 2001]. The example of Silicon Valley in the next section illustrates the importance of university-industry relationships in developing a Regional Innovation System.

1.3.3 University-Industry Clusters as a driver of Regional Innovation Systems and Knowledge-Based Economy

From Radio to Self Driving Cars: The case of Silicon Valley The post World War II era has seen a transition of the centre of innovation from military research, mostly as a result of "cold war inventions to university generated academic inventions which tend to find commercial applications by converting basic science to applied science. The rise of clusters of high-technology firms

Silicon Valley Company	Fortune-500 Rank	Market Cap($USD)	Date Founded	University Origins
Hewlet-Packard	107	39.101 Billion	1939	Founded by Stanford Alumni
Apple	3	1.069 Trillion	1976	Founders influenced by hobby club Homebrew Computer Club (Meetings at Stanford)
Intel	38	214.18 Billion	1968	Spun off of MIT research leading to spin-off Fairchild Semiconductors
Google (Now Alphabet)	22	814.07 Billion	1998	Founded by Stanford Alumni
Yahoo (Now Altaba)	343	39.249 Billion	1995	Founded by Stanford Alumni
Cisco Systems	54	215.08 Billion	1984	Founded by Stanford research staff
Sun Microsystems	112	2.22 Billion	1982	Founded by Stanford Alumni; originally designed for Stanford network communications
Sandisk	408	15.46 Billion	1988	Founded by Intel employees; Intel already has university links.

Table 1.3.1: Fortune 500 Silicon Valley companies and their university origins. Source: Yahoo!Finance ([Yahoo-Finance, nd]

has changed the innovation landscapes in this century. A prominent example being *Silicon Valley*. If you are using an Apple brand computer, which has an Intel processor and your homepage on the internet is Google, you are enjoying a significant amount of knowledge from the Silicon Valley in California, United States of America. What makes Silicon Valley different enough? –is the fact that the Silicon Valley is one of the most powerful examples of how modern age innovations have transitioned from military to universities and how academic knowledge and industry work in synergy to impact millions of lives every day.

As seen in Table1.3.1, silicon-valley based technology companies are one of the premium technological brands existing today and also they come from a university-related origin, in most cases Stanford University and MIT. Lessons from silicon valley can be highly beneficial for other promising technological clusters for their regional innovation.

Silicon Valley is a direct result of Stanford's entrepreneurial strategy, in engagement with government and industry. *Stanford University* provided a knowledge base for spin-offs to form new industries and firms resulting in regional development, largely because of pioneer university staff that believed in the fact that university can work better in an industrial environment but if the industry does not exist it should be created. Education from technical universities provides a lot of

career choices, with engineering graduates ending up being academia (researchers) or employees in an industry.

1.3.4 Introduction to University Incubators -*First and Second Academic Revolution*

Isolated Research Labs to University incubators

[Etzkowitz, 2001] studied the changing academic landscape and researched systems of innovation to establish important linkages between university, government and industry. Etzkowitz [2001] classifies academic entrepreneurship history in two ways -*First Academic Revolution* and *Second Academic Revolution*.

First Academic Revolution

According to Etzkowitz [2001], First Academic revolution is described as the period when the role of the university was primarily based on cultural conservation, preservation and transmission and new research directions were towards philology, primarily motivated to encourage and revive classical learning. The research efforts were higher in directions like interpreting historical Greek and Roman texts. There was no distinction between pure science and applied science. The university funding was largely influenced by private donors, and universities would take limited risks in entrepreneurial ventures. However in the mid-1900s when World War-II influenced the basic research to be utilized for military purposes. The research centres were isolated and worked in secrecy, unlike the research organizations of today. This marked the spread of academic revolution from philology to science and the result were discoveries like radio astronomy, radars and communication systems.

Soon the post-war dawned with the realization of scientific research for technology, the financial support at the university increased, however, researchers still worked in an isolated manner as individual researchers without collaboration.

The Second Academic Revolution - Rise of University Incubators

According to Etzkowitz [2001], The second academic revolution represents the contemporary period where the role of universities is changing fundamentally. Realising the importance of university-industry relationships, from success stories like the Silicon Valley and M.I.T.'s growing research in basic and applied sciences, universities have started acquiring business engagement capabilities. This was largely influenced by the Bayh-Dole Act of 1980 that empowered universities legally to gain income by licensing their technologies in the form of intellectual property rights and exploit federal funds. Soon, new academic roles like technology transfer officers emerged and

valorisation centres were put in place. Ultimately, the universities started establishing *'University Business Incubators'*.

Definition of an *University Incubator*: Etzkowitz [2001] defines university incubator as an institution where knowledge and technology of the university are embodied in a firm and instead of licensing the technology, it is moved out of the university by an entrepreneur (page 6). Incubators utilize academic knowledge to transform the older linear and isolated innovation model to a space of collaboration and open innovation practices. In addition to knowledge for commercialization, incubators might provide business coaching in the form of a mentor or an assigned director to a firm. Incubators provide academic entrepreneurs advantages of location and reputation by supporting them with office, secretary, reception, office utilities etc.

1.4 Second Academic Revolution and Regional Innovation System

As seen from the effects of world-war in the first academic revolution on the second academic revolution, technology trends are mostly explained through a science-push and demand or technology pull model as seen in figure 1.4.1 Manley [2002]

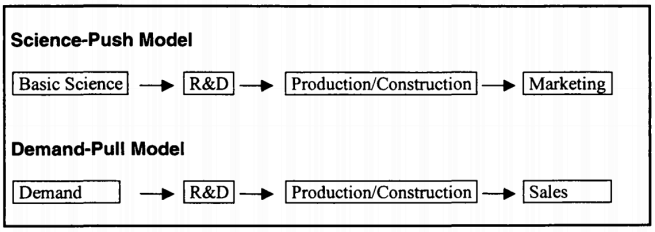


Figure 1.4.1: Linear Science Push and Technology Push Model (Manley, 2002)

Etzkowitz and Leydesdorff [2000] argue that a linear model is incapable of explaining the roles of various institutions involved in knowledge transfer. Thus, they developed a model known as the *triple helix model* which highlights the relationship between government-industry and university.

As discussed in the first section, a system of innovation consists of components, the triple helix model visualises a regional innovation system made up of three components: *University*, *Industry* and *Government*.

The triple-helix model has numerous advantages in a knowledge-based economy over other models of systems of innovations because the triple helix model provides a robust explanation of collaboration between the different actors (components) in a regional innovation system. The

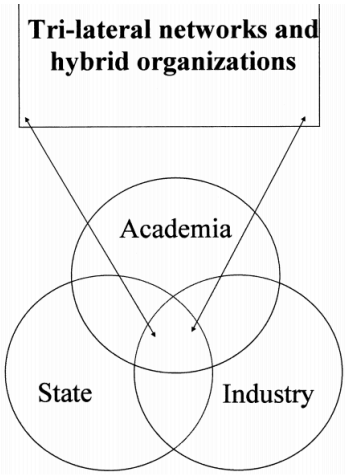


Figure 1.4.2: Triple Helix Model of Innovation Systems (Etzkowitz and Leydesdorff, 2000)

Triple Helix model identifies the boundaries of the individual institutions and carves out their knowledge-based roles. The triple helix model also helps the policymakers to moderate conflicts, strengthen collaborations, analyse and justify resource allocation.

1.5 Introduction to Open Innovation

The open innovation model is coined by Chesbrough [2006] and has gained immense prominence in strategic management science since the past decade. The definition of open innovation as defined by Chesbrough [2006]) is
"the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation" (Chesbrough 2006, page 1). It denotes a change in the paradigm of innovation processes because the boundaries of firms are becoming more permeable to external knowledge and it can be used to complement the internal knowledge generated in the firm, that is a shift from a closed innovation model to an open innovation model. Open Innovation is visualized as a funnel as seen in Figure 1.5.1

1.5.1 Closed Innovation vs Open Innovation

The fundamental difference that separates a closed innovation model from open innovation is the generation of knowledge with respect to the boundaries of a firm. In a closed innovation model, the knowledge is generated within the boundaries of the firm, while in an open innovation model, the firms are characterized by permeable boundaries that help it to exploit knowledge both from sources located both internally and externally. The contrasting principles as described by

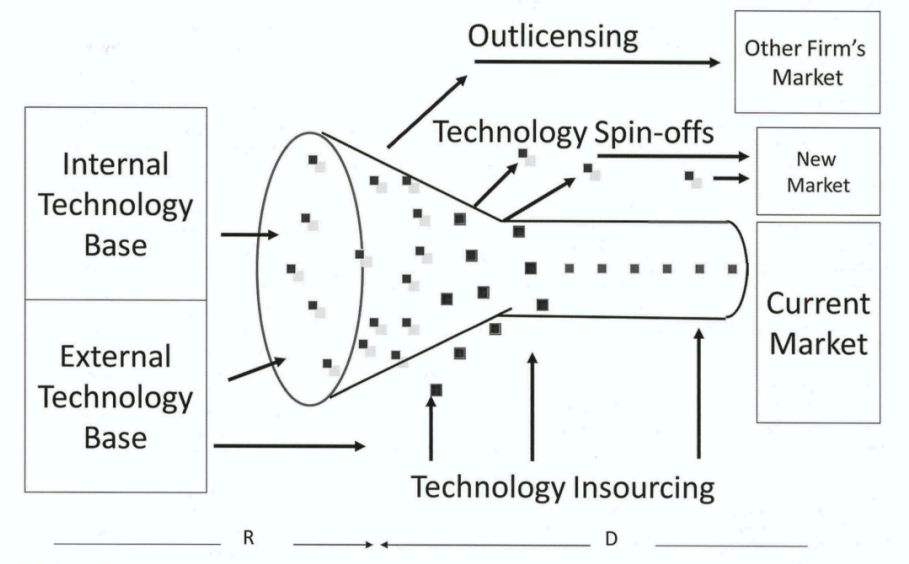


Figure 1.5.1: Open Innovation, Chesbrough, 2003

Closed Innovation Principles	**Open Innovation Principles**
All smart people in our are field are working for us	Not all the smart people in our field are working for us, therefore we work with smart people inside and outside our company
The R&D profits should come after discovering, developing and shipping it on our own	Significant value can be generated from external R&D, and internal R&D can be used in some portion of that value
We will get our R&D to the market first if we discover it first	The research not necessarily needs to originate from us to profit it
Winners are decided by the company that brings innovation to the market in the first place	It is better to build a better business model than entering the market
Winners are decided by companies that create the most and best ideas in the industry	Winning is decided by making the best use of internal and external ideas
Our intellectual property should be controlled by us so that competitor's do not get it	Intellectual property can be bought and we can profit from it

Table 1.5.1: Closed Innovation vs Open Innovation-Chesbrough [2006]

Chesbrough [2006] are described in Table 1.5.1

1.6 Background of the study : Yes!-Delft: University Incubator of Delft University of Technology

The Knowledge city of Delft

Historically, Delft has been a cultural city largely recognized for its Delft blue pottery and birthplace of the famous painter Vermeer, but in present times, Delft is seen as a medium-sized university town in the Randstad area of The Netherlands. The city houses the Delft University of Technology which is an important technical university in The Netherlands with a worldwide reputation of an innovative university. The presence of a major technical university and research institutes like TNO make Delft a hub for technological innovations. This is evident from the ambitious expansion initiatives by the city of Delft to establish a 120-hectare area science business park Delft Technopolis which house various R&D intensive firms like 3M and also the university incubator of TU Delft, Yes! Delft. The university incubator of TU Delft shows the entrepreneurial university characteristics of TU Delft and by offering business courses to engineering graduates of the university, the university encourages academic entrepreneurship in its students. Thus the Delft University of Technology becomes a great example of the second academic revolution and an entrepreneurial university.

For example, Dap Hartmann [2014] narrates the success of university's business courses which students take as part of their program or electives in a research paper titled *Turning Technology into business* which is also the title of the course module. The course deals with actual intellectual property generated by the researchers of TU Delft and students are instructed on how to find commercial applications from the patents. The growing popularity of the course every year has made the course manager Dap Hartmann selection criteria to the course so that only really serious students enrol to know more about the university incubator. [Hartmann, 2014] describes a successful case study of an academic start-up *Holland Containers* whose product *"4FOLD"* that originated from the course after working on university patent (Dutch patent (NL1017159)) and worked as a full-time organization in the university incubator, Yes! Delft. The academic start-up was successful enough to win 'Promising Innovation in Transport' award. (Hartmann [2014]). This course is one of the many starting milestones that technology startups follow to get admission in the university incubator, Yes! Delft. An entrepreneur's interview illuminates the entrepreneurial inclination of the university.

"We took part in a course [aimed at] turning technology into a business," where they were given a patent by a TU Delft researcher, without knowing the exact application of the invention. "We had to brainstorm it ourselves because inventions can often be used for much more than their original applica-

tion." [Yes!Delft, nd]

Figure 1.6.1: Yes Delft, the student business incubator, Delft University of Technology

The Yes-Delft university incubator was started in 2005 and is commissioned by Ministry of Economic Affairs and Climate Policy and Ministry of Justice and Security and its founding partners are TU Delft, the technical university; Gementee Delft, the municipality of Delft city and TNO a government-funded industry research institute ([Yes!Delft, nd]). This makes Yes! Delft a classic example of the triple helix model of innovation systems as seen in Figure 1.12.1

Since its inception, Yes! Delft has supported more than 200 technological companies (Appendix 5.5.1. The academic start-ups of Yes! Delft has shown promising performances in the industry. Some examples are

1. Epyon: Developed fast-charging solutions for electric cars.[2]
2. Bird Control: Developed technologies to fend birds and animals at the Schiphol airport, Amsterdam using laser beams.[3]
3. Ampellmann: Developed technologies for efficient transfers of commodities from ship to ship.[4]

[2] Epyon got acquired by ABB on July 2011. For more information please see https://www.yesdelft.com/startups/abb-epyon/

[3] For more information please see https://www.yesdelft.com/startups/bird-control-group/

[4] For more information please see https://www.yesdelft.com/startups/ampelmann//

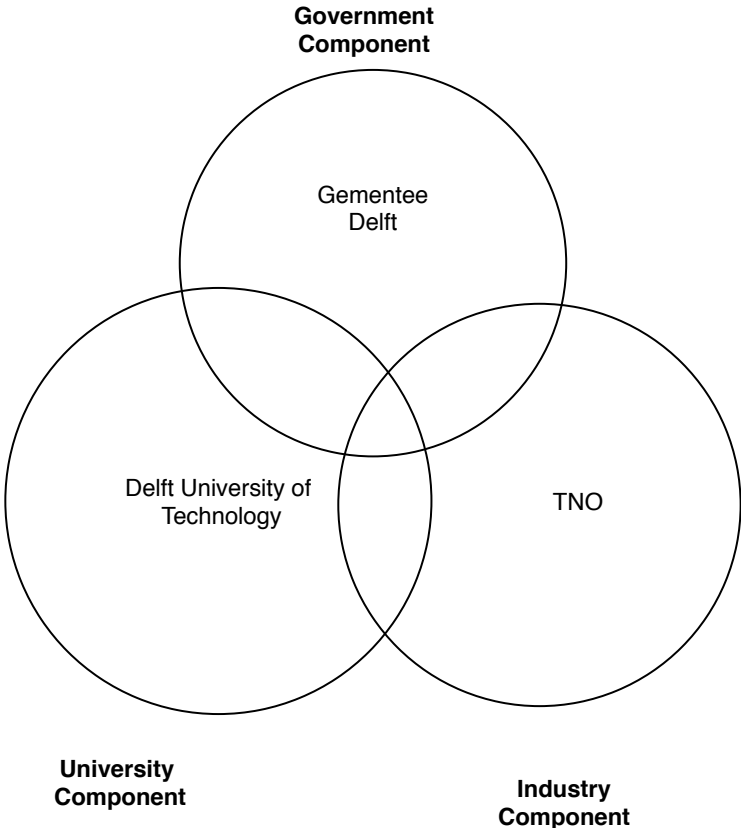


Figure 1.6.2: (Yes! Delft and Triple Helix Model of Systems Innovation)

Part II

1.7 Problem Identification and Research Goals

In accordance to the Second Academic revolution ([Etzkowitz and Leydesdorff, 2000]), Delft University of Technology in their Road Map 2020 aims to improve valorization of technology transfer to increased commercialization of university-generated knowledge, with a higher objective of providing economic growth stimulus to the region and maintain its reputation as a modern university working towards innovation for social contribution. The seriousness of the university in their this particular mission and vision is depicted by the university's incubator Yes! Delft which ranks as one of the highest performing high-tech incubators of Europe.

The founding partners of Yes! Delft includes *Gementee Delft* and *TNO* which are government and industry stakeholders respectively. The local government at Delft, *Gemeente Delft* also plans to boost innovation in the region and prepare the region to generate more than 10.000 new jobs by the year 2040 [GemeenteDelft, nd]

Thus, Yes! Delft is a great example of the triple-helix model of industry-university-government interactions to foster innovation (Etzkowitz [2001]). Academic Spin-offs like most small and medium enterprises (SMEs) and NTBFs face critical obstacles in their innovation process (Van Geenhuizen and Soetanto [2009]). Broadly, the major reasons that study highlight for such barriers is a scarcity of resources like difficulties in obtaining the required technical know-how, limitations due to human capital qualifications and immature experiences, marketing and R & D inefficiencies etc. due to the failure of firms to obey crucial management principals ([Kleinknecht, 1989]; [Bughin and Jacques, 1994]).

Kleinknecht [1989] empirically studied the problems faced by Dutch SMEs in their innovation process and provides a list of possible factors that limit the capabilities of a small manufacturing firm to innovate owing to their resource scarcity. Their survey found that more than 90% of the private R&D in the Netherlands is done by large firms characterized by employee size of more than 500 (Kleinknecht 1989, p. 218) and thus indicating to us that small firms have limited innovation capabilities. Kleinknecht [1989] further categorizes major limitations for firms to innovate and grow as:

- Lack of Capital
- Difficulties in forecasting market demand
- High expected costs of innovation projects
- Problems in adapting marketing functions
- Problem to find employees of certain qualification
- Problems due to government regulations ([Kleinknecht, 1989], p. 219)

Other studies in the context of SMEs also point out to such limitations. For example, in the context of academic start-ups, the study by Vohora et al. [2004] gives us a relatively recent insight to different obstacles (University Spin-offs) USOs face obstacles in their growth process because of reasons which the authors call as "critical junctures" which they define as ["...complex problem that occurs at a point along a new high-tech venture's expansion path preventing it from achieving the transition from one development phase to the next"] (Vohora et al. [2004], p.159). The authors base their study on the assumption that *University Spin-offs* (USOs) lack resources and the entrepreneurs lack commercializing skills due to their non-commercial backgrounds.

The identified Problem: The fundamental difference between regular SMEs and academic spin-offs in the university incubator is that the latter enjoys substantial additional support from the parent organization, that is the university incubator for managing business difficulties and resource deficiencies [Khodaei et al., 2012]. This university facilitator/incubator invested resource support elevates academic spin-offs from actual commercial realities that regular (non-incubator) SMEs do not have the luxury to do so [Trott et al., 2008]. Instead, the regular SMEs have to manage their resource allocation more diligently even after their limited availability [Kleinknecht, 1989].
Naturally, due to scarce availability of resources to utilize, university spin-offs (USOs) will tend to be permeable to allow external knowledge sources from their parent organization (universities) thus making them a powerhouse of open innovation practices that are based on sourcing knowledge from external sources in combination with the internal research efforts [Chesbrough, 2006]. However, as argued by scholars, firms cannot use external knowledge for their competitive advantage just by the virtue of being exposed to it, but are required to develop and use absorptive capacity which enables them to acquire, assimilate, transform and exploit the external knowledge they receive due to their openness (Cohen and Levinthal [1990]).

The Open Innovation model consists of inbound external knowledge, a luxury academic start-ups in university incubators enjoy. Bughin and Jacques [1994] after empirically studying Belgian high-tech industry conclude that SMEs can innovate for better outcomes even after scarce resources but on the condition of efficiency of managerial efforts, but the management science literature is silent on how does these managerial efforts to implement open innovation translates to outcomes based on capabilities of the academic start-up, that will help it grow after it leaves the university incubator.

A popular *Harvard Business School* study claims 75% of all startups fail ([Blank, 2013], page 4). Academic Startups in business incubators are not immune to failures as well. Drawing from the Resource Based-View of the firms and Social Capital theory, [Trott et al., 2008] in a preliminary study supported the arguments presented above. The authors (Trott et al. [2008]) suggest that in a parent-spin-off relationship, the parent organization (in this case the university and the university incubator) might restrict freedom of the academic spin-off and hamper their growth potential. So the academic spin-off might enjoy a temporary cushion from commercial realities, it might fail to show maturity once it leaves the incubator. This claim is also supported by the findings by [Van Geenhuizen and Soetanto, 2009] who investigate the key obstacles to the growth of academic spin-offs at different ages. Their study highlight that technology-related academic spin-offs face difficulties even until the age of 4 years. This indicates an issue with the capabilities

of a firm to manage their resources (for example knowledge) that helps them enjoy sustainable competitive advantage and growth. Thus, there is a research gap on understanding the managerial processes that help academic spin-offs to implement open innovation processes (the external component of open innovation) and the influence of the actions on the development of the firm's internal capabilities (the internal component of open innovation). Further, most studies regarding *Growth of Academic Start-ups* are based on *Social Capital Theory* and Research & Development based *pecuniary* point of view and literary scholarship is silent on how can the growth of academic start-up, and the risks an academic start-up might face after it matures and leaves the university incubator be explained from *'Knowledge'* as a resource-based perspective ([Grant, 1996]. Thus, the study of academic spin-offs in university incubator requires to be revisited with respect to open innovation as the management technique to generate or source knowledge as a strategic resource and absorptive capacity as the dynamic capability of the firm to manage this resource and serve competitive advantage. Vohora et al. [2004] have contributed seminal work in recognizing the barriers an academic start-up might face and Klein and Klein [2001] argue that it is not always possible for entrepreneurs to predict failures, therefore, the scope of problem identification also covers the possible growth risks that the managers of such academic spin-offs. Thus, we have identified our research gaps and to fill in the gaps, we need to outline the research objectives of this study as discussed in the next section.

1.8 Research Objectives

Based on the research gap, the following research objectives are identified for this thesis study

- **For Entrepreneurial Actions & Open Innovation**: To open the black box of how the managerial actions of an academic are captured by the internal capabilities of the firm and if the capabilities of the academic start-up influence its growth potential in order to assess if university incubators are overprotective or not as pointed out by Trott et al. [2008].

- **For Strategic Management of Dynamic Capabilities**: To provide a framework in the form of written strategies that can help academic start-ups balance their managerial actions in the form of Open Innovation activities (Chesbrough [2006], Zobel [2017]) and dynamic capabilities (in the form of *Absorptive Capacity*) that helps them achieve competitive advantage (Cohen and Levinthal [1990], Zahra and George [2002]) .

- **For The Regional Innovation System- Growth of Academic Start-ups:**

  To gain a non-pecuniary perspective of open innovation and absorptive capacity of the academic start-up in university incubators and the possible implications of the findings on

the identified critical junctures during their growth (Vohora et al. [2004], Van Geenhuizen and Soetanto [2009]) .

1.9 Research Questions

The main research question of this thesis is

> **"What are the implications of a university incubator's support to academic startups to implement open-innovation & develop dynamic capabilities on the growth of academic start-ups? "**

The central research question is answered with the help of following sub-research questions

1. **How do the managerial processes of implementing open innovation affect the dynamic capabilities of the firm?**

   The open innovation funnel emphasizes on sourcing in external knowledge resources and complementing it with the internal capabilities of the firm for competitive advantages (Chesbrough [2006]. [Cohen and Levinthal, 1990] maintain that to exploit the acquired external knowledge, the firm needs to develop its own capabilities, in the form of its absorptive capacity. This research sub-research question will guide us to find the answers to the research objective of the underlying processes that help an academic start-up build their internal capabilities. This will be done by analyzing the relevant literature to delineate the managerial processes taken in order to implement open innovation and how are they a component of the internal capability of the firm (absorptive capacity) [5].

2. **How do the experiences of academic start-ups in university incubators influence their growth?**

   Teece et al. [1997] suggests that the future growth of a firm is a function of its current position and *'Bygones* are rarely *'Bygones'*. Thus, the internal capabilities that a firm might develop in the current period, will stick with it for future paths ahead. Cohen and Levinthal [1990] in their seminal work of absorptive capacity highlight the fact that absorptive capacity (the ability of a firm to recognize, assimilate and exploit external knowledge) is a path-dependent capability that builds over time through learning by doing. Based on this, the time spent at the incubator will build up their absorptive capacity. In this study, the path dependency of the absorptive capacity of an academic startup are studied and based on this the sub-research question can be answered.

[5] Discussed in detail in Chapter-2

3. **How do the internal dynamic capabilities of the academic start-ups in university incubators help them achieve competitive advantage?**

   The growth of the startups is essential for the regional innovation System of Delft, however the academic startups from the business incubator will at some point face the change of circumstances after they graduate from the incubator, because survival of companies is dependent on how well they react to face of change and their dynamic capability is a deciding factor (O'Reilly III and Tushman [2008]).

   Finally, to understand the growth of academic start-up and assess if the university is overprotecting the start-ups or not, the relationship between the internal capability of the firm (it's *absorptive capacity)* and the final outcome *(the competitive advantage)* is analysed.

1.10 Research Scope

The scope of the research is confined to investigate data from university business incubator Yes!Delft and provide insights relevant to the regional innovation system of Delft area, using the data collected in the years 2014 and 2013. The data was collected by Delft Center for Entrepreneurship [6](DCE) and has been used in this thesis study for data analysis in order to answer our research question. Due to time and monetary limitations of masters thesis research, the thesis intends to contribute preliminary findings from the years 2014 and 2013 supported by data analyses, which could be used as theoretical foundations for a longitudinal study in future for deeper understandings. The theoretical scope of this study is knowledge based view of the firm Grant [1996], therefore the contributions stay limited to non-pecuniary perspectives that are based on knowledge management based processes.

1.11 Relevance of the research

1.11.1 Theoretical Relevance

This study intends to add to the burgeoning literature of open innovation and absorptive capacity by providing an academic start-up perspective. The implications of analysing the growth of spin-offs are essential for the literature of systems of innovation and university incubators are an important source of knowledge in the triple-helix model. Additionally, the implications of external knowledge and its effect on the internal capability of the academic start-up will be a contribution to Knowledge-based View (extension of Resource-Based View) of the firm. Ultimately, by

[6]https://www.tudelft.nl/en/tpm/about-the-faculty/departments/staff-departments/delft-centre-for-entrepreneurship/

studying the capability of a firm and its relationship with underlying processes will add to the literature of strategic management and entrepreneurship by re-conceptualizing the open innovation model for academic spin-offs in university incubators based on a framework of managerial actions to implement open innovation (external component) and their corresponding dimension of absorptive capacity, a dynamic capability of the firm to handle external knowledge inflows based on their internal knowledge (internal component)

1.11.2 Practical Relevance

In today's knowledge-based economy and competition, knowledge-based capabilities are crucial and firms want to develop capabilities to strategically manage their resources faster than their rivals (Hamel and Prahalad [1990], Lane and Lubatkin [1998]). Academic startups in business incubators have a unique advantage of the ease of accessing knowledge resources, but capabilities are required to strategically manage these resources for competitive advantage (Barney [1991] as just mere exposure to these knowledge resources doesn't help unless it is transformed and exploited (Cohen and Levinthal [1990], Zahra and George [2002]).

The practical relevance for this study is to give insights to open innovation in practice for academic startups by delineating the underlying processes which enable the academic start ups capabilities to manage the inflow of knowledge from external technological resources. This study also aims to provide managerial recommendations to young high-tech startups in business incubators for analysing their entrepreneurial actions and how they translate to economic outcomes based on their internal capabilities. This can help them realise the organisational routines and practises that they might need to keep a check on in order to balance their internal capabilities and the corresponding actions for external scouting. This may help them improve their efficiency in implementing open innovation.

1.11.3 Relevance to Management of Technology

The thesis is strongly aligned with the degree program Management of Technology as the theoretical foundations of the study have been motivated by the course modules taught in the program. The program Management of Technology aims at understanding how technology can be used as a corporate tool. The following courses in the program had core elements and theoretical concepts which helped in this research study and the study aligns with two of the main themes of the program - *Technology, Innovation & Organisation and Technology, Innovation & Engineering Economics*:-

- **MOT 1412 Technology Dynamics:** the course Technology Dynamics introduced the theories of innovation systems and in particular the theory of *Triple-Helix* system of Innova-

tion. The course introduced how university business incubators form an integral component of the triple helix model through the works of Etzkowitz [2001].

- **MOT 1421 Economic Foundations**: The course introduced to various concepts of microeconomics that helped in the study. The concept that is used in the study from this course is 'path-dependency' as mentioned in Teece et al. [1997].

- **MOT 1524 Leadership and Technology Management:** The course Leadership and Technology management introduced the importance of knowledge as a resource, the creation of knowledge in the organisations and how the structure of organisations play a role in strategic management. The course introduced the dynamics of knowledge creation through the seminal work of Nonaka [1994].

- **MOT 1435 Technology, Strategy and Entrepreneurship:** The course of Technology, Strategy and Entrepreneurship introduced theoretical foundations such as strategic management of resources, competitive advantage and organisation structures for strategic management. This course introduced the theories of competitive advantage by Barney [1991] and O'Reilly III and Tushman [2008].

- **MOT 1451 Inter and Intra Organisational Decision making:** The course introduced the link the between decision making and strategy. The course exposed to the works of Kahneman [2011], which helped in answering sub-research questions in the later parts of this study.

- **MOT 2312 Research Methods and MOT 2003 Preparation for the Master Thesis:** Introduced the scientific procedures for Research Methods for business which helped in formulating research methodology for this research that ensures scientific quality. The course introduced the guidelines of research by Sekaran and Bougie [2016] and Hair et al. [2013]

- **Emerging Technology-based Innovation and Entrepreneurship Specialisation courses**: The specialisation phase had various courses which directly contributed to understanding the concepts used in the study. Starting with the course WM0156TU Turning Technology into Business was the first practical introduction to an incubator Yes Delft and working of academic startups Hartmann [2014]. The course MOT9610 Entrepreneurship Basic Course and MOT9612 Business Development Lab introduced the dynamics and growth of startups through works like Vohora et al. [2004]. The course MOT9556 Corporate Entrepreneurship introduced the history of technology transfer and relevance of academic startups in Regional Innovation Systems. Finally the course WM0787TU Patent Law and

Patent Policy introduced the commercialisation processes of intellectual property by academic startups.

1.12 Structure of the thesis

The present **Chapter One** gives the background of the study, the identified problem, the research objective and the research questions. Following this, **Chapter Two** discusses a literature review was done to build a conceptual model to analyze and answer the sub research questions and the main research question, **Chapter Three** discusses the Research Methodology adopted in order to operationalize and statistically analyze the conceptual model as built-in Chapter 2. Following, **Chapter 4** provides the results from statistical analysis done in order to get the findings and answer the research questions. **Chapter 5** is devoted to discussing the results obtained from Chapter 4 and finally, **Chapter 6** discusses conclusions and answer to the research questions Based on the conclusions, recommendation, implications and reflections are discussed in Chapter 6. Additional support to claims in various parts of the document are presented in the Appendixes followed by Chapter 6.

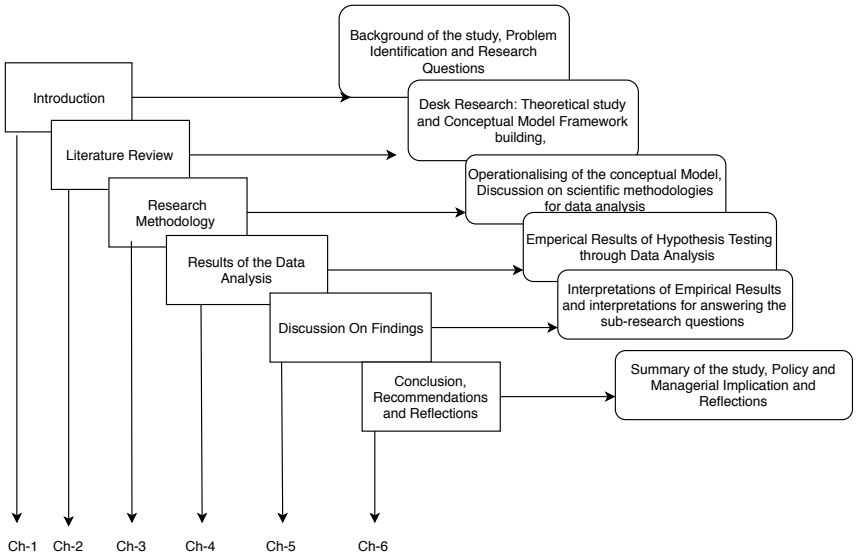


Figure 1.12.1: Structure of the Thesis

2

Literature Review

This chapter deals with the Literature Review of core concepts adopted in this study. The objective of this chapter is to understand the concepts of 'Knowledge' in management science and further extends into understanding more complex applications of knowledge as a resource, in the form of Absorptive Capacity and Open Innovation. This is done in order to construct a conceptual framework drawn from scientific literature which can be used to answer our research question. The aim of this chapter is to build a conceptual model that will be used to answer our research questions. The literature review is done in two parts

1. *Part I:* Part one of this chapter deals with understanding 'Knowledge' from a resource point of view and how it needs to be managed through the capabilities of a firm.

2. *Part II:* The second part of the chapter is the backbone of the thesis. In this part *Absorptive Capacity* is identified as the dynamic capability a firm requires in order to benefit from external knowledge after implementing *'Open Innovation'* strategies. Relevant important literature was studied which have resulted in an integrated conceptual model which we will test to answer our research questions

Part I

2.1 What is 'Knowledge'?

Knowledge in itself has a very complex nature which can be open to various interpretations ([Grant, 1996], [Davenport et al., 1998], [Nonaka, 1994]) therefore before we analyze the components of knowledge empirically it is important to understand the scientific meaning of knowledge and what form of knowledge has been taken as the focus of this study. This section deals with discussing the definition of knowledge, how it is created in organizations, how is it respected as a strategic resource and its role in innovation as understood by management science. The core problem that we try to solve with the help of this thesis is that how managers of technology make use of external knowledge to translate it into innovation related outcomes. Thus, we need to understand what does knowledge really mean for organizations and how do they behave as a strategic resource.

Taking an example of classical-quantum physics, Davenport et al. [1998] describe knowledge open to more than one interpretations like an atomic particle which can be tracked as a particle or a wave, depending upon how the scientist track it. In this context, Knowledge can be seen as a process, or as stock depending upon the context of research ([Davenport et al., 1998], p5). The meaning of knowledge has been a topic of debate within philosophy and scientific circuits for centuries as it has intrigued researchers and thinkers to a great extent and due to its such complex and abstract nature, it has always been hard to pin down a universally accepted definition.

For the purpose of this scientific study, we understand knowledge as it appears in two different forms highlighted by Nonaka [1994] –explicit and tacit knowledge.

- Explicit knowledge refers to knowledge which is codified and is easily transferable, processed and stored through a systematic formal approach like scripts, manuals, sign codes, scientific formula, library archives and databases.

- Tacit knowledge refers to knowledge that finds itself deeply embedded in cognizance of human mind and body such as intuitions, opinions, beliefs, viewpoints and paradigms, it is a personal asset which is harder than explicit knowledge to be transmitted and understood. Tacit knowledge is generated through actions, procedures, routines, application of skills, know-how based on practice and personal experiences etc.

2.2 How Is Knowledge Created In Organizations?

The process of knowledge creation was put forth in a widely popular study by [Nonaka et al., 2000] which addressed a research gap bridging the importance of knowledge as a vital source of competitive advantage (Grant [1996]) and the process by which organization create and manage knowledge Nonaka [1994]. The study is a seminal work in management science where the research focus departs from the traditional view of knowledge management in theories of the firm as information management and shifts to the fact that organizations are not such information processing machines, but entities that create knowledge through actions and interactions and these entities create knowledge continuously. According to Nonaka et al. [2000], knowledge is not created by either of the knowledge forms –explicit or tacit alone, but when the two forms of knowledge interact with each other to create new knowledge. This assumption of knowledge creation through tacit and explicit knowledge interactions can be conceptualized as four different modes of knowledge conversion –SECI.

1. Socialisation-*from tacit to tacit knowledge*-Socialization is the process of creating new knowledge with the help of shared experiences due to spending time together or living in shared environments. This helps in building a routine or set of coordinated actions that transmit knowledge, which is otherwise difficult to comprehend from a manual or codebook. This process of socialization can take place in both formal and informal environments enabling individuals to create shared mental models, worldviews and trust. Nonaka et al (2000) give an example of socialization as when firms (managers) profit from tacit knowledge dwelling in customers and suppliers by making attempts to interact with them to gather insights on sales information and engage in dialogue with competitors.

2. Externalisation *-from tacit to explicit knowledge* This is the process of articulation of tacit knowledge to explicit knowledge by codifying it through pictures, manuscripts and similar activities. The conversion sets the base of creation of new knowledge, in the form of *Combination* discussed in next point.

3. Combination *-from explicit to explicit knowledge*

   The process of *Externalization* helps create explicit knowledge from existing tacit and in the combination process, the explicit knowledge from different areas is connected through formal exchanges like documents, meetings and networking. This enables the creation of new knowledge in the firm.

4. Internalization *-from explicit to tacit knowledge*

The explicit knowledge existing in organisations is now converted to tacit knowledge through learning by doing. This is the process that makes the knowledge as a valuable asset because the individuals and the organisation will now embody the knowledge into their cognizance to create new knowledge and thus share same mental models for sharing with other individuals of the organisation.

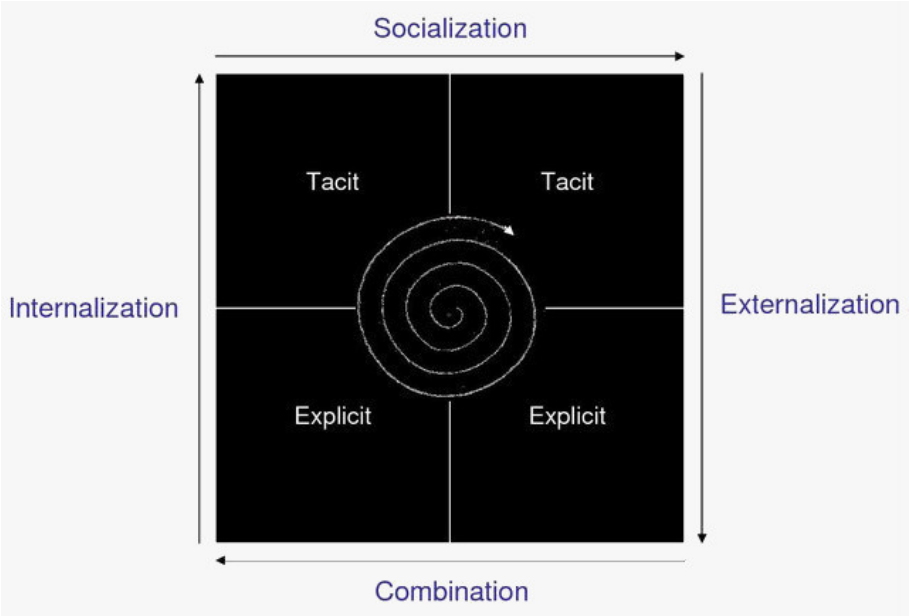


Figure 2.2.1: The Knowledge Creation Process

2.3 The Resource-Based View and Knowledge as a Strategic Resource

The element of most importance for this thesis is capabilities of a firm to utilize *External Knowledge* as a resource, but the question that remains unclear is that *'How is Knowledge a strategic resource?*. To find this out a literature analysis is done to understand what is meant by resources in management and how does knowledge qualify as a strategic resource.

Literature in strategic management science that illustrates the resource-based view and competitive advantage was studied. The strategy management science literature is overwhelmed with studies of resource utilization in firms to understand and answer how do firms effectively compete with each other and why do some firms perform and grow differently than other firms and the strategies behind their high rate of returns, also known as rents (example Barney [1991]; Porter [1985] Grant [1996]; Wernerfelt [1984]). The answers that most economists found consensus

with is with how firms manage the resources they have strategic control on (Barney 1991; Wernerfelt 1984).

As per [Mahoney and Pandian, 1990] the RBV studies could be said to have stemmed out from Penrose [1959] who distinguishes resources as anything under the heading of land, labour and capital which can be further sub-classified depending on the contextual problem. Mahoney and Pandian [1990], building on this management scholars' works extend the theory to define resources as firms capability to generate above normal rate of returns called as 'rents' from it to achieve competitive advantage (Porter [1985];Barney [1991]; Mahoney and Pandian [1990]).Wernerfelt [1984] recognizes resources simply as anything that could be seen as tangible or intangible assets which can be thought of as strengths and weakness of a firm.Wernerfelt [1984] asserts that differences in performances of firms can be explained using RBV as firms can enjoy rents in quasi-monopolist form because of possessing resources which other firms do not possess. suggest that firms generate high rents not just because of possessing these resources but also the capability of the firm to use it in a logical manner. Thus, the Resource-Based View of the firm is a focus on how firms use resources and their capacity to generate profit from such resources to get a competitive advantage.

The field of strategic management finds the work by Barney [1991] as seminal and is such widely referred to base a firm's strategy to realize competitive advantage on the basis of resources. The author defines *resources* as all assets, capabilities, organisational processes, firm attributes, information and knowledge. (Barney [1991], page 101). Barney [1991] explains the underlying link between the firm's resources and their sustained competitive advantage. Here, he defines *competitive advantage* as when a firm implies a value-creating strategy which is not implied b any other competitor in the market simultaneously. The important assumption behind this study is that firms strategically control resources that are heterogeneous and immobile, as opposed to earlier studies that assumed that firms operate in market conditions with homogeneous and perfectly mobile resources. The major findings of the study provide a framework known as 'VRIN' an acronym for Valuable, Rare, Imperfect Imitability and Non-Substitutability (Figure 2.3.1). The VRIN framework lays down four attributes that a firm should have with respect to its resources in order to achieve sustainable competitive advantage. The attributes are that;

- *The resources must be valuable.*
  Barney [1991] argues that Resources are valuable when they allow a firm to be in a position to implement strategies that might improve their efficiency by improving their performance. Firms can improve their performance when the resources they manage are able to

exploit opportunities and defend them from threats due to the firm's environment.

- *The resources must be rare*
  The resources a firm possesses to craft strategies to be in a situation to use valuable resources, it must be seen because the resources owned by the firm should not be owned by its competitors. In a situation when the resources are not rare, the competitors can implement the same strategies and thus no position of competitive advantage can be reached.

- *The resources of the firm should be imperfectly imitable*
  To achieve competitive advantage, the firm should have valuable strategies and rare resources, which its competitors do not possess, but these valuable strategies due to the rare resources should not be imitable to avoid other firms from imitating the same strategies. The virtue of imperfectly imitable resources explains the *first mover advantage* the firm might enjoy.

- *The resources of the firm should be should not have substitutability*
  Last but not the least attribute, the resources which can provide competitive advantage through implementing strategies that make them valuable, imperfectly imitable and rare should not be easily substituted. This means that even if the firm has resources that make it achieve competitive advantage through its strategies, the competitive advantage will not be sustainable if other firms can implement the same strategies but using different resources

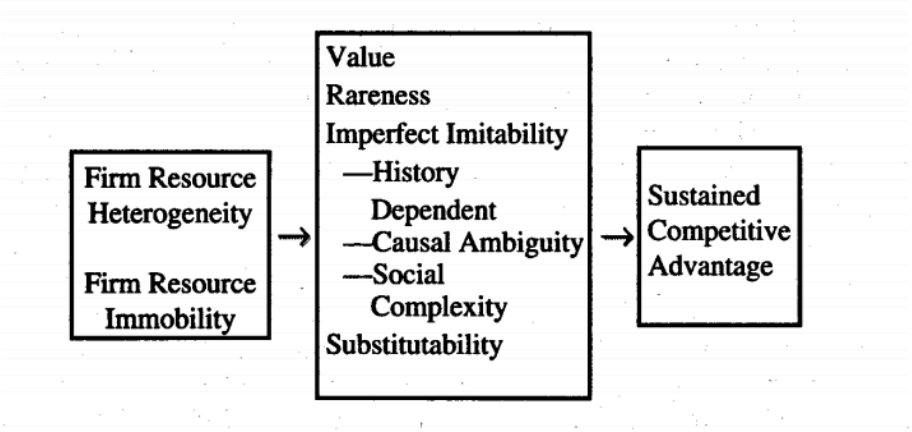


Figure 2.3.1: VRIN Framework of Resource Based Competitive Advantage (Barney,1991)

Hamel and Prahalad [1990] explain how firms use their resources to build up core competencies and leverage it to diversify their product portfolio. They cite an example of 3M whose adhesive technology application knowledge resource is leveraged to produce multiple products,

like Post-It Notes, Sticky tapes et cetera –they do so to highlight the fact that US firms do not lack technical resources, but firm's ability to compete in the market for a larger market share of its products depends on the ability of the managers to convert their resources to core competencies as shown by the case of 3M, where a large product portfolio is achieved even though the core competency is limited. This is in line with Barney's (1991) version of RBV to see resources as valuable assets.

2.3.1 Resources and Dynamic Capabilities

Other RBV school of thoughts see resources as dynamic capabilities and competencies. Amit and Schoemaker (1993, p.35) describe capabilities as the firm's capacity to deploy resources. They (Amit and Schoemaker [1993]) claim that the capabilities are deployed into resources using information based organisation processes which are developed over time and become *invisible assets*' to the firm. These capabilities can help firms to reduce their product development cycles and gain strategic flexibility and ultimately become a source of economic rents and sustainable competitive advantage. (Amit and Schoemaker, 1993), thus repackage the success factors for competitive advantage for firms as:

- Strategic Industry Factors which are the set of resources and capabilities that are prime determinants for economic rents in the industry.
- Strategic Assets which are a set of firm-specific resources which help in creating and protecting the position of competitive advantage.

and the success of a firm depends on the extent to which they overlap their strategic assets and strategic industry factors.

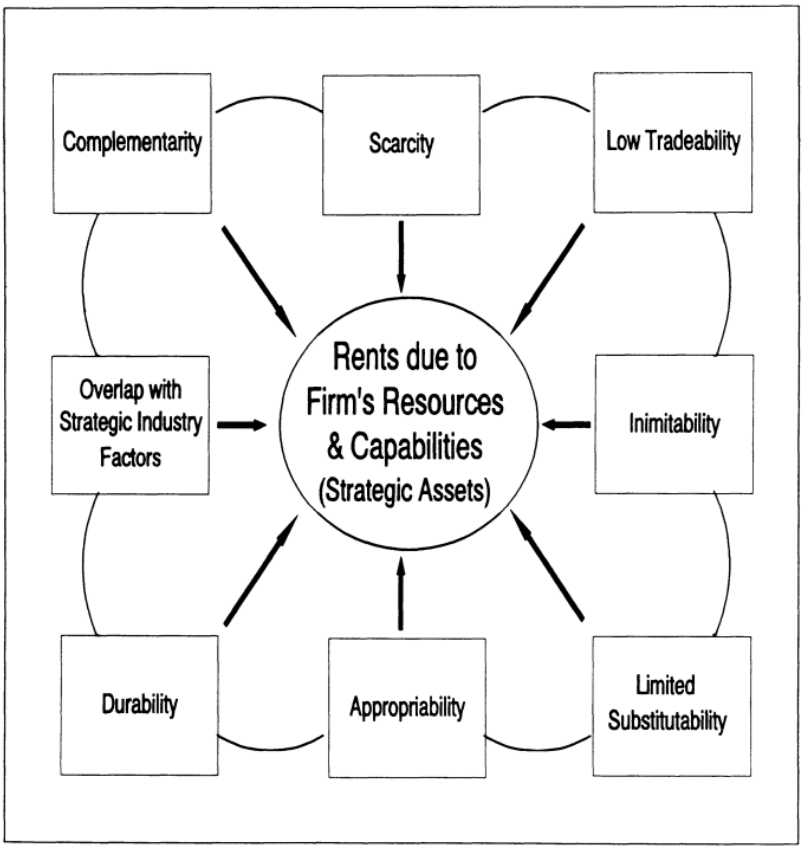


Figure 2.3.2: Resources as Strategic Assets (Amit and Schoemaker, 1993, p.38)

2.4 The Knowledge-Based View

A knowledge-based view of the firm is seen as an extension of Resource-Based View of the firm, where the scholars assert that knowledge is a resource important for achieving competitive advantage. Grant [1996];Kogut and Zander [1992] add to the theory of the firm from the knowledge-based view perspective by suggesting that the firm exists on the basis of managing knowledge. They put forth a model as shown in figure 2.4.1 for how organizations manage their knowledge capabilities to grow and explain firm as a bundle of capabilities due to knowledge in its social network, meaning that existence of a firm is because firms use knowledge to build their products and services.

[Grant, 1996] assesses the role of knowledge in joint ventures to conclude that in a knowledge-based economy, knowledge serves to be an important resource in the form of joint alliances. This is also studied by [Mowery et al., 1996] who conclude that the capabilities of the firm are influenced by knowledge interactions between strategic allies.

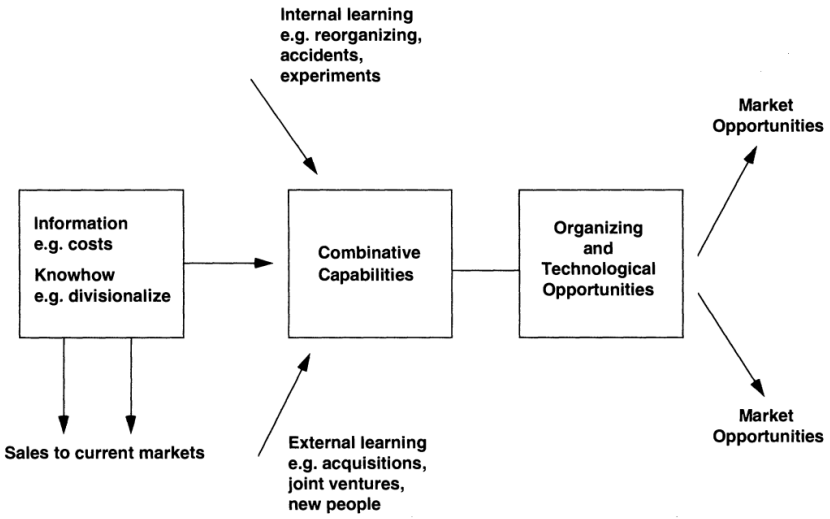


Figure 2.4.1: The growth of knowledge in firm (Kogut and Zander, 1990

Charles [2003] sees university entrepreneurship as an important factor in regional development as the university knowledge and economic rents from university engagements become a vehicle for technology transfer. This can be seen in the light of Knowledge-Based View as the university and its partner relationships are crucial for the economic development of a regional, and thus making knowledge a strategic resource.

Van Geenhuizen and Soetanto [2009] also suggest that university incubators are important from knowledge-based view because the founders usually have their origins or close relationships with the university and this enables a direct transfer of knowledge from university to the companies. Thus, we can say that academic spin-offs are explained by the Knowledge-Based view as the academic spin-offs find their foundations in commercializing their knowledge obtained from the university.

Lockett et al. [2005] argue that academic spin-offs are ventures created by commercializing university knowledge thus the differences in the performances of different spin-offs is based on the knowledge related obstacles they face at different levels. This confirms the knowledge-based view of the firm as it indicates that knowledge is a crucial resource for academic spin-offs.

Part II

2.5 Incubators and Academic Startups from Knowledge-Based View

2.5.1 Growth of Academic Start-ups

Bergek and Norrman [2008] have studied the Swedish incubator ecosystem to deliver a framework of the support an incubator might provide to the tenant startups it hosts. According to the authors, an incubator, regardless of the nature working, that is for profit or not for profit works towards mainly two types of goals, that are:

- Enhancement of economic development, along with a reduction of unemployment in a region, training and largely, training entrepreneurs to aid the growth of startups
- Commercialization of scientific research and facilitating technology transfer from universities and research institutes to technology-based firms, especially in the case of emerging technologies

The critical junctures that an academic startups experiences in their process of growth from the event of identifying an opportunity of commercial potential to the point of enjoying sustainable returns from it were first identified by Vohora et al. [2004]. Vohora et al. [2004] investigated 9 spin-out companies, that were technology-based startups in the development of academic spin-offs through a case study methodology, (referred to as University Spin-offs or USOs in their literature) and identified the critical phases of development and the critical junctures that arise and are needed to be crossed in order to progress to the subsequent stages of development. Various literature articles use this framework to study development of academic startups in a region, this study also gives us an important insight into how academic start-ups have a constant requirement of knowledge as a resource at different phases of development and thus the role of incubators become stronger to help young academic start-ups to acquire the external knowledge it needs.The critical junctures are the conditions an academic spin-off should overcome in order to progress to the subsequent next stage of growth.

As seen in figure 2.5.1, the critical junctures are as follows

- **Critical Juncture A: Opportunity Recognition** this critical juncture is navigated to transit from research phase to opportunity framing phase. Thus, Vohora et al. [2004] define opportunity recognition as the match between an unfulfilled market need and a solution that fulfills that market need, which others might have overlooked. They (Vohora et al. [2004] add that this phase involves the acadmeic startup's to develop a set of skills, which

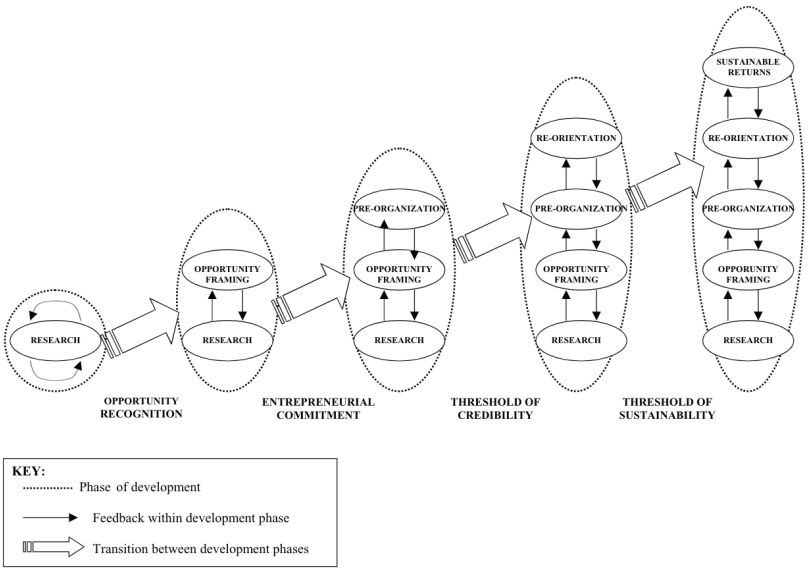


Figure 2.5.1: Navigating Critical Junctures Vohora et al. [2004]

can be seen as their dynamic capability to build a connection between the specific knowledge they possess and the commercial opportunity that arises from it. Vohora et al. [2004] stress that without building such capabilities for navigating the critical juncture of opportunity recognition, the academic startup might find it difficult to find commercial opportunities for their knowledge possessions.

- **Critical Juncture B: Entrepreneurial Commitment** According to Vohora et al. [2004], this is the critical juncture needed to be crossed in order to move from opportunity phase to the state of 'pre-organisation' the academic startup should be able to navigate the critical juncture of entrepreneurial commitment. Thus, they define entrepreneurial commitment as the actions that bind the venture to their course of events. The authors suggest that entrepreneurial commitment requires individuals to develop a solid committed to their recognised opportunity for commercialisation and a failure to tackle this critical juncture may lead to weaknesses and deficiencies in decision making and successful exploitation of technology for sustainable returns and also failure in establishing credibility.

- **Critical Juncture C: Credibility**

  This is the critical juncture that a firm has to navigate once they have successfully identified their opportunity for commercialisation and now require initial stock of resources to start their function. In all of the nine cases studied by Vohora et al. [2004], this critical juncture was the most crucial to attract business angels, seed capitalists and venture cap-

italists, therefore maintaining healthy customer relationships and acquisition of key customers becomes an important element in order to navigate this critical juncture. In other words, during the navigation of this juncture, the academic startups should be in a position to create and deliver value to its customers.

- **Critical Juncture D: Sustainable Returns**

  According to Vohora et al. [2004], after successfully navigating the critical juncture of Credibility and receiving the seed finance, the academic startups now move to this final juncture of exploiting their technology and technological assets for commercialisation. This juncture marks the beginning of sustainable revenues from customers and a sign to the investors that the academic startups have the ability to deliver and create value out of their products for financial returns.However, even after reaching here, the firm still has to show consistency in development of their internal capabilities that help them strategically configure and reconfigure their resources.

  Khodaei et al. [2012] suggests that this is the juncture where the support of business incubators is very crucial because of opportunities that the incubator may provide to access key financial resources and build strong networks and relationships.

2.5.2 Incubators & Managing External Knowledge-Open Innovation

Khodaei et al. [2012] explain that the five fundamental support services an incubator provides help to the academic startups to navigate five critical junctures. We can identify the characteristics of external knowledge as a resource support an incubator might provide to the academic start-ups with the help of the study conducted by Khodaei et al. [2012].Khodaei et al. [2012] extensively study the incubator and academic startups literature to identify the fundamental types of facilitator support. They identify the support system focused on majorly five types of fundamental facilitator supports; *Infrastructure Support, Business Support, Financial Support, Social Support* and *Legal Support*

Type of Support (Khodaei et al. [2012]	Description	Knowledge Type (Author's interpretation)
Infrastructure Support	Provision of working space, which includes reception, meeting and conference rooms, laboratories, equipment etc.	No direct Knowledge Support but indirect Tacit support
Business Support	Mentoring/Coaching and Individual Counselling. Facilities can vary from business plan drafting training and providing training to approach potential business investors	Explicit and Tacit Knowledge Support
Financial Support	Direct or indirect access to venture capitalists, assistance in financial planning, grants for growth paid from public funds, seed capital in return of equity	Explicit Knowledge Support
Social Support	Providing a link to professional contacts, stakeholders and networks of individuals and organizations with the goal of building the firm's social capital	Explicit knowledge Support
Legal Support	Development of procedures to protect the academic spin-offs from exploitation, for instance, specialized legal consultancy and advise on appropriate costs of Intellectual Property	Explicit and Tacit Knowledge Support

Table 2.5.1: External knowledge from types of Business Incubator Support to the Academic Startups based on Khodaei et al. [2012]

The types of support as seen in figure 2.5.2 can also be seen as managerial actions that facilitate open innovation and help the academic startups in the business incubator Yes Delft to develop heir dynamic capabilities.

Figure 2.5.2 ***(following page)*****:** Types of Support- Infrastructure, Business, Financial, Social and Legal that help in creating Explicit and Tacit Knowledge Resources. These support can be seen as examples of managerial processes of implementing Open Innovation and developing the dynamic capbilities of academic startups in the incubator. (Source: Retrieved from publicly available information on Yes!Delft [nd]


BUSINESS MODEL


Building
tomorrow's firms
leaders

2.6 Absorptive Capacity

2.6.1 Definition

In the previous sections we have understood what is knowledge and the importance of knowledge as a strategic resource in providing competitive advantages to a firm, but should the firms develop this knowledge internally or externally? —this was still unclear until Cohen and Levinthal [1990] tried to fill this research gap by analyzing the relationship between a firm's investment in R & D as the input and its effect on the firm's performance as the output and subsequently introducing the term absorptive capacity. The idea of absorptive capacity has existed in management science in the form of prior-knowledge, organizational learning etc., however, it was first conceptualized as a management term by Cohen and Leventhal's widely cited work on managing external knowledge of the firm ([Cohen and Levinthal, 1990]). It is from the paper by Cohen Leventhal that the management science gets an accepted definition of absorptive capacity as

"'the ability of a firm to recognize the value of new external information, assimilate it and apply it to commercial ends" ([Cohen and Levinthal, 1990], page 129).

The definition explicitly highlights the argument that all firms behave differently (heterogeneously) and the ability of a firm to handle the knowledge it possesses decides the commercial appropriability of its products and ultimately how it can be exploited for competitive advantage.Cohen and Levinthal [1990] argue that knowledge flows from outside the boundaries of the firm are significantly critical to the firm's innovative capabilities. The ability to evaluate the knowledge stocks from external knowledge is a function of the firm's prior knowledge which may exist in the form of shared basic skills, knowledge of recent technological developments or even a shared language. However, absorptive capacity can also be generated.Cohen and Levinthal [1990] seminal work proposed a critical link between the importance of external knowledge and the innovative capabilities of a firm. Their work suggests that ACAP is essentially a by-product of firm's R&D investment, manufacturing operations with the help of being directly involved in manufacturing, and experience of production and as a result of sending employees for advanced technical training. This explains to us that even though firms work in an intensive economy with an abundance of knowledge available around them, firms cannot expect high economic rents or better capability to innovate merely by the virtue of being exposed to external knowledge but it is essential to constantly invest in R&D efforts to appreciate external knowledge and assimilate

it in their human capital, products and processes. Cohen and Levinthal [1990] also suggest that absorptive capacity is a component of the firm's decision-making ability to allocate resources for innovative activity.

For almost a decade, the phenomenon of ACAP attracted importance and various studies were performed to study ACAP and its effects on various organizational outcomes, however, due to weak operationalising and different definitions of the research made the concept of ACAP significantly vague. It was thus essential to carve out clarity in defining the construct ACAP, which was eventually recognized by Zahra and George [2002]. Zahra and George [2002] stood on the shoulders of giants by collating all relevant past researches on organizational learning to conceptualize ACAP as

"a set of organizational routines and processes by firms acquire, assimilate, transform and exploit knowledge to produce a dynamic organizational capability" (Zahra and George [2002])

2.6.2 Dimensions of Absorptive Capacity (ACAP)

Cohen and Levinthal's definition of ACAP gives us the core components of ACAP as 'recognition', 'assimilation' and 'exploitation' of external knowledge while other prominent works like Lane and Lubatkin [1998] see it from organisation learning and skills point of view.

To reconceptualize ACAP Zahra and George [2002] propose a multidimensional framework of ACAP with four recognised dimensions –Acquisition, Assimilation, Transformation and Exploitation. This multidimensional classification of ACAP by Zahra and George [2002] has served to be a repetitive framework in various further researches ACAP. Following is the description of the absorptive capacities

2.6.3 Potential Absorptive Capacity (PACAP)

PACAP constitutes of two dimensions of ACAP -Acquisition and Assimilation. Zahra and George [2002] suggest that PACAP is crucial for building up capabilities to value and acquire new knowledge but does not explain the exploitation of this knowledge for returns. However, they maintain that PACAP is an important dimension because firms cannot exploit their external knowledge unless they acquire it and assimilate it into their routine and practises. This is in line with Cohen and Levinthal [1990] version of ACAP that maintains that merely exposed to external knowledge isn't sufficient but the capability of acquiring and assimilating the knowledge is what helps a firm exploit the knowledge for competitive advantage. The two dimensions of PACAP are now briefly discussed.

Acquisition

Zahra and George [2002] define acquisition as a firm's capability to identify and acquire externally generated knowledge that is critical to its operations (p. 189).

They maintain that the quality of a firm's acquisition capability is affected by the efforts that the firm put in with respect to the intensity, speed and direction of the knowledge acquisition and greater the efforts put in, quicker the firm builds up its acquisition capacity. The importance of knowledge acquisition has also been verified by various other scholars like Van Geenhuizen and Soetanto [2009] and Lane and Lubatkin [1998].

Assimilation

Zahra and George [2002] define assimilation as a firm's routines and processes that allow it to analyze, process, interpret and understand the external knowledge.

The core of this dimension is understanding or comprehending the knowledge, which to a great extent differs from firm to firm. Comprehension of knowledge can be difficult because it comes with various context-specific features which prevent the managers from replicating it unless they develop the intellectual capital in the form of expertise that promotes the process. This is where knowledge as a strategic resource and it's management comes into play and that decides how the knowledge acquired is ready for exploiting for rents.

2.6.4 Realized Absorptive Capacity (RACAP)

RACAP consists of two dimensions of ACAP as well, that is, Transformation and Exploitation.

Transformation

Transformation is the third dimension as put forth by Zahra and George [2002]. By *'Transformation'* Zahra and George [2002] mean the firm's capabilities to develop and refine the routines that are followed to facilitate a combination of existing knowledge of the firm and the knowledge from PACAP (acquire and assimilated).

According to the authors, this happens due to the phenomenon that arises due to the capacity of the firm, known as *'bisociation'* which helps the firm recognize two different schemes of the idea or set of information and convert them into a single scheme of information that is useful. This bisociation capability is responsible for entrepreneurial actions because by practising transformation capabilities, firms help shape their entrepreneurial mindset. This leads to the overall assessment of their competitive landscapes and promotes opportunity recognition and shaping strategic change.

Exploitation

The seminal work of Cohen and Levinthal [1990] on ACAP discussed the end results of an organization capable of handling external knowledge as exploiting it for commercial use.

Zahra and George [2002] build on this to classify exploitation as one of the dimensions of ACAP that deals with organizational capabilities based on firm's routines that permit leveraging of acquired and transformed knowledge into its operations to create new knowledge and competencies

2.7 Absorptive Capacity and Open Innovation

Cohen and Leventhals' work has inspired other scholars to use it in management science (Lane and Lubatkin [1998],Jansen et al. [2005].Lane and Lubatkin [1998] view absorptive capacity from an inter-organisational learning point of view, more specifically from a teacher firm and a student firm narrative, where the knowledge-generating or knowledge sharing firm is regarded as the teacher firm, while the learning or knowledge capturing organisation is regarded as the student firm. The authors used a sample of pharmaceutical (as students) and biotechnology-based firms (as teachers) and found empirical evidence that the concept of absorptive capacity is *relative*, meaning that knowledge transfer between two organizations is fruitful when the so-called 'student' firms have well understood and refined routines and processes in place which help them to manage knowledge as an asset, just as they would manage physical assets in their organisation. Thus their contribution in re-conceptualizing absorptive capacity as a 'dyad' relationship hints to us that absorptive capacity is a component of crucial managerial processes which enable a firm to develop routines and experiences and as suggested by Lane and Lubatkin [1998], as the competition becomes more and more knowledge-intensive, the firms should have adequate understanding of their own knowledge handling process so that they benefit competitive advantage through their performance and use knowledge as an important asset (p. 474).

Following Lane and Lubatkin [1998] work on absorptive capacity as inter-organisational learning, it can be understood that a firm should work as a student to find the best teacher outside the firm's boundaries. This makes absorptive capacity and open innovation as blades of the same scissor because open innovation makes a firm's boundaries permeable to purposed inflow of external knowledge, for the case of academic start-ups, as discussed in previous chapters, SMEs like academic start-ups lack resources to generate innovation outcomes solely on the basis of their own research and development efforts and largely depend on their social capital and complementary knowledge generation assets, like universities. This makes academic start-ups (SMEs) inclined

towards openness to most obvious centres of innovation -that is university and becomes a powerhouse of open innovation. Investigating further on dynamic capabilities, Ambrosini et al. [2009] compare different typologies that are developed to understand dynamic capabilities. Ambrosini et al. [2009] suggest that dynamic capabilities develop at different levels depending upon the type of environment the firm operates in. Thus, a marriage of open innovation and absorptive capacity should be firmly visible in the functioning of academic start-ups in university incubators.

Potential Absorptive Capacity (PACAP) includes the dimensions of acquisition and assimilation capacities, which focus on the capacity to explore and process knowledge outside the boundaries of the firm. In implementing open innovation, companies try to achieve competitive advantage by leveraging discoveries of others into their products and it is highly relevant to high-technology based firms [Chesbrough and Crowther, 2006]. From the knowledge-based view of the firm, here external knowledge becomes a strategic asset [Amit and Schoemaker, 1993] which should be complemented with implementation strategies that help the organisation use it as *valuable* and *rare* resources [Barney, 1991] for which the organisations might have to build their realized absorptive capacity (RACAP) that deals with exploitation and transformation capacities of the firm to determine commercial applications of their resource and combine it with their internal knowledge.

As management scholars who studied absorptive capacity suggest ([Cohen and Levinthal, 1990]; [Zahra and George, 2002]) the capability to acquire and assimilate external knowledge is embedded in the organisation routines of the firm, it can be implied that set of actions taken to implement open innovation enable the absorptive capacity of the firm. In the context of university incubators, the academic spin-offs largely depend on external knowledge to innovate and leverage knowledge to their products and services and try to find suitable partners in their social network to use for complimenting their lack of resources ([Van Geenhuizen and Soetanto, 2009]). However, there is still no research done for academic spin-offs which focus on the processes that implement open innovation and how does it translate to valuable outcomes based on the academic spin-offs capabilities [Shutyak, 2016]

Zobel [2017] has developed a multidimensional model of absorptive capacity for open innovation. This study identifies the original three components of absorptive capacity: recognition, assimilation and exploitation and links with the competitive advantage. The author investigates the absorptive capacity and its effects on the competitive advantage of firms and in doing so absorptive capacity has been conceptualized as a component that is captured by the underlying process based on an open-innovation related set of actions.

The work by Zobel [2017] to reconceptualize absorptive capacity as a dynamic-capability of a firm due to the embedded organizational actions which are based on a set of open innovation paves way for management scholars to see absorptive capacity in a new light and also provides important linkages of open-innovation and absorptive capacity as dynamic capabilities of the firm. The open innovation based set of actions used in the model are a result of a comprehensive compilation of open innovation literature and matching it to its corresponding absorptive capacity dimension. The results of this research highlight the inter-organisational relevance of absorptive capacity and close the research gap of explaining how firms translate their openness to external technological resources into a competitive advantage.

The most attractive feature of open innovation is shunning the traditional closed innovation model to make the boundaries of the firm more permeable to external knowledge sources. In our attempt to study the translation of openness of an academic start-up to innovation outcomes, it becomes natural that the external knowledge sources are the knowledge obtained from universities which are exploited by these start-ups. However, just the collaboration with university incubator will make the firm exposed to external knowledge but does not necessarily guarantee that it will be exploited unless the external knowledge from universities include the capability to value and acquire this available knowledge they have access to.

Zobel [2017] label such knowledge in-flow as "external technological resource access" defined as the knowledge that dwells in the firm's external network which is a requisite for commercializing the technology know-how into its products. The author finds that external technological resource access in open innovation has an indirect relationship with the competitive advantage and is dependent on a positive relationship between recognition capacity and moderation effects of assimilation capacity. Thus, this research is in line with knowledge as from resource-based view and helps explain differences in benefiting from knowledge as an asset and open innovation as an organizational behaviour of functioning.

Further investigation on dynamic capabilities is done by Ambrosini et al. [2009] who compare different typologies that are developed to understand dynamic capabilities. Ambrosini et al. [2009] suggest that dynamic capabilities develop at different levels depending upon the type of environment the firm operates in. Therefore, the model developed by Zobel [2017] should be valid to assess different levels of organizational capabilities and capacities as it intends to do so. The final nomological model by Zobel [2017] is thus a hierarchical framework that in which the open innovation activities are denoted as *low order processes* and the corresponding dimensions

of absorptive capacity as *higher order components of absorptive capacity*.

The multidimensional model developed by [Zobel, 2017] is as shown in figure 2.7.1. As seen in the figure, the dimensions of absorptive capacity are higher-order components of their respective lower-order managerial actions (External Scanning, Strategic Assessment, Coordinating, Integrating, Knowledge Management, Resource Cognition, Recombining) taken by organizations as business tasks.

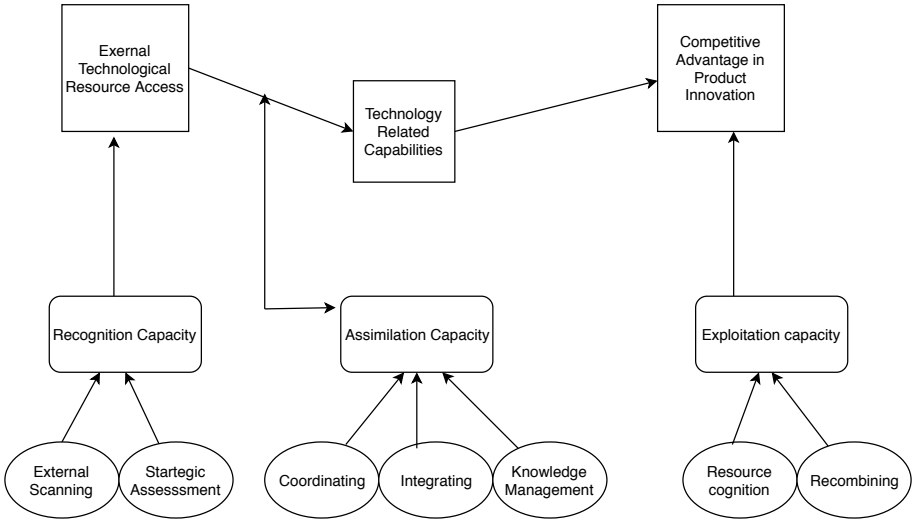


Figure 2.7.1: Structural Model of Absorptive Capacity for Open Innovation by Zobel [2017]

This model also supports the suggestions by [Cohen and Levinthal, 1990] that absorptive capacity as a firm's dynamic capability is embedded in its organization routines. The approach taken to build a testable conceptual model is to open the black box of the managerial activities a firm performs that drives its absorptive capacity and the impact of the activities on innovation outcomes. [Stevenson and Jarillo, 1990] has put forth a set of propositions that identify the following managerial actions as

1. Pursuit of opportunities
2. Attitudes of individuals
3. Efforts to lessen negative consequences due to failure
4. Abilities of the employees to exploit opportunities

which are also the final explanation of absorptive capacity as a dynamic capability of a firm. Therefore, we can conclude that managerial actions taken by the firm for open innovation should

be a component of absorptive capacity that is embedded in the routines of the organisation.

Hypothesis 1: *There should be a positive significant relationship between open innovation activities and absorptive capacity of the firm.*

2.7.1 Path Dependent Nature of Absorptive Capacity

One of the important highlights of Cohen and Levinthal [1990]'s work is the path-dependent nature of ACAP. According to the authors, the new knowledge of a firm is dependent on prior knowledge and experience making ACAP cumulative capability. Therefore, it is not the sum of individual capabilities but the capacity of the organizations as a whole to develop the dynamic capability (ACAP). This means that if an organization develops absorptive capacity in one time-period, it will be accumulated and this will make it easier to permit more accumulation of absorptive capacity in the successive period, thus making better predictions and exploitation of their technology's market applications in their products.

The consequences of low investment in ACAP will result in a phenomenon which the authors term as *'technological-lockout'* which means that the firms will not be able to make better use of the knowledge they receive and make no use of technological opportunities developed due to the changing market situations. Thus the path-dependent nature of absorptive capacity is a crucial factor in a firm's success. It is important for the firm to make use of expertise available with it to proactively exploit technological opportunities. The authors further add that a higher absorptive capacity helps the firm to cope up with difficulties due to the process of creative destruction as explained by Schumpeter (1942).

Academic start-ups in University incubators enjoy additional entrepreneurial support from the facilities at the incubator, like business courses and marketing, sales skills etc which makes them different from other SMEs from resource-based view because the non-incubator start-ups have to invest additional resources in developing these capabilities, therefore, university incubator as a parent organization should act as a complementary support in helping organizations develop their absorptive capacity. As a result, the absorptive capacity of university start-ups should show a path-dependent relationship.

Hypothesis 2a: *Acquisition Capacity of should have a positive relationship with Assimilation Capacity*

Hypothesis 2b: *Assimilation Capacity should have a positive relationship with Transformation*

Capacity

Hypothesis 2c: *Transformation Capacity should have a positive relationship with Exploitation Capacity*

2.8 Absorptive Capacity and Competitive Advantage

The fundamental viewpoint of Knowledge-Based View is that knowledge as an asset is important in achieving a competitive advantage. Zahra and George [2002] argue that absorptive capacity as a dynamic capability should be able to explain the competitive advantage of a firm. The model of Absorptive Capacity by Zahra and George [2002] is as seen in figure 2.8.1

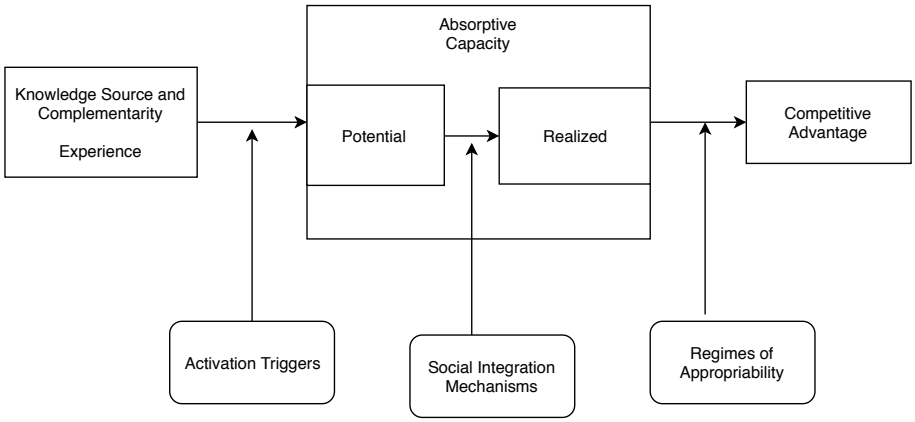


Figure 2.8.1: Model of Absorptive Capacity by Zahra and George [2002]).

Zahra and George [2002] suggest that the firm's working environment is important in decision making and problem-solving capabilities of the firm. In their model, they consider external knowledge sources as knowledge acquisition through licence purchasing, contractual agreements and inter-organizational relationships (p.191). In the context of academic start-ups which are resource-deficient, the knowledge sources are found outside the boundaries of the firm and are facilitated by incubator programs like business courses, university research and facilities and existing professional networks with the university. As seen in the research by Zobel [2017], this knowledge is sourced through open innovation activities that help build the corresponding absorptive capacity of the firm.

Trott et al. [2008] discuss that the support of university incubator as a parent organization poses a different nature of the relationship, as the university incubator might tend to control and embrace the spin-offs too closely with their mentorship and interference in business approach.

It can be argued that the support mechanism of the university incubator might help the firm develop dynamic organizational capabilities, temporarily for the time till they are in the incubator, but this might be interesting to check if the firm can translate the university support into a competitive advantage.

As discussed by Trott et al. [2008], the university incubator might help academic spin-offs to have a successful launch in the market that might increase the commercialization of its products capabilities, but the spin-offs might be not self-sufficient to analyze their external network, beyond the boundaries of the incubator. This might lead to their failure as a firm once they leave the incubator because the parent support which was excessive during the growth phase will be absent in the maturity phase. hence, it can be argued that university incubators might be an overprotective parent as suggested by Trott et al. [2008].

True to these propositions, Van Geenhuizen and Soetanto [2009] investigated and concluded that most spin-off firms in Delft region experience problems to perform and also fail to grow to more than 10 employees in 6 years. Van Geenhuizen and Soetanto [2009] also recommend that start-ups need professional support even after they leave the university incubator and still might need additional professional support beyond 4 years. These findings make the argument stronger that university incubator might give temporary dynamic capabilities to the firm, but the firm might not be able to able to achieve competitive advantages. However, one thing to consider is that these researchers were done in the last decade and then the incubator of Delft University had just begun its operations. The findings should be empirically tested for recent implications of university incubator support.

In the conceptual model, the outcome as the competitive advantage is based on the model of Zahra and George [2002] who operationalise competitive advantage due to absorptive capacity through their ability to provide the firm with innovation outcomes, strategic flexibility and performance Barney [1991]. Zobel [2017] suggests that the final outcome of open innovation activities is the performance in product development. Hence, the performance constituent of competitive advantage as in the model of Zahra and George [2002] can be taken as product development related performance.

Hence we hypothesize,

Hypothesis 3a: *There should be a positive relationship between Assimilation and Acquisition Capacity (Potential Absorptive Capacity and Strategic Flexibility*

Hypothesis 3b: *There should be a positive relationship between Assimilation and Acquisition Capacity (Potential Absorptive Capacity and Innovation*

Hypothesis 3c: *There should be a positive relationship between Assimilation and Acquisition Capacity (Potential Absorptive Capacity and Product Development Related Performance*

Hypothesis 4a: *There should be a positive relationship between Transformation and Exploitation Capacity (Realised Absorptive Capacity) and Strategic Flexibility*

Hypothesis 4b: *There should be a positive relationship between Transformation and Exploitation Capacity (Realised Absorptive Capacity) and Innovation*

Hypothesis 4c: *There should be a positive relationship between Transformation and Exploitation Capacity (Realised Absorptive Capacity) and Product Development Related Performance*

In our research, we aim to investigate the implications of the support of university incubator on the individual capabilities of the firm. Based on the research by Zobel [2017] and Zahra and George [2002], an integrative model of open innovation-absorptive capacity and competitive advantage of the firm is constructed and used for data analyses. The conceptual model is as seen in figure 2.8.2.

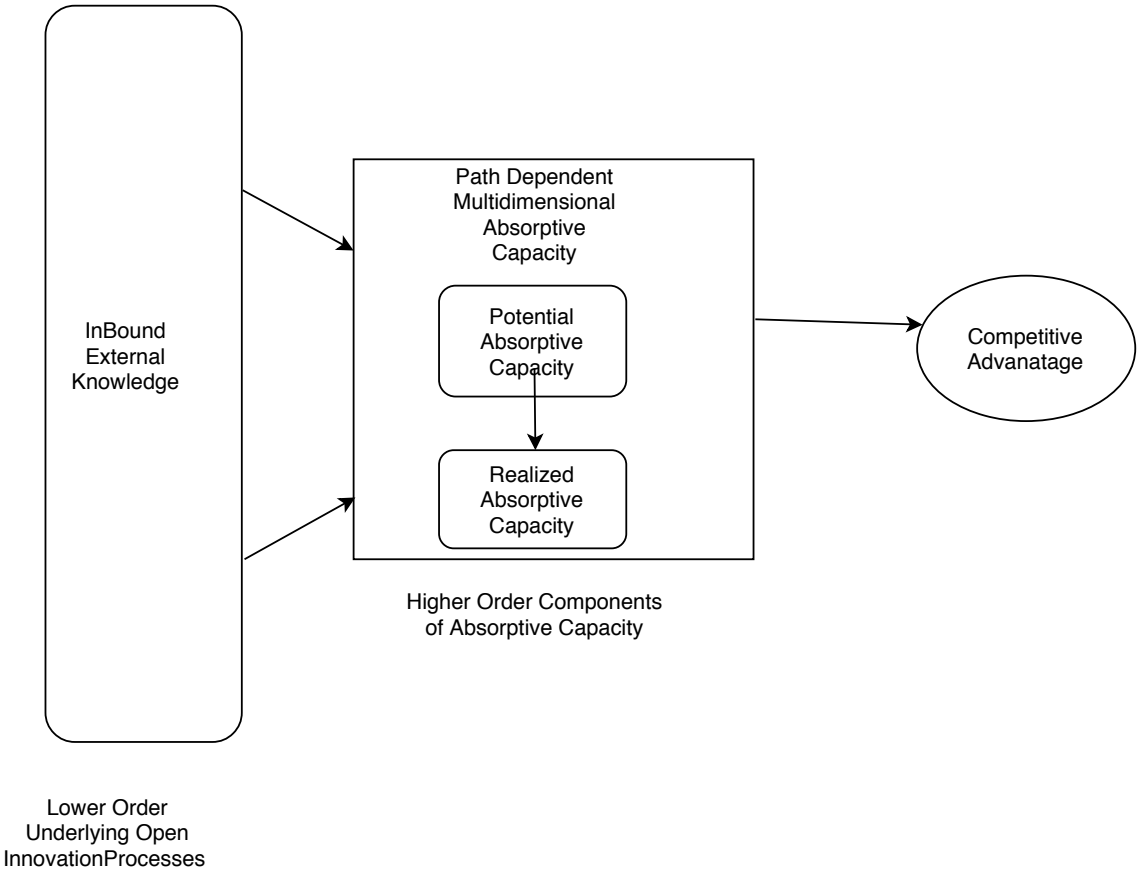


Figure 2.8.2: Integrative Conceptual Model based on Zahra and George [2002] and Zobel [2017]. The model is operationalized for data analysis using independent and dependent variables as seen in figure 3.2.1

3

Research Methodology

This chapter discusses the scientific research methodology followed in this thesis work to test the formulated hypothesis in Chapter 2 to answer the sub research questions as discussed in the introductory chapter and finally the main research question to arrive at conclusions. The upcoming sections discuss the data collection, sampling process, response rate of samples, data handling method for processes such as dealing with missing data, outliers and so on.

3.1 Data Collection and Sampling Strategy

The data used in this project was taken from an existing database collected by *Delft Center for Entrepreneurship* in the year 2014,2013 and 2012. However, in order to obtain insights as recent as possible the data was used only from the year 2014. The data consists of responses from start-ups which are housed at the university incubator of Delft University of Technology, YES! Delft (Young Entrepreneurs Society Delft) which is aimed at start-ups that use university related knowledge in the form of research infrastructure, technical know-how expertise, intellectual property or social capital like researchers and students as interns. This makes it appropriate for this research as they meet the definitions of an academic start-up. The data consists of responses from 80 start ups, but only 67 responses are useful for our research. This makes a response rate of close to 83,75%. (Please see Appendix 5.5.2

3.2 Structural Equation Modelling for Path Analysis

The conceptual model was built after the literature review in chapter 2. The constructs in the model need to be operationalized to test our hypothesis. The operationalization of constructs will help us build the theoretical research model for our analysis. The conceptual model consists of a hierarchical structure in which the dimensions of absorptive capacity are components of a set of open innovation activities. therefore, the dimensions of absorptive capacity are independent variables that are conceptualized using a set of managerial actions based on open innovation activity, as conceptualized by Zobel [2017]. The figure 3.2.1 gives us an overview of the conceptual model developed for testing.

3.3 Measure of Variables

Reducing the abstract concepts to render them measurable in a tangible way is called operationalizing the concepts. (Sekaran and Bougie [2016]). In this study, the variables are based on the conceptual model developed from literature reviews in Chapter 3 and 4. As we are trying to delineate the underlying open innovation process that correspond to the dimensions of absorptive capacity, we will have to construct a model with latent variables made up of indicator factors. Thus, in Table 4.1 we identify the independent variables, dependent variables, moderating variables and mediating variables used in this research.

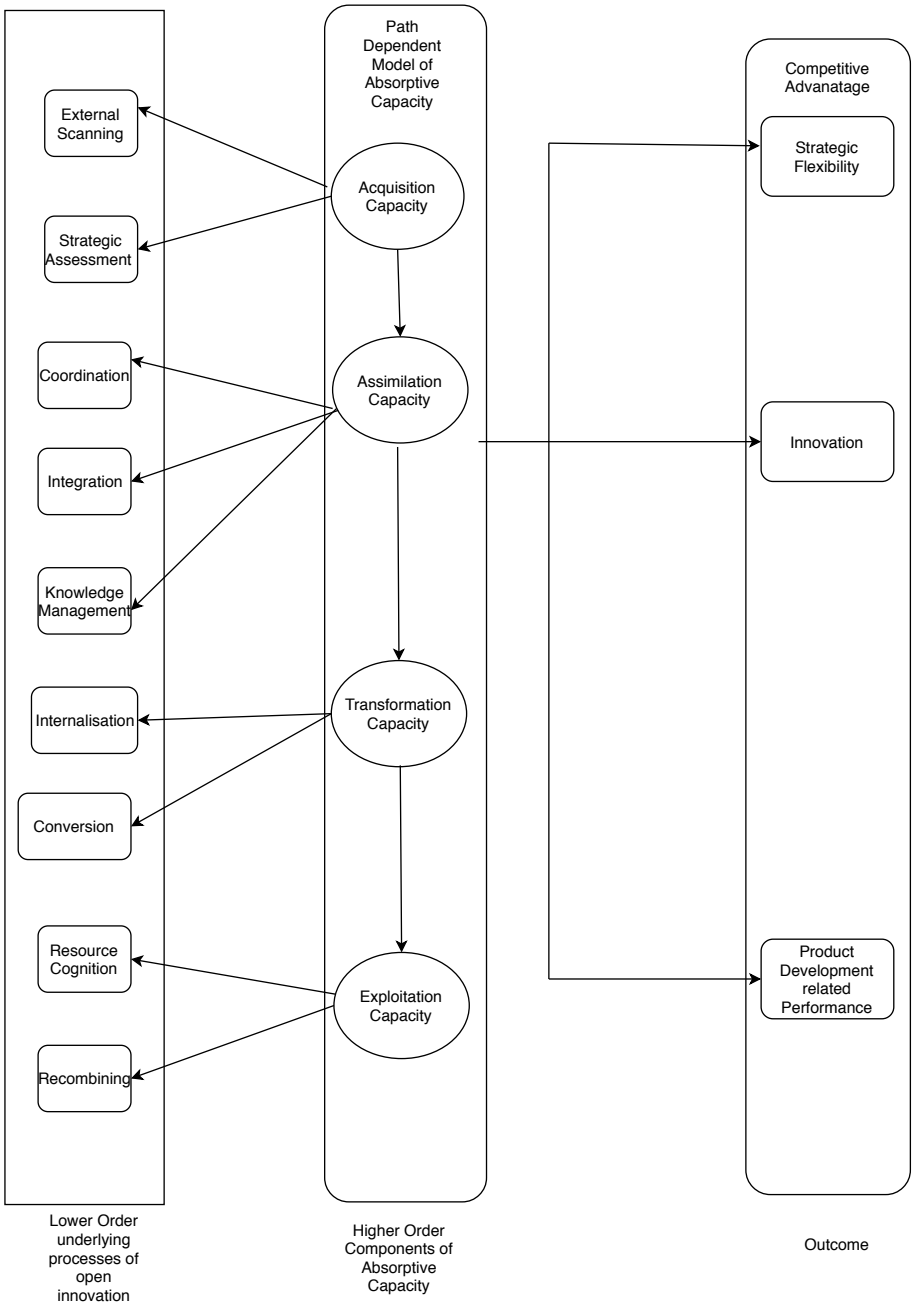


Figure 3.2.1: Structural Equation Model for Path Analysis

3.3.1 Independent Variables

This section discusses the independent variables used in the research. The independent variable constructs in this study are *Acquisition Capacity*, *Assimilation Capacity*, *Transformation Capacity* and *Exploitation Capacity*. These form the higher order component of the conceptual model and are unobserved. These constructs are seen as latent variables. The latent variables are operationalized using the set of open innovation managerial actions, as identified in the conceptual model

by Zobel [2017].

The following discussion focuses on the each independent construct (higher order component of absorptive capacity) and the underlying process (lower order actions of open innovation) that are observed values capturing their corresponding construct components. All the definitions are based on ([Zobel, 2017],page 272). The questionnaire items from the dataset are summarized in Table 3.4.1

Operationalizing Acquisition Capacity

- **External Scanning-** External Scanning refers to the process of wide range external monitoring of emerging partners, technologies and markets. This dimension is also researched by [Laursen and Salter, 2006] who found out that organisations that lack openness to external knowledge sources suffer consequences like failure in balance internal and external sources of knowledge flows, thus external search strategies and important component of knowledge acquisition capacity.

- **Strategic Assessment**- Zobel [2017] describes Strategic Assessment as the organisational activities that engage the organisation in evaluating external innovation sources and evaluating their business fit within the firm. This is a complimentary approach to open innovation as discussed by Chesbrough and Crowther [2006] where they suggest that not all important ideas come from outside the firm but the firm needs internal capabilities to evalute them as well. This is also in line with Cohen and Levinthal's (1990) suggestions that acquired knowledge should be analysed, which is enabled by the acquisition capacity of the firm.

Operationalizing Assimilation Capacity

- **Coordinating** Zobel [2017] describes the process of Coordinating as formal and informal mechanisms that an organisation performs to linking external knowledge resources with the firm's internal business.

- **Integrating** - Integrating is described as the activities that enable the implementation of external knowledge sources.

- **Knowledge Management**- it is the efforts put in by the organisation to have infrastructure or processes that enable codifying and disseminating external knowledge resource

Operationalizing Transformation Capacity

The research model by Zobel [2017] *does not* consider this dimension of absorptive capacity, however various further studies since Cohen and Levinthal [1990] have identified the importance of the transformation capacity dimension (example Zahra and George [2002]; Todorova and Durisin [2007]), therefore in our model we find it important to consider this dimension of absorptive capacity. To operationalize it, we take the components of transformation capacity as suggested by Zahra and George [2002]

- **Internalisation and Conversion**-

  As discussed in the SECI model in Chapter 2, Internalisation is the process of recodification and recognition of assimilated knowledge and Conversion is converting it into new knowledge for entrepreneurial actions (Nonaka et al. [2000].

Operationalizing Exploitation Capacity

Resource Cognition Zobel [2017] defines resource cognition as the internal evaluation and monitoring to identify problems.

Recombining The process of recombining is defined as activities to match external and internal resources and bundle them. This can also be seen as the component of exploitation capacity described by Zahra and George [2002] to be implementation of resources.

3.4 Dependent Variable

In this study, The cause and effect relationship studied is of independent variables (Dimensions of Absorptive Capacities as components of open innovation based activities) on Competitive Advantage. The Competitive advantage construct is conceptualized using the suggestions byZahra and George [2002] in their model of absorptive capacity. The construct competitive advantage is operationalized as *Strategic Flexibility, Innovation, Product Development Related Performance*. These three items are considered as separate *dependent variables* in the study.

- ***Strategic flexibility*** Strategic flexibility is the organization's. capability to identify major changes in the external environment, quickly commit resources to new courses of action in response to those changes (Shimizu and Hitt [2004], page 42). As suggested by [Barney, 1991] and [Porter, 1985], an organisation can achieve a competitive advantage position when it knows how to engage its resources, thus Strategic Flexibility becomes a source of competitive advantage.

Strategic Flexibility is measured using the following questions in the available dataset on 7-likert scale. (mostly disagree<—> mostly agree)

- We typically respond to actions which competitors initiate
  Variable in Dataset: Ent_Orient_D
- We typically seek to avoid competitive clashes, preferring a 'live-and-let-live' approach
  Variable in Dataset: Ent_Orient_F
- In general we prefer low risk projects (normal and certain return)
  Variable in Dataset: Ent_Orient_G
- We believe that it is best to explore new ideas gradually, carefully and incremental
  Variable in Dataset: Ent_Orient_H
- We prefer a 'wait-and-see' approach, to minimize the probability of making costly decisions
  Variable in Dataset: Ent_Orient_I

- ***Innovation***

  [Cohen and Levinthal, 1990] and [Zahra and George, 2002] both consider the final outcome of exploiting external knowledge as innovation and innovation based performance. Measuring innovation has been a fuzzy subject in management science due to various interpretations of innovation as a concept results in different metrics for innovation in different research. In this study it is measured as stock of patents in possession of the firm as proxy for innovation. Theoretical validity for patents as proxy for innovation comes from research done by Acs et al. [2002] who conclude that patents are reliable indicators of innovative activities. Further, Cohen and Levinthal suggest patents to be source of innovation as level of knowledge spillovers depends on strength of patents in the industry ([Cohen and Levinthal, 1990], 1990 page 4)

  The data for patents is available in the available dataset through the question

  - How many of your patents (assigned and pending) is in a full 100% ownership with your company?
    Variable in Dataset: PATENT_AANTAL

  Additionally, from resource based view of firms, academic spin-offs due to their resource deficiencies might invest in R&D only where they feel necessity and not unnecessarily stock patents. Patents also explain quantified knowledge the firm posses due to their knowledge spillovers with the university and industry.

- **Product Development Related Performance**

  Zahra and George [2002] suggest that firms need external knowledge exploitation and transformation capacity to leverage it into their products in order to extend the line of services or new product development related capabilities. In order to stay in competition in market, firms need to regularly keep up with changing trends (as explained by activation triggers by Zahra and George [2002]), thus making Product Development related Performance a source of competitive advantage.

  Product Development Related Capabilities are measured using the following questions in the dataset. The responses to the questions are recorded on a 7-likert scale (completely disagree<–>completely agree)

  - Do you agree with the following statements? - Last year, we invested significant time and money in analyzing new business opportunities.
    Variable in Dataset: Progress_A
  - Do you agree with the following statements? - The characteristics of our clients are completely clear to us.
    Variable in Dataset: Progress_B
  - Do you agree with the following statements? Last year, we identified a variety of prospective customers.
    Variable in Dataset: Progress_C
  - Do you agree with the following statements? - Last year, we conducted a detailed market study.
    Variable in Dataset: Progress_D
  - Do you agree with the following statements? - Last year, we conducted extensive product and service tests.
    Variable in Dataset: Progress_E
  - Do you agree with the following statements? - Last year, we established good relationships with our first customers.
    Variable in Dataset: Progress_F
  - Do you agree with the following statements? - Last year, we clearly specified tasks and roles for each of us in the management team.
    Variable in Dataset: Progress_G
  - Do you agree with the following statements? - Last year, we started a co-development program with our client.
    Variable in Dataset: Progress_H

3.5 Data Analysis

3.5.1 Structural Equation Modelling (SEM)

The theoretical model used in this study consists of multiple measurements that need to be analyzed simultaneously. Such a model is analyzed using Multivariate Analysis techniques that simultaneously analyze multiple measurements on objects under investigation (Hair et al,).Structural Equation Modelling is a multivariate statistical analysis technique that enables researchers to accommodate several variables at once and analyze separate relationships for a series of multiple regression equations, all tested simultaneously. A structural equation model consists of two major components -

- The structural model which is the the *path model* consisting of relations between independent and dependent variable which are distinguished on the basis of theoretical foundations. A path model is a diagram for statistical analysis that connects the independent variables to the dependent variables and visualize the relationship of hypothesis that is to be tested.

- The measurement model which holds several variables as indicators that help construct a single independent variable known as the latent variable. Latent variables are the variables of the construct which are not observed directly, but are a component of indicator items that are directly measured variables and represent the latent variables.

[Hair Jr et al., 2016] distinguish two types of SEM methods, *covariance based SEM (CB-SEM)* and *partial least squares SEM (PLS-SEM)*. The former is a technique used primarily to test existing theoretical relationships while the latter is used in exploratory research to develop theories, where a theory is less developed. This study investigates the relationship between inbound external knowledge of an academic start-up and its capabilities to handle it for competitive advantage, based on a theoretical based conceptual model which has never been explored before. Therefore, in this exploratory study, PLS-SEM approach is adopted. The procedure to conduct PLS-SEM were followed as according to the guidelines given by [Hair Jr et al., 2016].

According to Hair Jr et al. [2016] PLS-SEM is a technique growing in popularity due to its ability to investigate complex relationships and less stringent requirements to accommodate small sample sizes and non-parametric distributions. As a rule of thumb, the minimum sample size should be equal to or larger than 10 times the largest number of structural paths directed at a particular construct ([Hair Jr et al., 2016]).

Independent Construct	Indicator Variable (Corresponding Open Innovation Process)	Variable as in Dataset	Relevant questions (items)	Item-Scale	Adapted from Literature/Concepts
Acquisition Capacity	External Scanning	ABSORPTIVE_ CAPACITY_A	We frequently scan the environment for new technologies	7-point Likert Scale	Cohen and Leventhal, 1990; Zahra and George (2002); Chesbrough (2003); Zobel (2017)
		ABSORPTIVE_ CAPACITTY_B	We thoroughly observe technological trends	7-point Likert Scale	Cohen and Leventhal, 1990; Zahra and George (2002); Chesbrough (2003); Zobel (2017)
	Strategic Assessment	ABSORPTIVE_ CAPACITTY_C	We observe in detail external sources of new technologies	7-point Likert Scale	Cohen and Leventhal, 1990; Zahra and George (2002); Chesbrough (2003); Zobel (2017)
		ABSORPTIVE_ CAPACITTY_D	We thoroughly collect industry information	7-point Likert Scale	Cohen and Leventhal, 1990; Zahra and George (2002); Chesbrough (2003); Zobel (2017)
Assimilation Capacity	Coordination	ABSORPTIVE_ CAPACITTY_M	We have a clear division of roles and responsibilities	7-point Likert Scale	Cohen and Leventhal, 1990; Zahra and George (2002); Chesbrough (2003); Zobel (2017)
	Integration	ABSORPTIVE_ CAPACITTY_E	We can quickly interpret changing market demands	7-point Likert Scale	Cohen and Leventhal, 1990; Zahra and George (2002); Chesbrough (2003); Zobel (2017)
		ABSORPTIVE_ CAPACITTY_F	New opportunities to serve our clients are quickly understood	7-point Likert Scale	Cohen and Leventhal, 1990; Zahra and George (2002); Chesbrough (2003); Zobel (2017)
	Knowledge Management	ABSORPTIVE_ CAPACITTY_J	We record and store newly acquired knowledge for future reference	7-point Likert Scale	Cohen and Leventhal, 1990; Zahra and George (2002); Chesbrough (2003); Zobel (2017)
Transformation Capacity	Internalisation and Conversion	ABSORPTIVE_ CAPACITTY_I	We regularly consider the consequences of changing market demands in terms of new products and services	7-point Likert Scale	Cohen and Leventhal, 1990; Zahra and George (2002); Chesbrough (2003); Zobel (2017)
		ABSORPTIVE_ CAPACITTY_H	We analyse different sequences for new product development and introduction	7-point Likert Scale	Cohen and Leventhal, 1990; Zahra and George (2002); Chesbrough (2003); Zobel (2017)
		ABSORPTIVE_ CAPACITTY_G	We analyse various combinations of attributes for our products	7-point Likert Scale	Cohen and Leventhal, 1990; Zahra and George (2002); Chesbrough (2003); Zobel (2017)
		ABSORPTIVE_ CAPACITTY_L	identifying different customer groups that might have an interest in our products		
Exploitation Capacity	Cognition of Resources	ABSORPTIVE_ CAPACITTY_N	We constantly consider how to better exploit knowledge	7-point Likert Scale	Cohen and Leventhal, 1990; Zahra and George (2002); Chesbrough (2003); Zobel (2017)
	Resource Implementation	ABSORPTIVE_ CAPACITTY_K	We determine how customers will use our technologies	7-point Likert Scale	Cohen and Leventhal, 1990; Zahra and George (2002); Chesbrough (2003); Zobel (2017)
		ABSORPTIVE_ CAPACITTY_P	We have a common language regarding our products and services	7-point Likert Scale	Cohen and Leventhal, 1990; Zahra and George (2002); Chesbrough (2003); Zobel (2017)
		ABSORPTIVE_ CAPACITTY_O	We easily implement technologies in new products	7-point Likert Scale	Cohen and Leventhal, 1990; Zahra and George (2002); Chesbrough (2003); Zobel (2017)

Table 3.4.1: Independent Variables (n=67)

3.5.2 Sequence flow of data analysis

The statistical test used to analyse model is Partial least square regression analysis. As discussed above, the sequence of data analysis using PLS-SEM is as shown in figure 3.5.1. The data analysis for the measurement model has been done on statistical software recommended by Hair Jr et al. [2016], SmartPls 3.0. which is available for free for students. The Data preparation, which includes examining the data, data cleaning and evaluation of distribution was done IBM SPSS statistics 24, which is provided by the university for students.

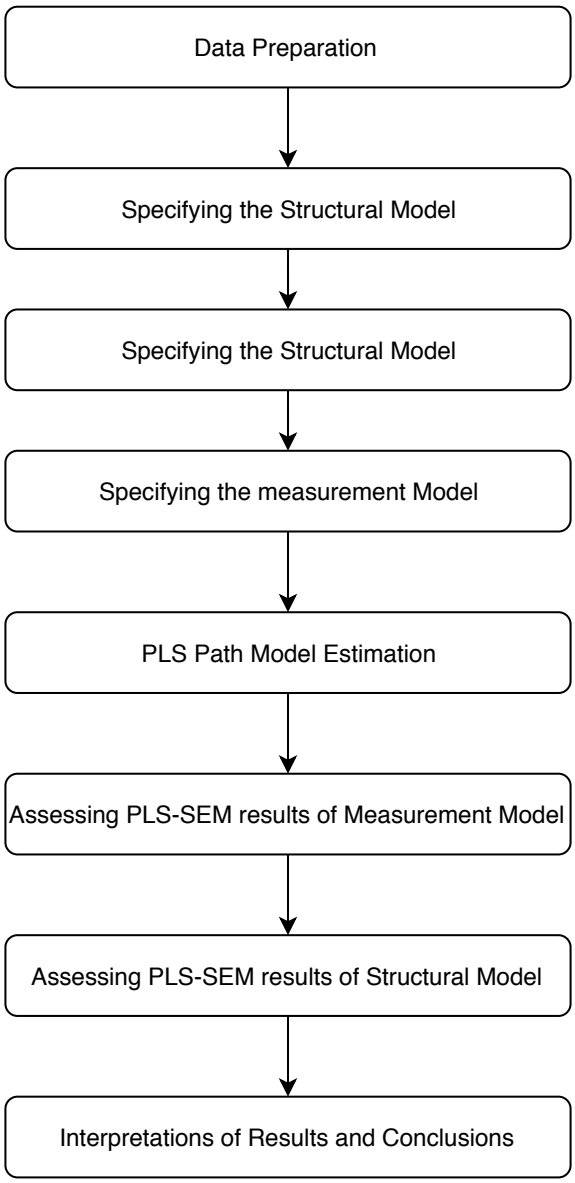


Figure 3.5.1: Sequence flow for PLS-SEM based on Hair Jr et al. [2016]

3.5.3 Estimation of the Path model

Path models are diagrams that are used to visually display the hypothesis and underlying variable relationships. Using the tools of software package Smart PLS 3.0, the path model can be estimated. the software SmartPLS 3.0 uses the inbuilt PLS-Algorithm to analyze all unknown relationships in the PLS-SEM model. The result of PLS-Algorithm testing is that we obtain the relationship between indicator variables and their respective latent construct in the outer model as factor loadings. These factor loadings are regression values of the outer measurement model (indicators and latent variable relationship).

Secondly, the path coefficients of the structural model are revealed which are the standardized regression coefficients. Path coefficients have standardized values ranging between -1 and +1, where a value closer to +1 signifies stronger relationship and closer the value is to 0 signifies a weak relationship between the variables.

Thirdly, the bootstrapping procedure is selected following the PLS-Algorithm run in the software package to get the p-value and t-statistics. p values and t-statistics are considered for assessing the level of significance to decide the condition on which the null hypothesis should be rejected. The p-value generally taken is at a significance level of 5%, meaning that the p value should be less than 0,05 to consider a relationship significant.

Fourthly, the predictive power of the independent and dependent variable relationship is given by the coefficient of determination, (R^2) whose value range from 0 to 1. The (R^2) value is used to see the predictive power. As a rule of thumb, (R^2) values of 0.75, 0.50 and 0.25 are seen as ranges for substantial, moderate or weak Hair et al. [2013].

3.6 Assessment of Collinearity, Reliability and Validity of the measures

Collinearity is generally assessed using the tolerance (TOL) values which represents the amount of variance an indicator is not explained by other indicator loading on the same construct. To asses the collinearity of the model, the variance inflation factor (VIF) value can be taken, which is defined as the reciprocal of tolerance (TOL) values. (VIF=1/TOL. According to Hair et al, 2011), the VIF values of 5.00 and higher indicate collinearity issues due to multicollinearity.

In the PLS-SEM procedure adopted for the study, the reliability and validity of the model is

considered with the following criteria.

Internal consistency reliability is the estimate of reliability based on the inter-correlations of the observed indicator variables and is measured using the Cronbach's alpha. The accepted values of Cronbach alpha are usually taken as above 0.70.

Convergent validity is the extent to which the measures of the latent variable correlate positively with the other measures of the same construct. In PLS-SEM model, the convergent validity can be checked from the outer loadings of the model and the average variance extracted (AVE) values. The outer loading values are also considered as indicator reliability and should be above 0.60 and the AVE should be above 0.50 for explaining that the constructs measure more than half the variance of the indicator items loaded on it. For single item measures, the AVE is fixed at 1.00. The variables that have indicator items below outer loadings of 0.60 and AVE of 0.50 are removed on the basis of low convergent reliability.

4

Results of the Data Analysis

This chapter contains the empirical results obtained from the data analysis of the operationalised conceptual model as described in Chapter 3 of this report. The overview of results from Structural Equation Modelling can be seen in the Figure 4.5.1. The empirical results of the data analysis from SEM lay the foundation for the subsequent chapters- Chapter 5 and Chapter 6 that focus on discussion of the results and answering the research questions that were formulated in Chapter 1.

4.1 Preliminary Data Analysis

As discussed in the previous chapter, the data has been cleaned and sample data has been prepared for our further analysis. In order to check the relationships between our variables and test the hypothesis of our model, we will have to statistically analyze the data and report the findings for conclusions and discussions. Prior to in depth data analysis of our hypothesis, we perform a preliminary examination of our data through graphical examination of data Hair et al. [2013]. It is also important to perform such preliminary data analysis to gain critical insights to our research data and ensure quality of statistical results.

The preliminary data is analysed using IBM SPSS Statistics Processor. Following this, the data has been analyzed using statistical software package Smart PLS 3.0, which is available for students. The preliminary data analysis is performed according to guidelines provided by Hair et al. [2013] and the data analyses on Smart PLS3.0 is performed according to the guidelines by Hair Jr et al. [2016]. Other practical information and tutorials related to handling the data and IBM SPSS software was taken from Field [2013].

The hypothesis were tested by employing the Partial Least Squares method (PLS) which is a technique of the Structural Equation Modelling technique. The use of Partial Least Squares methods allows us to develop our construct as a latent variable and test complex relationships like path modelling. It is beneficial for our case because our research constitutes a hierarchical relationship model where the open innovation activities are considered as second ordered processes and the firm's dynamic capabilities are researched in the form of absorptive capacity. The constructs of absorptive capacity are operationalized using open innovation activities. Absorptive Capacity serves as a latent variable while the set of open innovation activities as the underlying processes are considered as indicator variables of their respective latent variables.

PLS technique permits us other advantages as well as it allows us to accommodate small sample sizes. According to hair, the sample size should be larger than 10 times the number of indicators in the structural path directed at a particular construct. In our model, the maximum number of arrows at a particular construct do not exceed the number of 4, which is sufficient for our sample size (n=67). Additionally, the Smart PLS 3.0 software provides an ease of use interface which allows us to draw our conceptual model and make the desired structural path connections. The following steps were employed:

1. Data preparation: First the data was prepared by cleaning the data, handling the missing data, checking for outliers and parametric assumptions. The final prepared data set was saved as a .csv spreadsheet file and saved in duplicate.

2. Data Loading on the software: Next, the data (.csv file) was loaded to Smart PLS3.0 software which recognized the sheet as data and variable entities for analysis.

3. Construction of the conceptual model: In the next step, the conceptual model was drawn and connected and drawn using structural path arrows and the latent variables were connected with their respective indicator variables. The variables turned the colour from red to blue which means that our relationships are testable.

4. Reliability and Validity Testing: After the relationship model was constructed, it was tested for reliability and validity. To do so, the PLS algorithm in the software was used which gives us the factor loadings of the indicators on the respective constructs. To test the reliability of the model, the guidelines as per Hair Jr et al. [2016] and Hair et al. [2013] were followed. The internal reliability of the constructs in model was tested by checking the Cronbach's Alpha value which should pass the minimum criteria value of (0,6). The validity of the model is checked by the AVE of the indicators which should be above 0,50.

5. Factor Analysis and Developing the final model: After the Reliability and Validity testing, the final model has been constructed by removing the indicator items of the construct which are not reliable, that is the AVE value is less than 0,50. This means that the construct is unable to explain more than 50% variance in relationship with its indicators, resulting in poor validity and we can interpret that the particular indicator has weak or no significant role in capturing the construct to measure what it intends to measure.

6. Testing the hypothesis: To do so, the PLS Algorithm function is followed by Bootstrapping function. The bootstrapping process populates the conceptual model with path coefficients, t-test values and p-values which are analyzed for interpreting the relationships between the variables.

4.2 Data Cleaning and Handling of Missing data

Most multivariate analysis encounter the problem of inconsistent and Missing Data. **Missing Data** is defined as the condition in which valid values of one or more variables are not available for analysis and the process of remedy of such data using systematic actions is called the **missing data process** (Hair et al. [2013],page 40).

Prior to conducting the *Missing Data Process*, the raw data as received from **Delft Centre for Entrepreneurship** (See Appendix B) was examined checked for invalid cases. The total number of cases that were available were 88 out of which only 67 cases had a valid response. Other

responses were not useful because of errors in self-reporting in the response form, invalid entries and/or multiple no responses. The final number of valid responses was 67. The missing data process was performed on these 67 cases.

The missing data process was followed in four steps (Figure 4.2.1 as mentioned in Hair et al. [2013].

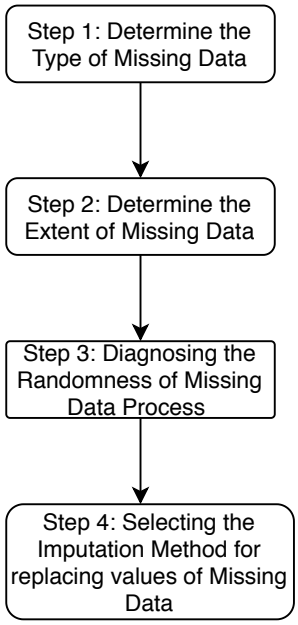


Figure 4.2.1: Four Step Process of handling missing data based on Hair et al. [2013], page 43.

The summary of missing data of both dependent and independent variables is as shown figure 4.2.2. As a rule of thumb, the acceptable percentage of missing data is 10% (Hair et al. [2013]). In the analyses we obtain that for the variable PATENT_AANTAL the missing value percentage is 6% and for all other cases it is found to 7,5%. Thus our missing data is acceptable and the missing values are replaced using imputation methods available on IBM SPSS.

Univariate Statistics

	N	Mean	Std. Deviation	Missing Count	Missing Percent	No. of Extremes[a] Low	No. of Extremes[a] High
PATENT_AANTAL	63	1,05	1,887	4	6,0	0	7
Progress_A	62	5,50	1,667	5	7,5	5	0
Progress_B	62	4,74	1,390	5	7,5	0	0
Progress_C	62	5,66	1,366	5	7,5	2	0
Progress_D	62	4,29	1,731	5	7,5	0	0
Progress_E	62	4,89	1,641	5	7,5	2	0
Progress_F	62	5,44	1,511	5	7,5	4	0
Progress_G	62	5,23	1,562	5	7,5	0	0
Progress_H	62	3,65	2,158	5	7,5	0	0
ABSORPTIVE_CAPACITTY_A	62	5,68	1,184	5	7,5	1	0
ABSORPTIVE_CAPACITTY_B	62	5,55	1,263	5	7,5	1	0
ABSORPTIVE_CAPACITTY_C	62	5,24	1,490	5	7,5	2	0
ABSORPTIVE_CAPACITTY_D	62	5,03	1,414	5	7,5	0	0
ABSORPTIVE_CAPACITTY_E	62	5,13	1,324	5	7,5	0	0
ABSORPTIVE_CAPACITTY_F	62	5,32	1,113	5	7,5	3	0
ABSORPTIVE_CAPACITTY_G	62	5,52	1,225	5	7,5	1	0
ABSORPTIVE_CAPACITTY_H	62	4,95	1,498	5	7,5	1	0
ABSORPTIVE_CAPACITTY_I	62	5,11	1,427	5	7,5	1	0
ABSORPTIVE_CAPACITTY_J	62	5,19	1,377	5	7,5	0	0
ABSORPTIVE_CAPACITTY_K	62	5,37	1,309	5	7,5	1	0
ABSORPTIVE_CAPACITTY_L	62	5,47	1,364	5	7,5	0	0
ABSORPTIVE_CAPACITTY_M	62	5,40	1,420	5	7,5	3	0
ABSORPTIVE_CAPACITTY_N	62	5,29	1,372	5	7,5	0	0
ABSORPTIVE_CAPACITTY_O	62	5,44	1,140	5	7,5	2	0
ABSORPTIVE_CAPACITTY_P	62	5,42	1,313	5	7,5	4	0
Ent_Orient_A	62	143374,74	1128889,185	5	7,5	1	1
Ent_Orient_B	62	143373,45	1128889,351	5	7,5	0	1
Ent_Orient_C	62	143373,97	1128889,284	5	7,5	2	1
Ent_Orient_D	62	143374,56	1128889,207	5	7,5	0	1
Ent_Orient_E	62	143374,69	1128889,191	5	7,5	0	1
Ent_Orient_F	62	143373,73	1128889,316	5	7,5	1	1
Ent_Orient_G	62	143374,18	1128889,257	5	7,5	0	1
Ent_Orient_H	62	143373,84	1128889,301	5	7,5	2	1
Ent_Orient_I	62	143374,11	1128889,266	5	7,5	0	1

a. Number of cases outside the range (Q1 - 1.5*IQR, Q3 + 1.5*IQR).

Figure 4.2.2: Summary of Missing Data (n=67) as obtained from analyses on IBM SPSS. The observations show a missing value percentage of 7,5% which is acceptable according to Hair et al. [2013]

4.3 Descriptive Data

Descriptive Statistics are used to get an preliminary understanding and feel of the data (Field [2013]). After the *'Data Cleaning'* and dealing with *'Missing Data'*, we can examine the descriptive statistics of the final data set that is to be used for data analysis.

4.3.1 Descriptive Statistics-Dependent Variables

The descriptive statistics of dependent variables can be seen in figure 4.3.1.

Descriptive Statistics

	N	Range	Minimum	Maximum	Sum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
PATENT_AANTAL	67	12	0	12	71	1,06	,224	1,831	3,354	3,831	,293	19,475	,578
Progress_A	67	6	1	7	367	5,48	,197	1,616	2,610	-,940	,293	,046	,578
Progress_B	67	5	2	7	318	4,74	,163	1,337	1,787	-,292	,293	-,490	,578
Progress_C	67	6	1	7	378	5,65	,161	1,318	1,738	-1,235	,293	1,794	,578
Progress_D	67	6	1	7	286	4,26	,205	1,682	2,829	-,306	,293	-,826	,578
Progress_E	67	6	1	7	328	4,89	,193	1,579	2,493	-,631	,293	-,281	,578
Progress_F	67	6	1	7	364	5,44	,177	1,453	2,110	-1,063	,293	,771	,578
Progress_G	67	6	1	7	350	5,23	,184	1,502	2,257	-,718	,293	,285	,578
Progress_H	67	6	1	7	244	3,64	,254	2,075	4,306	,150	,293	-1,214	,578
Ent_Orient_D	67	5	2	7	367	5,48	,166	1,361	1,852	-,650	,293	-,455	,578
Ent_Orient_F	67	13	-6	7	299	4,46	,247	2,022	4,089	-2,094	,293	9,622	,578
Ent_Orient_G	67	5	2	7	342	5,10	,159	1,302	1,696	-,456	,293	-,165	,578
Ent_Orient_H	67	6	1	7	319	4,76	,197	1,609	2,588	-,607	,293	-,416	,578
Ent_Orient_I	67	7	2	9	341	5,09	,175	1,430	2,045	,126	,293	-,063	,578
Valid N (listwise)	67												

Figure 4.3.1: Descriptive statistics for Dependent Variables. (n=67)

4.3.2 Descriptive Statistics- Independent Variables

The descriptive statistics of independent variables can be seen in figure 4.3.2.

Descriptive Statistics

	N	Range	Minimum	Maximum	Sum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
ABSORPTIVE_CAPACITTY_A	67	6	1	7	380	5,67	,139	1,141	1,302	-1,190	,293	3,022	,578
ABSORPTIVE_CAPACITTY_B	67	5	2	7	371	5,54	,148	1,215	1,477	-,705	,293	,189	,578
ABSORPTIVE_CAPACITTY_C	67	6	1	7	351	5,23	,175	1,435	2,060	-,900	,293	,805	,578
ABSORPTIVE_CAPACITTY_D	67	5	2	7	337	5,03	,166	1,361	1,852	-,454	,293	-,252	,578
ABSORPTIVE_CAPACITTY_E	67	4	3	7	344	5,13	,156	1,273	1,621	,021	,293	-1,019	,578
ABSORPTIVE_CAPACITTY_F	67	5	2	7	356	5,31	,131	1,073	1,151	-,448	,293	,430	,578
ABSORPTIVE_CAPACITTY_G	67	5	2	7	369	5,51	,144	1,180	1,393	-,532	,293	-,031	,578
ABSORPTIVE_CAPACITTY_H	67	6	1	7	331	4,93	,177	1,449	2,099	-,564	,293	,065	,578
ABSORPTIVE_CAPACITTY_I	67	6	1	7	343	5,12	,168	1,374	1,887	-,771	,293	,531	,578
ABSORPTIVE_CAPACITTY_J	67	5	2	7	348	5,19	,162	1,324	1,753	-,408	,293	-,384	,578
ABSORPTIVE_CAPACITTY_K	67	6	1	7	359	5,36	,154	1,264	1,597	-,627	,293	,625	,578
ABSORPTIVE_CAPACITTY_L	67	5	2	7	366	5,46	,160	1,312	1,720	-,810	,293	,305	,578
ABSORPTIVE_CAPACITTY_M	67	5	2	7	362	5,41	,167	1,366	1,865	-,685	,293	,003	,578
ABSORPTIVE_CAPACITTY_N	67	5	2	7	354	5,28	,162	1,323	1,749	-,662	,293	-,044	,578
ABSORPTIVE_CAPACITTY_O	67	4	3	7	364	5,43	,134	1,099	1,208	-,161	,293	-,805	,578
ABSORPTIVE_CAPACITTY_P	67	6	1	7	363	5,41	,154	1,263	1,596	-,750	,293	,914	,578
Valid N (listwise)	67												

Figure 4.3.2: Descriptive statistics for Independent Variables. (n=67)

The distribution of data also helps in examining the data graphically.

Frequency Distribution of Dependent Variables

- Innovation

The distribution of dependent variable PATENT_AANTAL has a positively skewed distribution on the left as seen in figure C.1.1. This is because 32 of 67 startups (42,8%) responded with having no active registered patents at the time of data collection.

- Product Development Related Performance Figure C.1.3shows the distribution of indicator variables of the dependent variable Product development related performance also show non-normal distributions but with relatively lesser skewness as compared to the previous discussed dependent variable (*Patent_Aantal*). The distributions show negative skewness, indicating higher scores distributions at the higher end of the likert scale. The most negative skewness value is -1,235 for the variable *Progress_C*.

- Strategic Flexibility The distribution of indicator variable of the dependent variable Entrepreneurial Orientation has a non-normal distribution as well. The distribution is however more leptokurtic than being skewed, except for the indicator variable Ent_Orient_F, which has a skewness score of -2,094 and a very high kurtosis value of 9,622

Frequency Distribution of Independent Variables

The frequency distribution of Independent Variables is as shown in figure C.1.4 for Potential Absorptive Capacity and in figure C.1.5 for Realized Absorptive Capacity. like Dependent Variables, the independent variables also show a non-normal distribution of data, with highest bars around frequency distribution score '5' on the likert scale. The mean of all distributions for PACAP and RACAP fall in the range of 4,93 to 5,67. The distributions for both PACAP and RACAP show positive leptokurtic bars.

4.4 Data Quality- Assessment of R^2, *Collinearity*, *ReliabilityandValidity*

4.4.1 Assessment of Collinearity

As discussed in the previous chapter, the collinearity can be assessed using the VIF values. The VIF values are as seen in the table below. As can be seen in table, 4.4.1 the values all the values are well below 5, therefore no multicollinearity issue exists in the model.

The collinearity between the variables can be seen in the collinearity matrix in Table C.1.1.

4.4.2 Assessment of Reliability

All the dependent variables pass the reliability test with Cronbach alpha value>0.60, Composite Reliability values >0.60 and Average Variance extracted values above 0.50. Table 4.4.2 The variable, *Product development related performance* shows low on AVE values, but since it has Cronbach's Alpha value above 0.60 we can ignore the AVE and still use the variable in our model.

4.4.3 The values of R Square

The values of R Square are 0.526 for Assimilation capacity, 0.423 for Exploitation Capacity, 0.108 for Innovation, 0.347 for Product Development Related Performance, 0.287 for Strategic Flexibility and 0.586 for Transformation capacity (Figure 4.4.1)

Item	VIF
Conversion_1	1.602
Conversion_2	1.335
Coordination_2	2.019
Ent_Orient_D	1.297
Ent_Orient_G	2.22
Ent_Orient_H	1.336
Ent_Orient_I	2.349
ExternalScanning_1	1.842
ExternalScanning_2	4.258
Integration	2.009
Internalisation_1	2.443
Internalization_2	2.517
Knowledge Management	1.107
PAT_Count_1	1
Progress_A	1.497
Progress_C	1.254
Progress_D	1.316
Progress_E	1.54
Progress_F	1.522
Recombining_1	1.272
Recombining_2	1.518
Resource Cognition_1	1.404
Resource Cognition_2	1.867
StrategicAssessment_1	2.777
StrategicAssessment_2	2.784

Table 4.4.1: VIF values (n=67)

	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
INNOVATION	1	1	1
Product Development Related Performance	0.63	0.767	0.399
Strategic Flexibility	0.757	0.848	0.587

Table 4.4.2: Construct Reliability Analysis. (n=67)

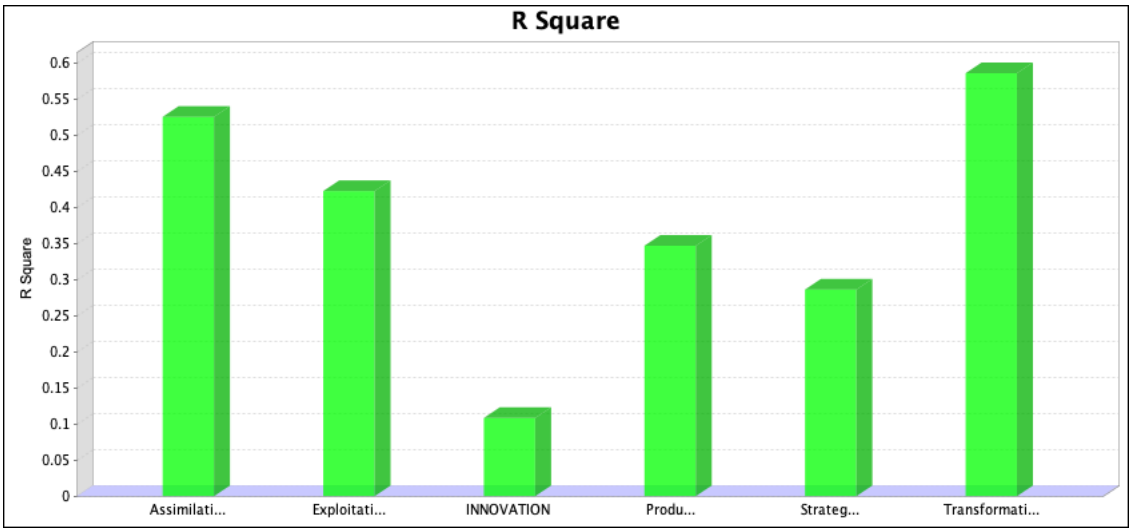


Figure 4.4.1: The R square values

4.5 Final Results of PLS-SEM

The final results of PLS-SEM were analysed and are as displayed in Figure 4.5.1.

4.6 Hypothesis Testing: Testing the Relationship Between The Dimensions of Absorptive Capacity and Managerial Actions

4.6.1 Testing of Hypothesis 1

In Chapter 3, we discussed how implementation of open innovation through entrepreneurial actions enables absorptive capacity of an organization based on the literature review. Thus, activities to implement open innovation are the underlying low order processes which enable absorptive capacity of a firm (higher order component). To test this, we constructed a testable hypothesis -

Hypothesis 1: *There should be a positively significant relationship between open innovation activities and absorptive capacity of the firm.*

In the following section, we will see for relationships between the managerial actions taken to implement open innovation (outer model indicator items in the lower order) and their corresponding component of absorptive capacity.

Testing the Relationship between low-order process from managerial actions and higher components of absorptive capacity

From the PLS-SEM we obtained the weights of indicator variables on their respective latent variables. Revisiting our conceptual model, we have lower-order managerial set of actions of open innovation as the indicator variables and their respective absorptive capacity dimensions as the latent variable. The results of the PLS-SEM are summarized in the table 4.6.1. The analysis confirms a significant relationship ($p<0{,}05$) between open innovation and the start-up's absorptive capacity. for all the dimensions of absorptive capacity. This means that all the open innovation activities as taken from literature review explain themselves as an underlying managerial process for open innovation.

For the dimension of Potential Absorptive Capacity, The first dimension of absorptive capacity is *Acquisition Capacity* and the two indicator items of *External Scanning* show significant relationship with acquisition capacity ($t=6.953$; $p<0{,}05$ and $t=13.354$; $p<0.05$) with a positive path coefficient of 0.709 and 0.942. Meanwhile, Strategic Assessment and Acquisition capacity also share a

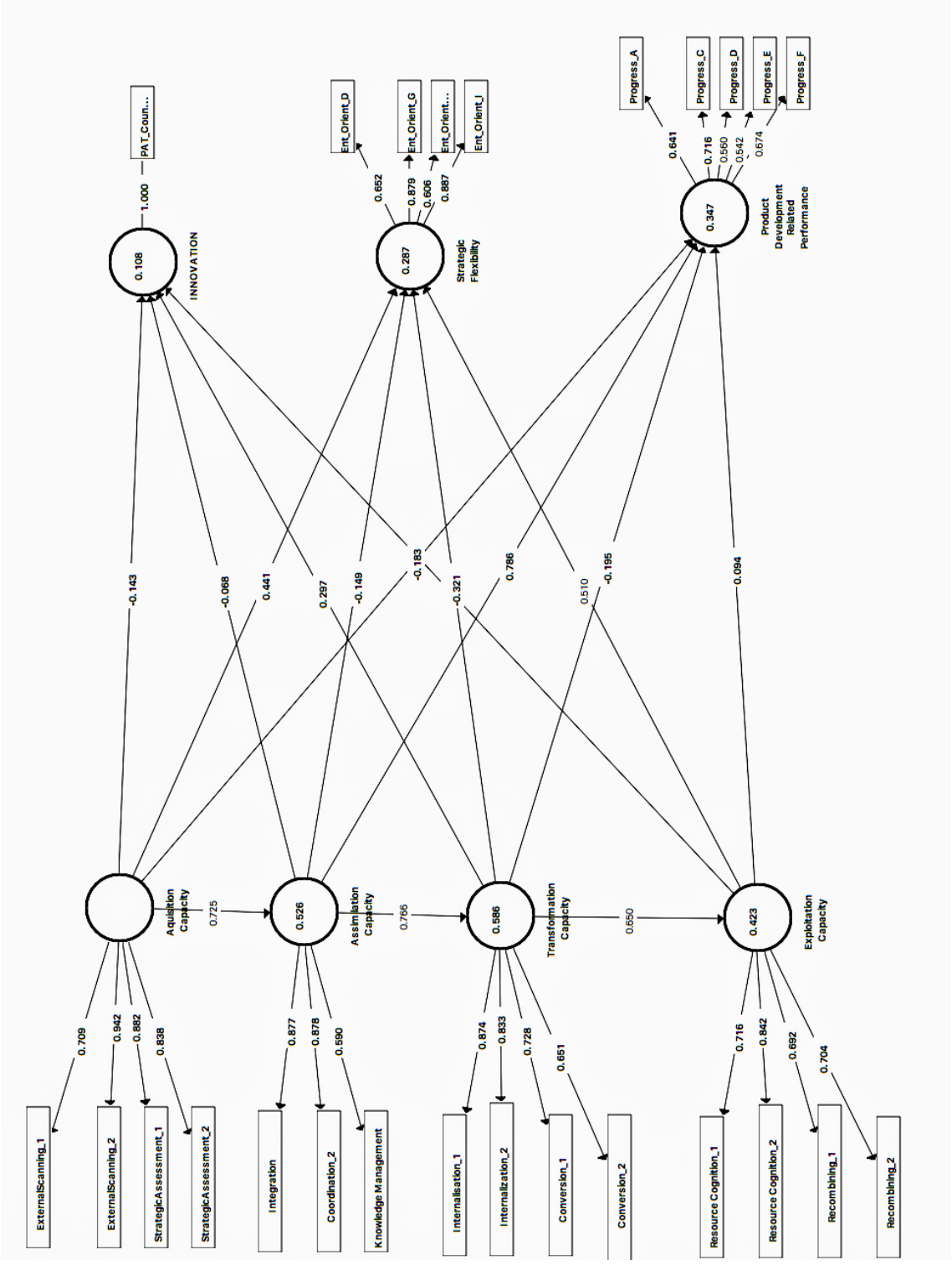


Figure 4.5.1: Structural Equation Model for Path Analysis- Final PLS-SEM Results

positive and significant relationship with path coefficient 0.882 and 0.838 respectively (t=12.036 and 10.234 respectively and p=<0.05 for both the indicators).Similarly for the second dimension

of PACAP -*Assimilation Capacity*, there is yet again a positive relationship between *Coordination, Knowledge Management and Integration* and Assimilation Capacity. The indicator item of *Coordination* explains a positive relationship of 0.878 (t=6.953;p<0.05) through its path coefficient, *Knowledge Management* has a path coefficient value of 0.59 (t=6.958;p<0.05) and the indicator item *Integration* has a value of 0.877 (t=11.918;p<0.05).

On the other hand for Realised Absorptive capacity, the dimension of absorptive capacity; *Transformation Capacity* has been constructed with two indicator items each of *Internalization and Conversion* processes. The two indicator items of Internalisation show path coefficient values of 0.874 and 0.833 each with positive significance. (t=11.918 and 9.085; p<0.05 each) and *Conversion* have path coefficient values of 0.728 and 0.651. (t=9.923 and 8.859;p<0.05). Similarly, for *Exploitation Capacity*, we had taken two indicator values of Recombining, for which we received the path values of 0.692 and 0.704 and significant at t=5.443 and 5.113; p<0.05 and Recombining, for which we have path coefficients as 0.716 and 0.842 (at t=6.064 and 8.93; p<0.05 respectively).

Thus with these positively significant results it can be implied that managerial actions of the organization to implement open innovation help build up dynamic capability (absorptive capacity) of an organization and absorptive capacity as a dynamic capability of a firm in an open innovation environment is a component of entrepreneurial actions that are embedded in a firm's routines and strategies.Thus, the null hypothesis can be rejected to accept our proposed hypothesis. Further, firms can help themselves to build better organizational capabilities if they focus on each component of dimensions of absorptive capacity as an identified underlying set of actions that build up their absorptive capacity.

4.7 Hypothesis Testing: Testing the Path Dependent Relationship Between The Dimensions of Absorptive Capacity.

4.7.1 Testing of Hypothesis 2a,2b,2c

This section tests the hypothesis 2a, 2b and 2c as formulated in Chapter 3. The motive of these hypothesis is to test if organisational capabilities of an academic startup follow path dependency.

Hypothesis 2a: *Acquisition Capacity should have a positive relationship with Assimilation Capacity*

Hypothesis 2b: *Assimilation Capacity should have a positive relationship with Transformation Capacity*

Hypothesis 2c: *Transformation Capacity should have a positive relationship with Exploitation Capacity*

Inter-Relationship Within Potential Absorptive Capacity (PACAP)

From the PLS-SEM analysis, the path relationship of dimensions of PACAP were obtained, and the summary of observations can be seen in Table 4.7.1. In the PLS-SEM analysis, it is found that Acquisition Capacity has a positive significant relationship with Assimilation Capacity. The path coefficient of this relationship is obtained to be [0.723] and the significance values of t-statistics is found to be t=10.408 at a significance level of p=0.00 (p<0.05). This shows that Assimilation capacity highly depends on the capacity of acquiring new external knowledge. The more that a firm puts in effort to acquire new external knowledge in its environment, the higher is its capability to assimilate, that is to improve its cognitive ability towards organization learning and leverage it in its decision making processes as suggested by Cohen and Levinthal [1990].

Inter-Relationship Within Realized Absorptive Capacity (RACAP)

The PLS-SEM Analysis gives us insight into the relationship between transformation capacity and exploitation capacity and similarly as PACAP, we find that there exists a positive relationship between transformation capacity and exploitation capacity. The path coefficient of their relationship is found to be positively correlated at a value of 0.65 and statistically significant with (t=8.328 p<0.05). This is in line with Zahra and George [2002] who suggest that a firm with higher transformation capabilities will have higher exploitation capacity as the transformational capacity enable the organisation to shape its entrepreneurial mindset, which helps it to make better decisions to judge its competitive landscape and encourages to recognize better opportunities.

Open Innovation Based Activity	Relationship	Path Coefficient	Standard Deviation (STDEV)	T Statistics	P Values	Siginificance level (*<0.05)
External Scanning	ExternalScanning_1 <- Aquisition Capacity	0.709	0.037	6.953	0.00	*
	ExternalScanning_2 <- Aquisition Capacity	0.942	0.025	13.354	0.00	*
Strategic Assessment	StrategicAssessment_1 <- Aquisition Capacity	0.882	0.022	12.036	0.00	*
	StrategicAssessment_2 <- Aquisition Capacity	0.838	0.031	10.234	0.00	*
Coordination	Coordination_2 <- Assimilation Capacity	0.878	0.035	12.976	0.00	*
Knowledge Management	Knowledge Management <- Assimilation Capacity	0.59	0.047	6.958	0.00	*
Integration	Integration <- Assimilation Capacity	0.877	0.039	11.918	0.00	*
Internalisation	Internalisation_1 <- Transformation Capacity	0.874	0.039	9.085	0.00	*
	Internalization_2 <- Transformation Capacity	0.833	0.033	9.923	0.00	*
Conversion	Conversion_1 <- Transformation Capacity	0.728	0.032	8.859	0.00	*
	Conversion_2 <- Transformation Capacity	0.651	0.044	7.355	0.00	*
Recombining	Recombining_1 <- Exploitation Capacity	0.716	0.06	5.443	0.00	*
	Recombining_2 <- Exploitation Capacity	0.842	0.056	5.113	0.00	*
Resource Cognition	Resource Cognition_1 <- Exploitation Capacity	0.692	0.058	6.064	0.00	*
	Resource Cognition_2 <- Exploitation Capacity	0.704	0.042	8.93	0.00	*

Table 4.6.1: Path coefficients and significance level test of low-order process and high order capacity (n=67)

4.7.2 The Relationship between PACAP and RACAP

As found in the previous section, the dimensions within PACAP and RACAP of the firm positively influence each other and now we shall analyse if the statistical relationship suggests a path dependency of a firm's dynamic capabilities in the form of absorptive capacity. As predicted, the Acquisition Capacity is positively related with Assimilation capacity (as discussed in previous section) ; Assimilation Capacity shows a positive relationship with Transformation Capacity with a path coefficient of [0.766] significant at t=12.28;p<0.05 and as discussed in the previous section, Transformation Capacity is positively correlated with Exploitation Capacity. Thus, we have found out that the absorptive capacity is a firm's dynamic capability that works in a path dependent fashion. The acquisition capacity enables the firm to develop assimilation capacity which helps it to transform and ultimately exploit the knowledge for commercialization. This also indicates to us that the support from university incubator is sufficient for the start-ups to possess dynamic capabilities and leverage it for competitive advantage. Hence all the three hypothesis for this section, 2a, 2b and 2c are supported.

4.8 Hypothesis Testing: Testing the Relationship Between The Dimensions of Absorptive Capacity and Competitive Advantage

4.8.1 Testing of Hypothesis 3a,3b,3c and 4a,4b,4c

This section tests the hypothesis 3a,3b,3c and 4a,4b,4c as formulated in Chapter 3. The motive of these hypothesis is to test if organizational capabilities of an academic start-up help it achieve competitive advantage.

Hypothesis 3a: *There should be a positive relationship between Assimilation and Acquisition Capacity (Potential Absorptive Capacity and Strategic Flexibility*

Hypothesis 3b: *There should be a positive relationship between Assimilation and Acquisition Capacity (Potential Absorptive Capacity and Innovation*

Hypothesis 3c: *There should be a positive relationship between Assimilation and Acquisition Capacity (Potential Absorptive Capacity and Product Development Related Performance*

Hypothesis 4a: *There should be a positive relationship between Transformation and Exploitation Capacity (Realised Absorptive Capacity) and Strategic Flexibility*

Hypothesis 4b: *There should be a positive relationship between Transformation and Exploitation Capacity (Realised Absorptive Capacity) and Innovation*

Hypothesis 4c: *There should be a positive relationship between Transformation and Exploitation Capacity (Realized Absorptive Capacity) and Product Development Related Performance*

Path Relationship	Path Coefficient	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics	P Values
Aquisition Capacity -> Assimilation Capacity	**0.725***	0.725	0.07	10.408	0.00*
Assimilation Capacity->Transformation Capacity	**0.766***	0.769	0.062	12.286	0.00*
Assimilation Capacity-> Exploitation Capacity	**0.498***	0.512	0.082	6.072	0.00*
Transformation Capacity-> Exploitation Capacity	**0.65***	0.664	0.078	8.328	0.00*
Aquisition Capacity-> Exploitation Capacity	**0.361***	0.372	0.075	4.816	0.00*
Aquisition Capacity-> Transformation Capacity	**0.555***	0.559	0.08	6.935	0.00*

Table 4.7.1: Path Coefficient and significance testing of Path Dependent Relationship of Absorptive Capacity (n=67)

Testing the direct effects of Absorptive Capacity on Competitive Advantage

The PLS-SEM analysis results of the direct effects of absorptive capacity on competitive advantage are summarized in Table 4.8.1.

- **Hypothesis 3a:** *There should be a positive relationship between Assimilation and Acquisition Capacity (Potential Absorptive Capacity) and Strategic Flexibility*

  The relationship between Acquisition Capacity and Strategic Flexibility is positive and statistically significant from the analysis. This is because the relationship shows path coefficient of 0.441 and significance from t-statistics and p-value (2.768; $p<0.05$).
  On the other hand, the relationship between *Assimilation Capacity* and *Strategic Flexibility* is negative and also insignificant (path coefficient= -0.149; $p>0.05$)

  Thus, the hypothesis is partially accepted.

- **Hypothesis 3b:** *There should be a positive relationship between Assimilation and Acquisition Capacity (Potential Absorptive Capacity and Innovation)*

  The relationship between Acquisition Capacity and Innovation is weakly positive but insignificant from the analysis with path coefficient of -0.143 and insignificant from t-statistics and p-value (t=0.874 ; $p>0.50$).
  The relationship between Assimilation Capacity and Innovation is also negative and insignificant (path coefficient= -0.68 ; t=0.241 $p>0.05$)

  Thus, the hypothesis is rejected.

- **Hypothesis 3c:** *There should be a positive relationship between Assimilation and Acquisition Capacity (Potential Absorptive Capacity and Product Development Related Performance)*

  The relationship between Acquisition Capacity and Product Development Related Performance is insignificant with a path coefficient of-0.183 and t-statistics value of 1.106 at $p>0.05$) and on the other hand, the relationship between Assimilation Capacity and Product Development Related performance is also positive and statistically significant at t=4.028 and p-value<0.05.

- **Hypothesis 4a:** *There should be a positive relationship between Transformation and Exploitation Capacity (Realised Absorptive Capacity) and Strategic Flexibility*

  Transformation Capacity has positive but insignificant relationship with Strategic Flexibility with a path coefficient of 0.01 and p-value of 0.965 however Exploitation Capacity has a positive relationship with strategic flexibility with a path coefficient of 0.51 and t-statistics of 3.466 (p=0.001) Therefore, we partially accept this hypothesis

- **Hypothesis 4b:** *There should be a positive relationship between Transformation and Exploitation Capacity (Realised Absorptive Capacity) and Innovation*

  Transformation Capacity and Innovation show a positive and significant relationship with a positive path coefficient of 0.41 and significance at p=0.015 (p<0.05) but exploitation capacity and innovation shows a positive but statistically insignificant relationship at path coefficient value of 0.173 p-value-0.187 (p>0.05)

  Thus, the hypothesis is partially accepted.

- **Hypothesis 4c:** *There should be a positive relationship between Transformation and Exploitation Capacity (Realized Absorptive Capacity) and Product Development Related Performance*

  There is a negative and insignificant relationship between Transformation and Product Development Related Performance with a path coefficient of -0.133 at p>0.05 also, Exploitation Capacity and Product Development Related Performance share a positive but insignificant relationship. Since both the dimensions fail to show a positive relationship, the hypothesis is rejected.

Path Relationship	Path Coefficient	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics	P Values	Significant? **p<0.05
Acquisition Capacity ->INNOVATION	-0.143	-0.131	0.164	0.874	0.382	
Acquisition Capacity ->Product Development Related Performance	-0.183	-.181	0.165	1.106	0.269	
Acquisition Capacity ->Strategic Flexibility	**0.441**	0.457	0.159	2.768	0.006	**
Assimilation Capacity ->INNOVATION	-0.68	-0.077	0.283	0.241	0.809	
Assimilation Capacity ->Product Development Related Performance	**0.786**	0.775	0.245	3.212	0.001	**
Assimilation Capacity ->Strategic Flexibility	-0.149	-0.164	0.211	0.706	0.480	
Exploitation Capacity ->INNOVATION	0.173	0.163	0.128	1.357	0.175	
Exploitation Capacity ->Product Development Related Performance	0.094	0.117	0.196	0.479	0.632	
Exploitation Capacity ->Strategic Flexibility	**0.510**	0.521	0.141	3.606	0.00	**
Transformation Capacity ->INNOVATION	0.297	0.288	0.155	1.912	0.056	
Transformation Capacity ->Product Development Related Performance	-0.195	-0.176	0.258	0.754	0.451	
Transformation Capacity ->Strategic Flexibility	-0.321	-0.321	0.228	1.411	0.159	

Table 4.8.1: Path Coefficient and Significance testing for direct effects of absorptive capacity on competitive advantage (n=67)

5

Discussion on Findings

5.1 Introduction

This chapter deals with in depth discussion and theoretical interpretations of the results obtained from the statistical analysis in Chapter 4. The summary of decisions of hypothesis testing is presented in Table 5.1.1. The chapter then proceeds to provide practitioner recommendations, limitations of research, theoretical contributions and directions for future research.

Sub research question	Hypothesis	Decision
How do the managerial processes of implementing open innovation affect the capabilities of the firm?	Hypothesis 1:There should be a positively significant relationship between open innovation activities and absorptive capacity of the firm.	Supported
How do experiences of academic start ups in university incubators influence their growth?	Hypothesis 2a: Acquisition Capacity should have a positive relationship with Assimilation Capacity	Supported
	Hypothesis 2b: Assimilation Capacity should have a positive relationship with Transformation Capacity	Supported
	Hypothesis 2c: Assimilation Capacity should have a positive relationship with Transformation Capacity	Supported
How do the internal capabilities of the academic start-ups in university incubators help them achieve competitive advantage?	Hypothesis 3a:There should be a positive relationship between Assimilation and Acquisition Capacity (Potential Absorptive Capacity) and Strategic Flexibility	Partially Supported
	Hypothesis 3b: There should be a positive relationship between Assimilation and Acquisition Capacity (Potential Absorptive Capacity and Innovation	Rejected
	Hypothesis 3c:There should be a positive relationship between Assimilation and Acquisition Capacity (Potential Absorptive Capacity and Product Development Related Performance	Supported
	Hypothesis 4a:There should be a positive relationship between Transformation and Exploitation Capacity (Realised Absorptive Capacity) and Strategic Flexibility	Supported
	Hypothesis 4b:There should be a positive relationship between Transformation and Exploitation Capacity (Realised Absorptive Capacity) and Innovation	Rejected
	Hypothesis 4c:There should be a positive relationship between Transformation and Exploitation Capacity (Realized Absorptive Capacity) and Product Development Related Performance	Rejected

Table 5.1.1: Summary of Hypothesis

5.2 Relationship between Managerial Actions to Implement Open Innovation and Absorptive Capacity as a Dynamic Capability of the Academic Start-Up

SQ1: How do the managerial processes of implementing open innovation affect the dynamic capabilities of the firm?

The findings of testing *Hypothesis 1* have implied that in a triple-helix system of innovation –the university incubator Yes! Delft, the dynamic capability of the academic spin-off is a component of an underlying entrepreneurial routine or process which is important factors in the implementation of Open Innovation Chesbrough [2006].

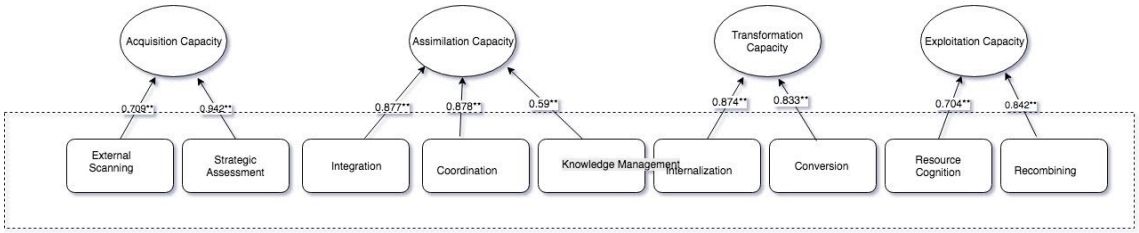


Figure 5.2.1: Caption

The study confirms the findings by Zobel [2017] who suggests that implementation of *Open Innovation* by firms is the underlying process which builds their absorptive capacity and also, in line with the concept of *'absorptive capacity'*, where Cohen and Levinthal [1990] suggest that dynamic capability of a firm is embedded in its routines and processes ([Teece et al., 1997]).

- ***Lower order Managerial Actions to implement Open Innovation and Potential Absorptive Capacity***

  The findings show that *External Scanning* and *Strategic Assessment* enable Acquisition Capacity of the firm equally strongly, as the cumulative loading of both of them are very close. This is a strong indication towards the Knowledge Base View of the academic start-up that resource deficiency makes the boundaries of the firm permeable.

  Strategic Assessment also has a high correlation with Acquisition Capacity, this means that academic spin-offs are able to enjoy good exposure to market information and changing trends. One of the reasons for this could be that academic spin-offs work in a technology *niche* and have strong focus on the particular market segment. This makes them channelize most of their efforts into products for a specific market niche, rather than having a diverse

portfolio of products.

Regarding Assimilation Capacity, it was seen that Coordination, Integration and processes for knowledge management has a significant influence on Assimilation Capacity, thus, academic start ups at Yes! Delft are able to build up their assimilation capacity by diffusing the knowledge from exposure to university knowledge resources into their organization. This maybe due to the fact that the location at knowledge city Delft and proximity to university resources help them find important *boundary spanners* in the form of researchers and academic interns, who could study their technology as a part of their research and provide different directions to the technology they are using. This is in line with Barney [1991] who suggests that resources become strategic assets when they can be understood well to be deployed in strategies of the firm. Also, the university incubator encourages social interaction mechanisms for the organizations so that they can get a good linkage to informal and formal network bases to analyze the business fit of the knowledge resources they possess.

Knowledge Management processes are also an enabler of assimilation capacity, as seen from the data analysis. However it had a comparatively weaker score than other two indicators. This could be due to the fact that academic start ups in the incubators share a common pool of knowledge processing mechanisms, like accelerator programs, and other common knowledge storing and retrieving infrastructure installed in the workplace. Therefore, the start-ups might not be interested in developing their own knowledge management processes. Therefore, the firms might tend to under-develop their own knowledge management capabilities.

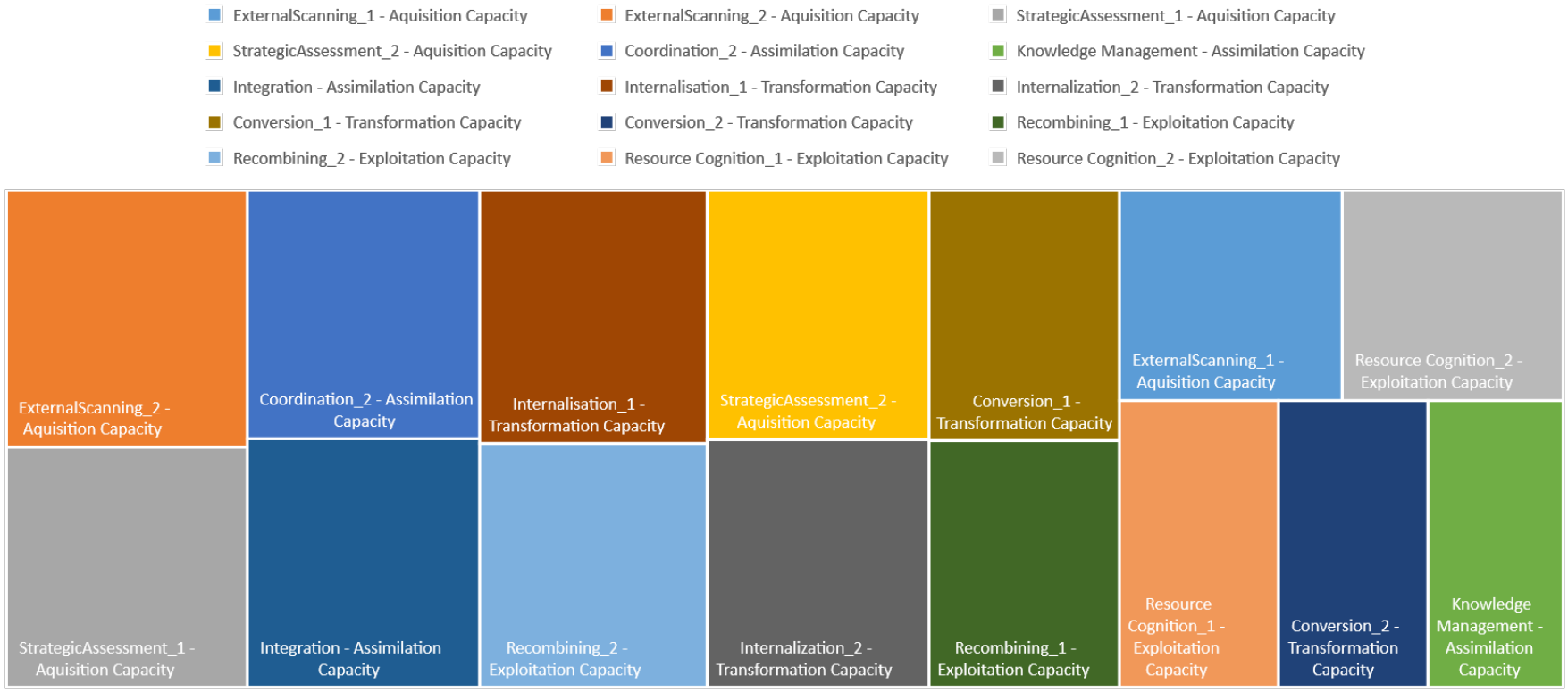
- ***Lower order Managerial Actions to implement Open Innovation and Realized Absorptive Capacity***

  Internalization and Conversion had a positive and significant relationship with Transformation Capacity. However there was an interesting observation that *Internalization* had higher regression coefficients than *Conversion*. Zahra and George [2002] describe Transformation Capacity as the dimension of ACAP that enables the entrepreneurial actions of the firm as the acquired external knowledge before being exploited needs to be transformed into the organisation through internalization and conversion that will assist the entrepreneurs in the process of yielding new insights for decision making through *Recodification* and *Bisociation* of the acquired knowledge as a resource.

Lastly, Recognition of Resources and Recombination have a positive relationship with exploitation capacity. This indicates that academic start-ups in university incubators are able to compliment their lack of resources by taking support from the university incubator. Support could be in the form business plans drafting, connecting to better partners and analyzing their value propositions with the help of advice and coaching.

Overall, The results give interesting insights into the relationships between knowledge as a resource and dynamic capabilities of the firm which can be linked to development of dynamic capability in the academic start ups and growth of academic spin offs in university incubator. Figure 5.2.2 shows us the distribution pattern to suggest the development of absorptive capacity due to implementation of open innovation based managerial activities. Next we examine the higher order hierarchy in the conceptual model that gives us insights into the relationship between dimensions of absorptive capacity (section 5.3) and the relationship between absorptive capacity and competitive advantage. (section 5.4)

Figure 5.2.2 *(following page)*: Hierarchy chart representation of *'Managerial Processes of Implementing Open Innovation' based on the results of testing Hypothesis 1.* The area of rectangle represents the relative size of coefficient of regression. This identifies the development pattern of absorptive capacity as a dynamic capability with the help of business incubator's support


ExternalScanning_1 - Aquisition Capacity
ExternalScanning_2 - Aquisition Capacity
StrategicAssessment_1 - Aquisition Capacity
StrategicAssessment_2 - Aquisition Capacity
Coordination_2 - Assimilation Capacity
Integration - Assimilation Capacity
Internalisation_1 - Transformation Capacity
Conversion_1 - Transformation Capacity
Conversion_2 - Transformation Capacity
Internalization_2 - Transformation Capacity
Recombining_1 - Exploitation Capacity
Recombining_2 - Exploitation Capacity
Resource Cognition_1 - Exploitation Capacity
Resource Cognition_2 - Exploitation Capacity
Knowledge Management - Assimilation Capacity
ExternalScanning_2 - Aquisition Capacity
Coordination_2 - Assimilation Capacity
Internalisation_1 - Transformation Capacity
StrategicAssessment_2 - Aquisition Capacity
Conversion_1 - Transformation Capacity
ExternalScanning_1 - Aquisition Capacity
Resource Cognition_2 - Exploitation Capacity
StrategicAssessment_1 - Aquisition Capacity
Integration - Assimilation Capacity
Recombining_2 - Exploitation Capacity
Internalization_2 - Transformation Capacity
Recombining_1 - Exploitation Capacity
Resource Cognition_1 - Exploitation Capacity
Conversion_2 - Transformation Capacity
Knowledge Management - Assimilation Capacity

5.3 Relationship Between Potential Absorptive Capacity and Realized Absorptive Capacity : Path Dependent Nature of Absorptive Capacity

SQ2: How do experiences of academic start-ups in university incubators influence their growth?

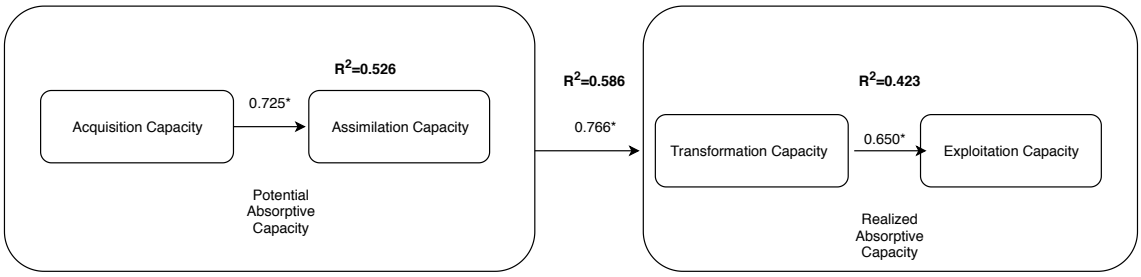


Figure 5.3.1: Findings for Path Dependency of Absorptive Capacity).

This study found out that there is a positive relationship between Potential Absorptive capacity (PACAP) and Realized Absorptive Capacity (RACAP) from hypothesis 2a,2b and 2c. This confirms that absorptive capacity of a firm follows a path that grows over time. *Acquisition Capacity* leads to accumulation of *Assimilation Capacity* and this Assimilation Capacity leads to *Transformation* and *Exploitative Capacities.* Therefore, it can be understood that the experience of the firm at the incubator will determine its future capabilities and might influence its growth once it leaves the incubator. This is in line with path dependency of firm capabilities from the resource based point of view and as Teece et al mention - *'History Matters'* [Teece et al., 1997].

Firstly, it is interesting to see the *cumulativeness* of absorptive capacity as a dynamic capability of the firm as described by Cohen and Levinthal [Cohen and Levinthal, 1990] to be true in the case of an university incubator ecosystem as well. The evidence from this study that academic start-ups at the university incubator Yes!Delft are able to convert their *Potential Absorptive Capacity (PACAP)*, that is, *Acquisition and Assimilation* to *Realized Absorptive Capacity (RACAP)*, that is *Exploitation and Transformation* is an indication of implication of university incubator support on the future of the start-ups it houses and their rational behaviour models to be based on historical experiences with respect to level of prior knowledge that a young firm develops as the level of prior knowledge is an important enabler of assimilating new knowledge as the new knowledge

might share a fraction of its characteristics with older knowledge. [Cohen and Levinthal, 1990].

Secondly, the possession of prior knowledge will assist development of related expertise that helps the firm to better develop, understand and evaluate the merits and demerits of new technological trends. Such expertise due to path dependency helps the organization in *Uncertain* environments. Such developed absorptive capacity helps the firm to accurately predict the commercial potential of the new technologies available, which is the ultimate goal of sourcing in external knowledge through open innovation (Chesbrough [2006] and commercializing it (Cohen and Levinthal [1990], Zahra and George [2002]).

However, path-dependency can also be a drawback and an emerging growth risk, because, *Thirdly*, as mentioned by Cohen and Levinthal [1990], absorptive capacity is a self-reinforcing mechanism therefore, because of such learning mechanisms the firm might lead itself to reduced efficiency because of rigidity, leading to a condition known as a potential *lock-in*. This is because as the competencies of the start-ups that will be shaped in the incubator might get carried forward with them on leaving the incubator and ultimately become obsolete if the firm is unable to keep renovating them to tackle new found changes and the challenges that come with it.

The findings of this study illuminate the path dependency and potential lock-in due to internal organization processes, with the absorptive capacity as the tool to delineate it and thus based on the framework provided by Sydow et al. [2009], we identify the three phases which the academic start-ups in the university incubator might experience due to their path-dependency. Sydow et al. [2009] distinguishes the organizational path due to path-dependency leading to lock-in into three distinct phases. Table 5.3.1 explains the mentioned phases and the corresponding organizational phases from the findings of this study .

Phase	Phase description for Organizational Path([Sydow et al., 2009]	Corresponding Phase from findings (OI-ACAP framework) of this study
Phase-I- Preformation Phase	The phase is categorized as the phase of inter organizational process which are the starting point of the all the processes. This is thus so called the *Preformation Phase*. The preformation phase is characterized as ***BROAD SET OF ACTIONS*** and it continues through until the broad set of actions start manifesting themselves into the dynamics of a *self-reinforcing* process and the organization crosses this juncture to enter into the Phase II, which is the *Formation Phase* of the organization.	The lower order managerial actions for implementing Open Innovation which are the underlying process constituting the corresponding dimension of ACAP based on ([Zobel, 2017])
Phase- II- Formation Phase	This is the phase in which a dominant pattern starts to emerge for the organization due to the self-reinforcing processes of the preformation phase. This new dominant pattern is usually irreversible.	The dimensions of ACAP as dynamic capability of the firm ([Zahra and George, 2002]). ACAP Dimensions behave as self-reinforcing dynamics for the organisation ([Cohen and Levinthal, 1990])
Phase- III- Lock-in	The transition from Phase II to Phase III characterizing further restriction of scope for the organization, because the self-reinforcing dynamics get deeply embedded in the organisational structure and are repetitively practised.	The path-dependent nature of dimensions of ACAP suggesting a potential Lock-In

Table 5.3.1: Organizational Path-Dependency and it's effects based on the findings

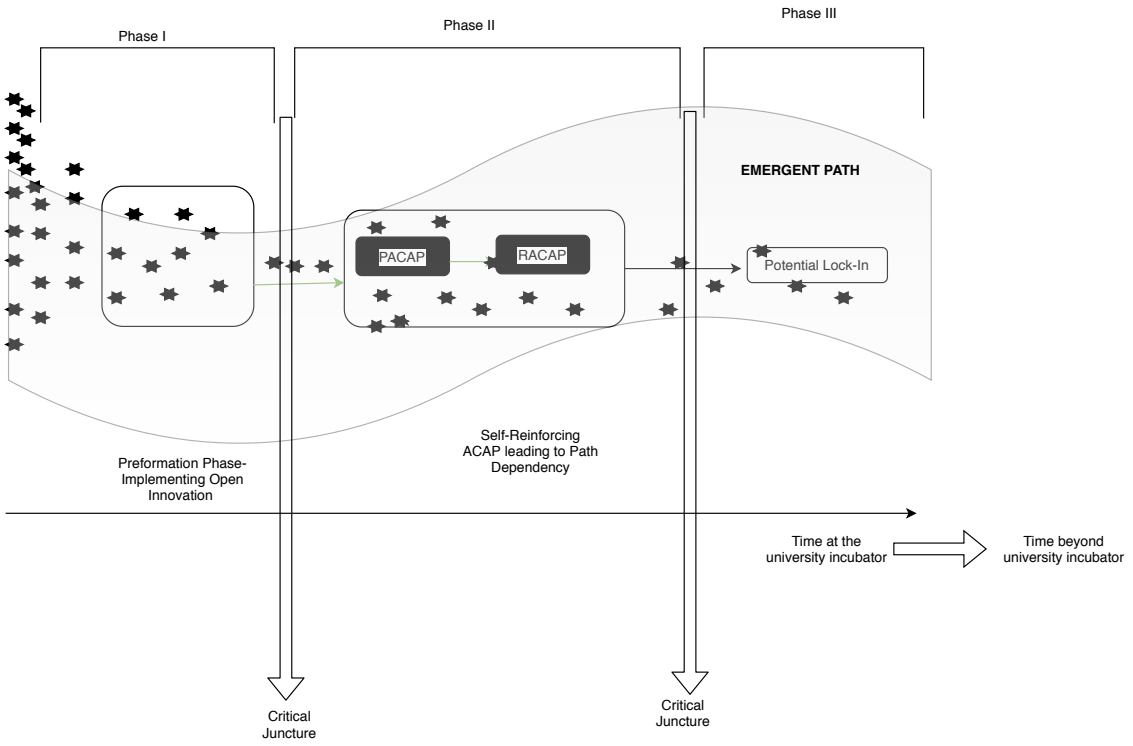


Figure 5.3.2: Implementing open innovation and path-dependency due to absorptive capacity, based on [Sydow et al., 2009]).

For the Main RQ: The findings from the path dependent relationship between PACAP & RACAP help us identify growth implications for *Critical Juncture B: Entrepreneurial Commitment* which is discussed in detail in Section 5.5.2

5.4 Relationship Between Absorptive Capacity & Competitive Advantage for Academic Start-Ups in University Incubators

SQ3: How do the internal capabilities of the academic start-ups in university incubators help them achieve competitive advantage?

From Hypothesis sets 3a, 3b and 3c the direct effects of Potential Absorptive Capacity on Competitive Advantage were analyzed and from the hypothesis sets 4a, 4b and 4c, the direct effects of Realized Absorptive Capacity on firms' competitive advantage were found.

5.4.1 Absorptive Capacity and Innovation

The Potential Absorptive Capacity (PACAP) did not show a significant relationship with Innovation, which suggests that academic start-ups at Yes! Delft have a limited ambition to expand their

portfolio through continuous breakthrough inventions and rather just focus on a smaller set of innovation portfolio as reflected by the intellectual property in possession of the firm.

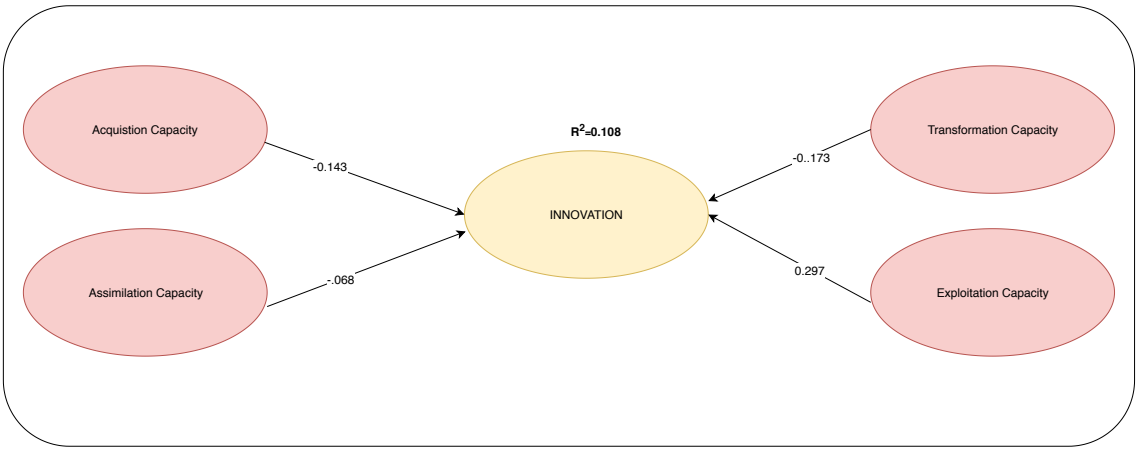


Figure 5.4.1: Empirical Results of Relationship between ACAP and Innovation for Competitive Advantage. It is observed that neither of the dimensions of ACAP –PACAP and RACAP have a significant relationship with Innovation

.

This helps us understand the effects of self-enforcing learning mechanism to manage knowledge as a resource by academic start-ups, which is in line with the study by Ahuja and Morris Lampert [2001] who study breakthrough inventions in large corporations from the learning process perspective. As discussed earlier, Absorptive Capacity is a by-product of research and development, and more so a product of learning-by-doing, we can argue that the conclusions by Ahuja and Morris Lampert [2001] are also valid not only in the case of large corporations but in small scale firms too, that is, the learning mechanisms like developing absorptive capacity might make the firm fall in learning traps -*Familiarity Traps*, *Propinquity Trap* and *Maturity Trap* [Ahuja and Morris Lampert, 2001]. With the help of these three terms, we can explain the insignificant relationship between Potential Absorptive Capacity and Innovation as in the process of implementing open innovation and research for novel technologies for their products, academic start-ups might be falling in these traps which depict shortsightedness in innovation growth for the firm in the future.

Familiarity Trap-: Ahuja and Morris Lampert [2001] describe familiarity trap as neglecting alternative directions because the company becomes increasingly competent and increasingly experienced with current set of technologies it is working with. As a result of this positive feedback, there is an enhanced absorptive capacity and this enhancement of the absorptive capacity cycle

makes the company invest low in their Potential Absorptive capacity to Acquire and Assimilate new knowledge in the form of innovation as recorded by the intellectual properties. This also suggests that the companies might develop ease in learning the technology at hand and might fall of latest technological trends in the market and thus proving to be a classic example of *Technological Lockout* due to low investments in Potential Absorptive Capacity.

Another explanation of falling in the *Familiarity Trap* can be the low-risk taking tendency of the firms due to lack of resources and work with product myopia until the *credibility* of the firm is sufficient to take risks of experimentation and break the familiarity trap. Vohora et al. [2004] also argue *Credibility* to be a critical juncture that academic start-ups face in their growth phase. A firm engaging with a lot of experimentation will be at a risk of losing credibility with its investors and sources of funds, like the incubator itself. Lack of resources makes familiarity trap a unavoidable choice for the start ups as risks of negative consequences of experimentation may result in troubles as suggested by Levinthal and March [1993] that there can be limitations to the learning process. University incubators and their facilities are by large a extensive learning experience for young firms, therefore, early recognition of such familiarity traps will be beneficial for future growth possibilities. However, dependency of the firms on such ease of learning due to the incubator support might interfere with their independent capability later in the lack of such private coaching as provided by the university incubators, like Yes!Delft.

Maturity Trap: Similarly, the next trap in the learning process is the maturity trap, as put forth by Ahuja and Morris Lampert [2001]. The *maturity trap* is the tendency to favour mature technologies over emerging technologies, thus reducing the affinity of the organization towards innovation and emerging technologies. *Emerging Technologies* here are described are new, leading edge technologies that are relatively newer in chronological terms (Ahuja and Morris Lampert [2001], page 527). Lack of experimentation as seen with insignificant relationship between Potential Absorptive Capacity and Innovation suggests that the firms in the incubator are playing safe by not focusing on expansion of their innovation portfolio by investing time and efforts in the direction of breakthrough inventions but focusing on specific technologies or research knowledge at reliable and mature technological avenues rather than developing emerging technologies, which might be unproven and cause a high risk of failure. This tendency can be beneficial for short term credibility, reputation and sustainable returns, but since we have already seen the path dependent nature of Absorptive Capacity, the firms might tend to fall in such maturity trap, out of a developed habitual routine to not scan for emerging technologies in an open innovation model and might be a growth implication on a later stage.

The Realized Absorptive Capacity (RACAP) also has an insignificant relationship with Innovation for Competitive Advantage. The dimensions of RACAP Transformation Capacity and Exploitation Capacity deal with entrepreneurial actions and implementation of the knowledge generated from Potential Absorptive Capacity. To do so, firms need to indulge in problem solving an important application of Absorptive Capacity as pointed out by scholarship (Cohen and Levinthal [1990], Zahra and George [2002]).

Ahuja and Morris Lampert [2001] argue that problem solving in learning development can be influenced by the availability of solutions to the firm, which decides the efforts it puts in technological problem tackling by looking for breakthrough technologies or developing innovation capabilities, which is also the core fundamental principle behind the open innovation model (Chesbrough [2006]. This comfort produced by the ease of learning is a trap known as the *propinquity trap* that companies can fall in and evidently, Academic Start ups in the university incubators suggest this from the statistical analysis. The following section discusses this trap.

Propinquity Trap: Ahuja and Morris Lampert [2001] describe propinquity trap as the developed ease in learning process for innovation due to easily available and used solutions in the firm's neighbourhood. *This might be a reason explaining why Realized Absorptive Capacity has an insignificant relationship with Innovation as academic start-ups in the incubator would depend on problem solving support provided due to the experience of university incubator coaching management.* As pointed out by Cohen and Levinthal [1990], absorptive capacity is essential for a firm to develop it's problem solving skills and thus such insignificant relationships could be as a result of adaptation of such existing solutions and reducing the necessity of incubator start ups to put in effort to solve technological problems through reliance on breakthrough inventions.

For the Main RQ: The findings from the relationship between ACAP and Innovation help us identify growth implications for *Critical Juncture A: Opportunity Recognition* which is discussed in detail in Section 5.5.1

5.4.2 Absorptive Capacity and Strategic Flexibility

Revisiting our discussion in Chapter 2 on knowledge as a resource and source of competitive advantage being from the dynamic capabilities of the organization to manage that resource. Regarding *Potential Absorptive Capacity*, it was found that *Acquisition Capacity* has a positive and significant relationship with strategic flexibility but *Assimilation Capacity* has an insignificant re-

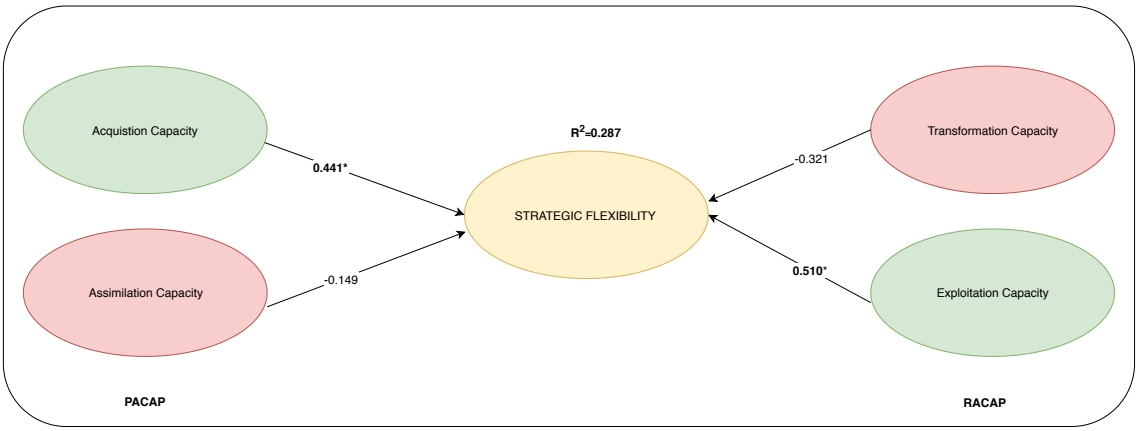


Figure 5.4.2: Empirical Results of Relationship between ACAP and Strategic Flexibility for Competitive Advantage. It is observed that only the extreme ends of dimensions of ACAP –*Acquisition Capacity* and *Exploitation Capacity* have a significant relationship with Strategic Flexibility but not the other two dimensions of –*Assimilation Capacity* and *Transformation Capacity*

.

lationship. Also surprisingly, for *Realized Absorptive Capacity*, there was a insignificant relationship with Strategic Flexibility for Transformation Capacity but positive significant relationship for Exploitation Capacity. This suggests that academic start-ups in our study have support to find the best possible source of required knowledge and support to implement or exploit it for having strategic flexibility, however the firms' independent capabilities are still not well developed, as the acquired external knowledge and exploiting it is not being the result of strategic flexibility due to their assimilation and transformation capacity. This is important to be balanced because as argued by scholars and also found in the earlier discussions of this study, absorptive capacity has a path dependent nature ([Teece et al., 1997], Cohen and Levinthal [1990]).

Hitt et al. [1998] have argued that for strategic flexibility, a firm needs to build dynamic capabilities in order to enjoy competitive advantage through it. In this thesis work, the dynamic capability has been 'Absorptive Capacity' through its dimensions and the parent-spin-off relationship is seen between the Academic Start-ups and the University Incubator (Yes! Delft). Zahra and George [2002] have argued how multidimensional nature of absorptive capacity (PACAP+RACAP) helps in attaining sustainable competitive advantage, which was tested in this thesis to see if academic start-ups have a relationship with the organizational capabilities developed and if it is helping it achieve strategic flexibility during its growth process.

Dynamic capability like *Absorptive Capacity* will be a prominent genetic characteristic of academic start-up, and most likely will carry with it after the start-up graduates from the incubator.

Thus, adaption of superior capabilities for *Strategic Flexibility* should be developed by the decision makers of the firm as a capability, so that the knowledge resources becoming valuable and difficult to be imitated by the competitors (Sanchez [1995], Barney [1991]). The findings suggest that the *cushion* support might fuel overconfidence in the firms when adapting to rough and harsh realities of competitive markets. This is a condition known as the *'Icarus Paradox'*. The **Icarus Paradox** is a management phrase that stems out of a Greek mythology in which a mythological character 'Icarus' flew too high with his artificial wings out of overconfidence that eventually melted with the heat of the sun and resulted in failure. This analogy is often used in management science when companies' habitual routine and factors that once were sources of success or competitive advantage also are the reason that lead to failure. In the context of this study, it is seen that the academic start-ups have developed the extreme ends of the absorptive capability for absorptive capacity - *Acquisition and Exploitation* due to the incubator support, however the crucial internal capabilities to assimilate the acquired knowledge and transform it is under developed to explain Strategic Flexibility.

University incubator support is providing a *cushion* support to help the academic start-ups to find the most appropriate knowledge sources of external knowledge and identified areas of exploitation, but not helping the academic start-ups to develop growth capabilities independently, and this protective nature might be dangerous when the start-up leaves the incubator, because of over-confidence in their abilities to stay strategically flexible. Such *'cushion'* may ultimately lead to over confidence in the firm to reconfigure their resources for strategic flexibility once they leave the incubator and may result in failure when the cushion is removed and the actual commercial realities of the market come into play. Thus, the academic start ups in incubator may be at a risk of failure due to over confidence in their strategic flexibility provided because of the incubator support. This is in line with findings by Trott et al. [2008] that incubator support reduces the cost function for start-ups and speeds up the founding process, due to low resource allocations and low interest rate investments in utilities like infrastructure, accommodation etc. Thus it is natural that the companies will be flexible with business resource allocation as a huge investment in the infrastructure during the founding process is already been taken care by the incubator support system.

This Icarus Paradox leaves the firm at a risk of overconfidence due to the *cushion support* of the incubator. Russo and Schoemaker [1992] define overconfidence as the belief that an individual or organisation possess greater knowledge or skill than that it actually possesses (page, 1). Moore and Healy [2008] categorize three ways in which companies can have trouble due to overconfidence, which are ***Overestimation of the actual performance, Overplacement of one's***

***performance in relational to others* and *Have excess precision in own beliefs*.**

The **problem with *'Overestimation of One's Performance'* or in other words, *misestimation***, can be a risk of ***Planning Fallacy Due to Overconfidence***: *Misestimation* is a form of overconfidence that occurs when the organization makes an incorrect estimation of quantities, but usually in a predictive manner (Moore and Healy [2008]. The most usual form of such misestimation in business is budget planning and deadlines. Due to errors in planning because of overestimation of the actual performance, the budget gets underestimated and hurts the financial strength of the organization. Overconfidence due to miss-estimation of planning time taken for completing tasks which were easier to be performed in the past but require more planning and efforts in the present times, this leading to the entrepreneurial failure (Russo and Schoemaker [1992], Moore and Healy [2008]). This situation is known as the *planning fallacy*, as put forward by Nobel laureate Daniel Kahneman and his partner Tversky ([Kahneman and Tversky, 1977]). Klein and Klein [2001] argue that not all mistakes by entrepreneurs can be predicted and if an entrepreneur is not making mistakes, then it would be unusual. However, Kahneman [2011] believes that with the predictive statistical data, planning fallacies can be prevented. Therefore, it is suggested that the start-ups in the university incubator should try to recognize their areas of *cushion* support provided that is helping them achieve competitive advantage through strategic flexibility. The **Problem with Over-placement of One's Performance can lead to a condition called the *Lake Wobegon Effect***. This is the form of overconfidence that leads to errors in relative comparisons mistakes an organization might make when people of the organization place themselves too highly when comparing themselves with their competitors. The firms start believing in the notion, that *'We are better than our competitors'* leading to a sense generating from *'Illusion of Superiority'*. Illusion of Superiority means that one marks oneself positively and above average in comparison to others when in reality the case might not be the same. This condition in management and psychology is seen as *'Lake Wobegon Effect'* ([Peterson, 2000], page 45). which is a story based on a fictional town where all the children are above average. The **Problem with having excess precision in one's belief** can be *Hurting Best Alternative to a Negotiated Agreement(BATNA)*. Misprecision leads to the belief that we are able to predict quantities or costs more accurately than it actually is in reality. For example, the probablity of final cost of completion of a project etc. This might affect the Strategic Flexibility of the firm for their BATNA or hurting the capabilities of negotiations in alliances.

For the Main RQ: The findings from the relationship between ACAP and Strategic Flexibility help us identify growth implications for *Critical Juncture C: Credibility* which is discussed in detail in Section 5.5.3

5.4.3 Absorptive Capacity and Product Development Related Performance

Product Development Related Performance is an essential source for competitive advantage as according the Knowledge Based View of firms, the existence of company is the conversion of knowledge into product or services ([Grant, 1996]), the most important result of open innovation is product development ([Chesbrough, 2006], [Chesbrough and Crowther, 2006], [Laursen and Salter, 2006]) and also the end result of exploiting external knowledge due to the capability of the firm known which is core of this study, the absorptive capacity ([Cohen and Levinthal, 1990], [Zahra and George, 2002], [Jansen et al., 2005])

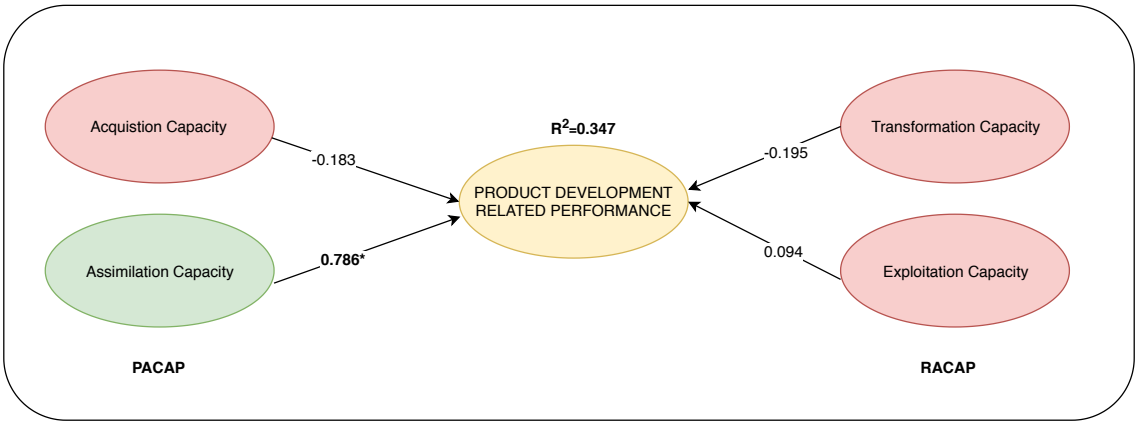


Figure 5.4.3: Empirical Results of Relationship between ACAP and Product Development Related Performance. It is observed that only *Assimilation Capacity* has a significant relationship with Product Development Related Performance

The findings of relationship between ACAP and Product Development Related Performance had a very interesting observation. It is observed that the efforts for PACAP, which is investing resources to assimilate knowledge the acquired knowledge has a significant relationship with Product Development however, the exploitation and transformation of the same knowledge does not have a similar relationship. This also suggests that the academic startups are focusing higher in their PACAP to assimilate their knowledge compared to their investment in RACAP. The path coefficient between Assimilation Capacity and Product Development Related Performance is **0.786** which is highly significant at (p=0.001; p<0,05) further strengthens the argument that there is a higher investment in PACAP compared to RACAP.

This suggests that due to well developed PACAP, the academic start-ups might have a good position to adapt to changing market trends, renew their knowledge stock for the product and thus reduce their sunk investments because they may not need to reconfigure their knowledge

for product development from time to time. However, the low developed RACAP might be a growth barrier because the acquired and assimilated knowledge is a resource and RACAP deals with knowledge exploitation and if such acquired and assimilated stocks are not implemented in products effectively, the companies might end up making unwise decisions in the future and spoil their benefits of first mover advantages.

As suggested by Cohen and Levinthal [1990] and empirically tested in this study, Absorptive Capacity follows a path dependency, this implies that having high Potential Absorptive Capacity (PACAP) might help in sourcing in new knowledge and assimilating it in their organisation for product developed, but unless Realized Absorptive Capacity (RACAP) is simultaneously developed for product development, it might be harmful for the organization to not consistently transform and exploit such knowledge intended for product development even if the firm becomes aware of technological trends and changing market demands, as suggested by Sanchez [1995] who argues that knowledge as a capability should be exploited for product development.

Additionally, as suggested by Zahra and George [2002], a well developed PACAP is supposed to be complimented with a well developed RACAP for competitive advantage because, the dimensions of RACAP, transformation and exploitation are directly associated with development of products and services. *Transformation Capacity* enables the organization to develop their entrepreneurial capability of *bisociation* which means to interpret the acquired and assimilated knowledge in two frames, meaning to find more than one interpretations of the same knowledge and this transformation capacity builds up the *Exploitation Capacity* to interpret and implement the knowledge from PACAP and embed it into the products and services.

This is an important application of *Absorptive Capacity* as a dynamic capability for start ups because the university research used for commercialization is still basic science and *opportunity identification* happens only when a commercial interpretation of such knowledge is made and implemented by the academic entrepreneurs, as demonstrated by the cases from the course *Turning Technology into Business* where the university patents have been interpreted for commercialization in a frame different from the original intention of the patent ([Hartmann, 2014]). Another argument for high developed PACAP but insignificant RACAP relationship could be higher much customer-oriented focus and relatively lower focus on the products, a product development strategy the start ups might be following, which might lead to ***Innovator's Dilemma*** as suggested by Christensen [2013].

The *Innovator's Dilemma* in product development is a condition proposed by Christensen [2013]

that suggests that companies often move into failure by aggressively investing in the products and services that is most profitable for their customers on a short term. The dimensions of RACAP, *Transformation Capacity* and *Exploitation Capacity*, which have an insignificant effect with product development related performance are important to be developed for competitive advantage (Zahra and George [2002]. From the path dependency nature of ACAP, such a result can be interpreted as a consequence of low Transformation Capacity, leading to low Exploitation Capacity. This might be because the efforts and intensity of Research & Development are higher to acquire and assimilate knowledge but lower to interpret, transform and exploit this knowledge.

This implies that these companies are focusing their efforts on products and services which are immediately profitable but the focus for product development is not intended for a long term with changing technological trends. *Positive and significant relationship of PACAP with Product Development Performance but insignificant RACAP might put the startups at a risk of 'Product Myopia' due to Innovator's Dilemma.* Steve Jobs, Co-founder and CEO of Apple Inc., had famously said for product development that *"A lot of times people do not know what they want until you show it to them"* [Times, 2011]. As suggested by the results, the academic start-ups at the university incubators are too customer focused and not product focused because of high efforts towards PACAP but insignificant efforts through RACAP for product development. Levitt [2004] calls this trap as *'Marketing Myopia'* by citing an example of railways in the United States. According to Levitt [2004], the railroads are in trouble even though the need for freight and passengers did not decline because railways were too focused in improving their rail products for customers and not considering expansion of rail roads. Due to this, the customers of railways were taken away by other industries like cars, aeroplanes, trucks etc.

The evidence of high efforts for PACAP and low RACAP suggest dangers for excessive R&D to improve and please current customers and not in *Transformation* and *Exploitation* to expand product lines for different customers. This is in line with propositions by Trott et al. [2008]. According to Trott et al. [2008], the academic start-ups in university incubators might tend to focus a specific *niche* in the form of a product category or market segment too early in their growth journey. This might be beneficial to allocate resources for a short term and enjoy competitive advantage, but in the long run it might lead to *product myopia.* Levitt [2004] therefore proposes four beliefs which misleads organization due to *Myopia* arising from excessive *customer orientation*. They are as follows

1. The belief of assured growth due to expanding population
2. The belief of absence of a superior competitive substitute for the particular industry's major

product.

3. Having too much faith in mass producing the products because it helps in declining unit costs as output rises and

4. Having too much confidence in declining need for research, development and experimentation expenditures.

Continuing with the path dependency of absorptive capacity argument, this short-sighted knowledge exploitation strategy might lead to hindered development capabilities in the long run for other market segments and product categories, if when the company grows in size and looks at expansion opportunities. This is because the knowledge stock of the academic start ups in the incubator might become out-dated even before they could realize directions to implement them. Such limitations to organizational capabilities due to the learning processes is known as *"myopia of learning* ([Levinthal and March, 1993] and such myopia might tend to make the companies neglect the larger scheme of things and ultimately lead to entrepreneurial problems. Levinthal and March [1993] thus put forward three main problems that could arise due to myopic learning processes. These are *Tendency to ignore long-run consequences, Tendency to ignore the larger picture* and thirdly, *Tendency to overlook failures* ([Levinthal and March, 1993], page 101). The following section shall discuss the implications of such problems due to myopia.

Consequences of Myopic learning: According to Levinthal and March [1993], myopic learning arises when there is an imbalance between *Exploration* and *Exploitation* of resources. From knowledge Based View, ([Grant, 1996] knowledge can be seen as a strategic resource and Exploration corresponds to acquisition and Assimilation (PACAP) and Exploitation corresponds to Transformation and Exploitation (RACAP) (Zahra and George [2002]. According to our findings where PACAP had a significant relationship with exploration but RACAP did not have a significant relationship, it can be concluded that there exists an imbalance between exploration and exploitation of knowledge as a resource.

1. **Problems arising due to tendency to ignore long-run consequences-**

   - ***Erosion of Enactment & Second-order Effects of Specialization***:
     Levinthal and March [1993] argue that even though it is fairly natural to believe that short-run survival strategies will be the reason for longer-run survival possibilities, however such myopic focus of strategies compel the firms to have *Simplification* and *Specialization* of strategies.

According to Levinthal and March [1993], Learning processes create a simplified world and creates an environment which is simple to enact and help in incremental benefits with problems at hand in current circumstances. This learning when repeated over time simplifies for the organization to tackle the problem regarding products when it comes back to it and ultimately making the firm specialize in such activities ongoing in the present times. This leads to development of mental models which will be used to tackle the problems of future using the elements of current circumstances. This is in line with the SECI model of Nonaka et al. [2000] that emphasizes of conversion of knowledge from explicit to tacit to create mental models for the organization and the relevance of such mental models to be translated into the products and services for competitive advantage. Thus, the simplification of learning processes may lead to decay of organizational competences and possibly damaging the dynamic capabilities of the firm, which in our study is captured using *Absorptive Capacity*. Levinthal and March [1993] term such risks as *erosion of enactment*.

Secondly, due to simplification of learning processes as discussed above, the organization becomes adaptive to problem tackling through a certain technique and later adapt it as its specialization. The specialized adaption in turn substitutes learning from one part of the organization to another. This in turn leads in decay of organizational capabilities which exist in the form of skills, procedure and technological learning because the company has become such a specialist that it is now immune to further specialization and new adaptations to problem solving skills. Thus even if the specializations in product development are proving benefits in such short run, it might be a hindrance to organizational capabilities in a long-run for competitive advantage. Due to the sticky nature of knowledge and path dependencies of ACAP as a dynamic capability, these specializations will be carried forward by the organization once they exit the incubator and this may be a reason for finding themselves with entrepreneurial troubles. Levinthal and March [1993] thus terms such problems as *second-order effects of specialization*.

- ***Problems of timing due to Knowledge Inventories***: From knowledge based view of resources, *Acquisition and Assimilation* of knowledge can be seen as stockpiling of knowledge and the knowledge inventory is intended to be used for solving problems that come to the organization in the distant future.

In this study, with respect to product development performance sharing a positive

and significant relationship for competitive advantage, it can be suggested that the organizations in the university incubator have been investing significant amount of efforts in stockpiling knowledge for their products and services, however, the insignificant relationships between RACAP and Product Development Related Performances suggest that the external knowledge Acquired and Assimilated due to investments in PACAP, are not being further *Transformed and Exploited* for product development. This could be because the problem solving style of these start-ups might be following a linear sequence of tackling issues and new information as they come to them.

Levinthal and March [1993] see such decision making process as a complication arising due to the tension between short-run and long-run decision making process. Organizations usually follow the sequence of first *discovering the problem*, then try to *diagnose* the cause of the problem which is succeeded by *experimentation* to find solutions for it. In most cases, the time available to respond to new problems with product development is not so adequate and organizations as a result use their stockpiled knowledge about their customers and products which enables them to create organizational competencies based on short term circumstances. The inventory of knowledge is then possessed by the group of members of the organization who store it with themselves as tacit knowledge.

As a result of this the organization develops contacts in their networks which can be used repetitively for problems and the implications of such strategies makes the organization lazy in developing new networks, scanning for better consultants and upgrading the inventory.

The implications of positive and significant relationship between PACAP and product development and insignificant relationship with RACAP is in line with the proposition by Trott et al. [2008] where the authors claim that the *university incubator might offer easy access to academic colleagues and friends and thereby hindering the development of new networks needed to be built with customers, suppliers and other stakeholders for the development of these start ups* ([Trott et al., 2008], page 3).

2. **Problems arising due to tendency to ignore the larger picture**

   It is argued that the likelihood of a strategy to maximize survival of components of a system is not guaranteed to be able to maximize the prospects of the system as a whole ([Levinthal

and March, 1993], page 103). Thus, there could be an imbalance between *Exploration* and *Exploitation* as the firms will become increasingly self-assured in their product development skills based on the current circumstances.

This is unfortunately a risk for the academic start-ups in the university incubator being analyzed in this study. The findings suggest the firms have a higher focus for exploration and relatively lower focus towards *exploitation*. The negative relationship between *Transformation Capacity* and Product Development Performance shows the Potential Absorptive Capacity developed from exploration lacks a strong support of *entrepreneurial commitment* which requires the organization to foresee distant scenarios and the larger picture with respect to their products. The implication of such strategies could be that when the market environment changes in the future the organization might find it difficult to superimpose learning tactics of the past realities into the new new environment. This concurs with Levitt [2004] argument that due to *myopia*, organizations might overlook the future scenarios for resource management and will be replaced by new organizations who specialize in the new market environment.

3. **Problems arising due to tendency to overlook failures**

   Levinthal and March [1993] argues that learning can lead to misleading biases that makes the organization look at future likelihoods based on past realities. Therefore, as organizational learning grow, the success likelihoods also grow because these learning increase with increased competencies and problem solving skills. This is also in line with Cohen and Levinthal [1990] who argue that investment in *Acquisition, Assimilation and Exploitation Capacities* which is the definition of Absorptive Capacity in their seminal work are the important learning elements for an organization to develop their problem solving skills.

For the Main RQ: The findings from the relationship between ACAP and Strategic Flexibility help us identify growth implications for *Critical Juncture D: Sustainable Returns* which is discussed in detail in Section 5.5.4

5.5 Implications of the findings on growth of the academic start ups

Main Research Question: "What are the implications of an university incubator's support to implement open innovation on the growth of academic start-ups? "

The findings from the data analysis now can be compared with the growth framework of Vohora et al. [2004] which are discussed in chapter 2 of this report.

5.5.1 Critical Juncture A: Opportunity Recognition

Vohora et al. [2004] argue that "without developing acquiring or accessing the capability to combine scientific knowledge with a commercially feasible offering that satisfies an unfulfilled market need, academic scientists would not be able to proceed towards commercializing their technologies" ([Vohora et al., 2004], page 160)

The relationship between ACAP and Innovation suggests a Familiarity trap, which means neglecting alternative directions and becoming increasingly competent with the current set of technologies, might lead to an inability to see information that others cannot see. ACAP is recognized as a dynamic capability and thus this might hurt the startups while navigating the critical juncture of Opportunity Recognition because of the incompetence to explore new opportunities.

Secondly, from the same relationship of ACAP and Innovation, it can be suggested that a Maturity Trap, which is an unwanted by-product of learning effects which enables the tendency to favour mature technologies over emerging technologies as the firms' affinity to the technology at hand, which might get mature with time to a point that it becomes outdated or lose its novelty. This can have an effect on Opportunity Recognition because due to maturity trap, the young startups might fail to go beyond the existing innovation portfolio they hold, most likely in the form of university's intellectual property or the initial concept they started with.

Thirdly,It can be understood that the academic start ups might be affecting their dynamic capabilities that assist in opportunity identification due to the Propinquity Trap as well. As Vohora et al. [2004] argue that moving from Research Phase to Opportunity phase, the critical juncture of Opportunity Recognition, the startups should be enabled by breakthrough ideas that trigger its commercialisation efforts. The *propinquity trap* may inhibit this effort as Vohora et al. [2004] further argue that ability to connect specific knowledge and the possible commercial opportunity requires a set of skills. The skills needed to do so can be seen as the dynamic capabilities in the form of ACAP of the firm from knowledge as a resource point of view. The propinquity trap develops ease in learning due to readily available solutions that the academic startups might make use of in the business incubator system and thus negatively affecting their dynamic capability once they leave the incubator.

5.5.2 Critical Juncture B: Entrepreneurial Commitment

According to Vohora et al. [2004], Entrepreneurial commitment is necessary to carry the firm's vision forward, which one of founders, either the academic scientist or the academic entrepreneur

might have mentally created for the potential venture and the kind of business transactions it wants to be involved with. From the path dependency we have understood the organisation's history matters, thus to successfully navigate the entrepreneurial commitment critical juncture, it is essentially important for the founding team to be the same even after graduating from the incubator, because the prior knowledge developed in the early years in the incubator will be an important enabler of assimilating new knowledge and transforming it to exploit for competitive advantage.

The path dependency phenomenon as suggested by the positive and significant relationship between *Potential Absorptive Capacity* and *Realized Absorptive Capacity* strongly suggests that the dynamic capability (absorptive capacity) that is developed in the university incubator will have an essential impact on the genetics of the firm as absorptive capacity as a dynamic capability of the firm is not individual absorptive capacities of its employees but *the absorptive capacities of organization as a collective entity* Cohen and Levinthal [1990].

This makes it interesting to understand that since a lot of development in absorptive capacity as a dynamic capability comes from external coaching and mentors as a temporary substitute, it might create an abnormal human capital deficiency affecting the knowledge as a resource arising from it, after the startup graduates from the incubator and sets up an independent approach to its operations. From Knowledge based View (an extension of Resource Based View) of the firm, a considerable reevaluation of knowledge resource allocation might become necessary and might be needed to be done rapidly because during the stage of graduation from incubator, the young startup would have developed to a considerable maturity and might be in a significantly developed market position.

5.5.3 Critical Juncture C: Credibility

From the relationship between Absorptive Capacity and Strategic flexibility, it was found that absorptive capacity had a relationship with strategic flexibility that hinted towards a strong *cushion support* of the incubator. This was because the extreme ends of both Potential and Realized Absorptive Capacity, Acquisition Capacity and Realized Capacity had positive and significant relationships but the dimensions of Assimilation and Transformation, which are largely a product of problem solving. the consequences of such learning effects according to scholars were identified as *'Icarus Paradox'* effect, which could leave the academic startup at a risk of *overconfidence* after the startup graduates from the incubator and the support is removed.

Informal self-enforcing safeguards like *'trust'* have a greater potential for generating rents and making the resources difficult to imitate, rather than formal self enforcing safeguards like financial hostages (Dyer and Singh [1998], page 671) . As discussed in section 5.4.2, for the young startups, the risk of damaging trust for credibility –due to overconfidence in the form of risk of overestimating the performance, leading to planning fallacies, the young startups might fail to plan resource allocation to meet product and service deadlines with the same efficiency at which they did while enjoying the incubator support. Secondly, due to the illusion of superiority (Lake Wobegon effect) and excess precision in the existing beliefs, they might risk judging reality differently then it actually is. The competition landscape is become ever more fierce with the changing based customer behaviour and evaluative measures such as online reviews and rapid word of mouth marketing through social media. In this information age, the consumers are becoming more connected, more informed and more demanding then ever before (Deloitte [2019]). This might have a damage on the credibility of the academic startups, if the threat of such risk is not sensed early by the decision makers.

Credibility for young academic start-ups is a very crucial element because, for most business angels and venture capitalists, the academic start-up is just an inexperienced firm with technology assets but little business know-how ([Vohora et al., 2004]. Due to this, academic startups need to maintain their reputation in order to uphold their credibility, mostly financial fundraising from investors. Jones and Hill [2017] argue that *"venture capitalists generally (though there are exceptions) are not interested in helping you grow as an individual or benefiting society at large. Their aim is to find projects that have the best chance of maximizing the return on investment of the limited partners in the fund in a limited time horizon"*. The 'cushion' support of the university incubator may expose the young startups to a dangerous blindness of continuing the current successful strategies without being strategically flexible enough to change with the new environment without the incubator support. The consequences of damaging credibility would mean creating a reputation of being a high-risk investment firm (Vohora et al. [2004]).

Thus, building the academic start-up's credibility becomes a very high priority especially for raising financial capital and in order to do so, it should be able to build its dynamic capabilities in such a way to remain strategically flexible and continue their sustainable competitive advantage.

5.5.4 Critical Juncture D: Sustainable Returns

Vohora et al. [2004] argue that an academic start-up should be able to configure and re-configure

their knowledge resources in order to generate sustainable returns because compared to larger and experienced organizations, inexperienced young startups lack elaborate policies and routines developed over time to be followed to simplify decision making processes for them, hinting towards the fact that managers need to continuously develop internal capabilities of the firm to continue being in a position of re-configuring resources to be in a position of generating sustainable returns.

The findings from the relationship of Absorptive Capacity and Product Development Related Performance was Potential Absorptive Capacity, that is, *Acquisition Capacity* and *Assimilation Capacity* having a positive and significant relationship while the relationship between Realized Absorptive Capacity, that is, *Transformation Capacity* and *Exploitation Capacity* and Product Development Related Performance being insignificant and negative indicated that the simplification of process for the startups might be leading towards an imbalance between exploration and exploitation of resources which ultimately might get embedded in the routines and decision making of the organisation and for the long run affect the benefits of sustainable returns. As discussed in the previous section, such imbalance might lead to a risk of Product Myopia (due Innovator's Dilemma) and it's consequences.The findings of PACAP being well developed to explain Product Development Related Performance but RACAP not so developed that it can explain product development performance in these firms suggested a likely emerging strategy leading to Innovator's Dilemma Christensen [2013] which is the that condition might put the startups at a risk of product myopia Trott et al. [2008]. Combining the two insights and comparing with [Vohora et al., 2004], the myopic learning may tend to put the academic startups at a risk of hurting their sustainable returns if strategies to balance between exploration and exploitation of the knowledge resources, by developing PACAP and complimenting with a developed RACAP are not adopted.

The first problem due to myopic learning as identified in section 5.4.3 was *Erosion of Enactment* and *Second-order effects of specialization* which may hurt sustainable returns in long-run. The two consequences were interpreted as a result of *simplification of learning processes* that the young academic startups might experience in the university incubator. Secondly, the relationship between PACAP and Product Development Related Performance hinted at *stockpiling of knowledge inventories* for the purposes of developing their products and services but the stockpiled knowledge not explaining competitive advantage through the relationship between RACAP and Product Development Related Performance also suggested that the startups are training themselves to tackle problems as they come to them and not foresee possible problems of the future, and hence developing a problem solving style based on short-run decisions. The consequences as discussed for this was risk of incapability in developing new networks, finding new consultants and customer relationships. In other words, the identified concern with the findings is myopia or unable

to foresee future circumstances. According to the findings of Vohora, Wright and Lockett, this is an ideal problem for academic spinoffs as they suggest that *"The juncture of sustainibilty proved to be particularly problematic to those USOs that were unable to foresee and resolve deficient levels of social capital, resource weaknessess and inadequate internal capabilities"* (Vohora et al. [2004], page 167).According to Barney [1991] in order to attain competitive advantage for sustainable returns, the resources must be valuable, non-imitable. rare and non-substitutable (VRIN). The problems that might arise from the aforementioned suggestions from the findings might make the firms unable to strategically reconfigure their resources with changing times to ensure consistency in their products and services, and thereby might make them vulnerable to be substituted by their rivals and lose their first mover advantage and university incubator invested resource advantages, or their *'VRIN'* Barney [1991]. Thus, the firms should sense and adapt their strategies and develop their dynamic capability of RACAP to make use of their developed PACAP due to the incubator support.

6

Conclusions, Recommendations & Reflections

In conclusion, we will revisit our research question and the sub-questions formulated in Chapter 1, based on our research objectives. The answers to Sub-Research Questions 1,2 &3 were discussed in Chapter 5 of this report and based on the answer to the sub research questions, the main research question was answered. In this Chapter, we summarize the findings, which is followed by recommendations to relevant stakeholders. Following this, the limitations of the study and future works directions are discussed and finally, reflections on the research project are presented to conclude the research journey for this project.

6.1 Conclusions

American business investor Warren Buffet quotes that *"Someone's sitting in the shade today because someone planted a tree a long time ago."* Forbes [2018]. University business incubators play a crucial role in nurturing young high-technology startups which might grow up to steer the economic development of a Regional or National Innovation System, so this project was aimed at identifying the influence of the university business incubator support on the growth of startup in the business incubator. To reach our research objectives at first we identified through literature review the managerial actions in the form of implementing *open innovation* (Chesbrough [2006], Zobel [2017]) that help build the dynamic capability of the firm –*absorptive capacity* (Cohen and Levinthal [1990], Zahra and George [2002]). Based on the literature review we constructed a conceptual model and operationalised it for data analysis using PLS-SEM on the SmartPLS 3.0 software. The findings were interpreted for the growth of the startup in the form of navigating the critical junctures of the growth process as suggested by Vohora et al. [2004].

Are University Business Incubators Overprotective Parents?: The extent of our findings propose preliminary findings due to availability of data only from the years 2014 and 2013 and out of which we could concretely use information only from the year 2014. Recent developments from Yes! Delft shows that the incubator support is indeed successful in providing support to a number of promising startups (See Appendix A) and thus proving its importance of parent-spin-off relationship for regional innovation system of Delft, as discussed in Chapter 1. However we know from our literature review that not all startups are successful (Blank [2013], Van Geenhuizen and Soetanto [2009]), thus the findings from the study, which identifies various implications of the incubator support for the navigation of critical junctures --*Opportunity Recognition, Entrepreneurial Commitment. Credibility* and *Sustainable Returns* (Vohora et al. [2004], that can used to improve the efficiency of the business incubator in supporting the growth of academic start ups in the region for higher regional economic growth.

The upcoming sections summarise the findings of the study that were used to answer our sub-research questions and finally the main research question.

6.2 Answer to The Main Research Question

The main research question that we formulated in Chapter 1 based on our research objectives was **"What are the implications of a university incubator's support to academic startups to implement open-innovation & develop dynamic capabilities on the growth of academic start-ups? "**.

The template to answer the main research question is as follows figure 6.2.1

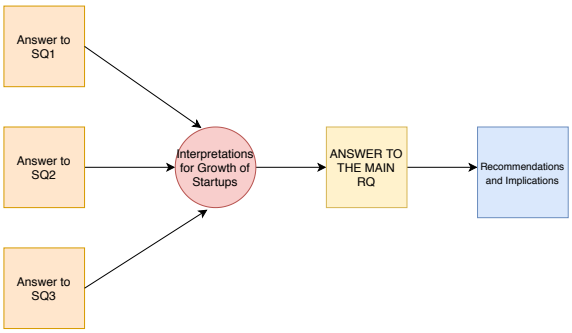


Figure 6.2.1: Template to answer the Main RQ .

6.2.1 Answer to Sub-Research Question 1

SQ1-How do the managerial processes of implementing open innovation affect the capabilities of the firm?

The answers to this research question were discussed in finding the relationship between the managerial processes underlying the components of Absorptive Capacity. It was found that there is a significant relationship between managerial actions taken to implement open innovation and their corresponding dimension of absorptive capacity, which makes a dynamic internal capability of the firm.

Regarding the Managerial Processes of Implementing Open Innovation to build PACAP, *External Scanning and Strategic Assessment* by academic start-ups in university incubators had an equally strong coefficient, suggesting that the incubator support through the processes of both; scanning external information and the strategic assessment of the market is helping the academic startups to build their *Acquisition Capacity* as a dynamic capability. On the other hand, for the second dimension of ACAP, *Assimilation Capacity* has a significant relationship with the processes of Coordination, Integration and Knowledge Management. However, out of the three mentioned processes of *Open Innovation*, the process of Knowledge Management of the firms had a comparatively weaker score, suggesting that the knowledge Management process developed by the academic startups in the incubator need to be developed better for building *Assimilation Capacity*.

Regarding the Managerial Processes of Implementing Open Innovation to build RACAP, *Internalisation* and *Conversion* had a positive and significant coefficient of regression with Transformation Capacity, with the process of Internalisation having a relatively higher score, thus suggest-

ing the incubator support to develop Transformation Capacity is higher through the support to internalise new knowledge, however, the process of conversion is weaker and needs to be better developed. Lastly, the managerial process of *Resource Cognition* and *Recombination* of knowledge sources had a positive and significant influence on developing the *Exploitation Capacity* of the firm. Although, the process of Resource Cognition was one of the weakest processes of all the managerial process to implement open innovation.

6.2.2 Answers to Sub-Research Question 2

SQ-2 How do experiences of academic start-ups in university incubators influence their growth?

The answer to the sub-research question is achieved by the results of the path dependency of the absorptive capacity of the firm. **Potential Absorptive Capacity** has a statistically significant relationship with **Realized Absorptive Capacity**, thus, Acquisition Capacity helps in enabling Assimilation Capacity which enables the firm to enable their Transformation and Exploitation Capacity. The empirical results from the analysis are in line with Zahra and George [2002] who maintain that Potential Absorptive Capacity is an antecedent that drives Realized Absorptive Capacity. This means that the internal capabilities of the academic start-up in university incubator follow a path dependency and accumulate absorptive capacity as a dynamic capability with the learning experience. So it may be implied that their experience in the university incubator will have an effect on their future growth. Thus, the managers of academic startups should strive to balance and develop their internal capabilities simultaneously during their time at the incubator and not completely rely on incubator support

6.2.3 Answer to Sub-Research Question 3

How do the internal capabilities of the academic start-ups in university incubators help them achieve competitive advantage?

The answers to this research question were discussed in the findings from the Hypothesis 3a, 3b, 3c, 4a, 4b, 4c, which is the relationship between dimensions of Absorptive Capacity- PACAP and RACAP and Competitive Advantage of the firm. The construct of *Competitive Advantage* was according to the model given by Zahra and George [2002] by using three dependent variables which are - Innovation, Strategic Flexibility and Performance differences (used as Product Development Related Performance in our study).

Firstly, both of the dimensions of ACAP- *PACAP and RACAP* had shown *insignificant relationship*

with Innovation. This hinted toward the self-enforcing learning mechanisms arising as the by-product of ACAP and suggesting vulnerability of the firms to fall into learning mechanisms traps, identified as Familiarity trap: which is neglecting alternate directions for innovation due to increase in competency and experience with the current set of technologies that is currently used by the firms, Maturity Trap: which is reduction in affinity of the organisation towards innovation and emerging technologies leading to a tendency to favour mature technology over emerging technology solutions and Propinquity Trap: which is the developed ease in learning due to simplification and easily available solutions in the firms' proximity and thus reducing the capabilities for problem-solving skills.

Secondly, The relationship between Absorptive Capacity and Strategic flexibility put forth a very interesting observation that had the extreme ends of Absorptive Capacity, that is *Acquisition Capacity* and *Exploitation Capacity* had a *positive and significant relationship* but the other two dimensions of ACAP- *Assimilation* and *Transformation* had *insignificant relationships*. This suggested that the academic startups in the university incubator have a very strong cushion support from the incubator to help them identify and acquire new knowledge resources and effectively exploit the acquired knowledge resources towards competitive advantage but this capability might not be effective once the incubator support is removed and the academic startups might have to assimilate and transform the new knowledge resources into their product and services without the help of the business incubator. This

Thirdly, The relationship between Absorptive Capacity and Product Development Related Performance showed a *positive and significant relationship* with both *Assimilation Capacity* dimensions of PACAP- but surprisingly a *insignificant relationship* with the *Acquisition Capacity* dimensions of PACAP and both the dimensions of RACAP –that is- *Transformation Capacity* and *Exploitation Capacity*. This suggested that for *Product Development*, there exists an imbalance in exploration and exploitation of knowledge as a resource, suggesting the focus on knowledge as a resource is to meet short term customer needs and not long term product expansions. This might lead the start-ups to a risk of *Innovator's Dilemma*, as suggested by Christensen [2013] and since Cohen and Levinthal [1990] suggest that ACAP is the product of learning by doing, the myopic learning of the academic start-ups in the incubator might give rise to long term consequences, such as decay in dynamic capabilities due to development of mental models that tackle the problems of the future using elements of current circumstances *(erosion of enactment)*, simplified learning of the incubator making the firm a specialist in tackling problem through a certain technique and making it immune to problem solving and adaptations of new situations *(second-order effects of specialisation)*

6.2.4 Answer to the Main Research Question

Based on the answers to the sub-research questions in the previous sections, we can now answer the main research question: *" What are the implications of a university incubator's support to academic startups to implement open-innovation & develop dynamic capabilities on the growth of academic start-ups? "*

- Opportunity Recognition

  From the **SQ-3**, The relationship between *ACAP and Innovation* suggested the academic startups in the university incubator might be at the risk of falling into three types of learning mechanism traps: *Maturity Trap, Familiarity Trap* and *Propinquity Trap*. As discussed in the These traps affect the dynamic capabilities of the firm to look into alternative directions, tendency to favour current technology over emerging and breakthrough technologies and rely on the ease of learning from the university incubator simplifications and find solutions to their problem in their proximity itself. thus, it was understood that these mechanisms might hinder the academic startups' growth while crossing the critical juncture of *Opportunity Recognition*

- Entrepreneurial Commitment

  From the **SQ-2**, The relationship between PACAP and RACAP showed that ACAP as a dynamic capability is in line with the propositions of Cohen and Levinthal [1990] and Zahra and George [2002] to be path-dependent and also with Teece et al. [1997] that *history matters*. Thus, we know that PACAP is an antecedent to RACAP and the learning of the firms while being in the university incubator will be a part of the firm's genetics when they graduate from the incubator and the university support is removed. For this reason, for navigating the critical juncture of entrepreneurial navigation it will be beneficial for the academic startups to continue with the same founding and executive team because absorptive capacity of the firm is not an individual capability but an dynamic capability of an organization as an collective entity Cohen and Levinthal [1990].

- Credibility

  From the **SQ-3**, The relationship between *Strategic Flexibility and ACAP* suggested strong cushion support of the university incubator because of the which the growth implications for the academic startup to navigate the critical juncture of Credibility were understood. As discussed, the cushion support to provide strategic flexibility in the current circumstances but without the development of Assimilation and Transformation Capacities, suggested that when faced with new economic realities after graduating from the incubator might be

dealt with overconfidence, and the illusion of superiority (Lake Wobegon Effect') might lead to consequences such as overestimation of performance and planning fallacies. These conditions might have entrepreneurial consequences such a hurting customer relations and the reputation of the startups. Overall, this suggested to be damaging for the credibility of the firm as performance is crucial for raising funds through investors and customer relationships in this fiercely competitive era of doing business with changing customer behaviours owing to developments like online reviews. These factors should be strategically dealt to avoid such entrepreneurial errors and navigate the critical juncture of *Credibility*.

- Sustainable Returns

  From the **SQ-3**, The relationship between *ACAP and Product Development Related Performance* showed that PACAP had a positive significant relationship with PACAP but not with RACAP. From this relationship it was understood that due to the simplification of learning processes due to the incubator's support, there was an imbalance in exploration and exploitation of knowledge as a resource. This imbalance in exploration and exploitation suggested the vulnerability of the firm to develop myopic learning mechanisms, which is higher customer focus compared to the focus in development of products. The consequences of such myopic learning due to simplification of learning was found to inhibit development of dynamic capability because of the effects of erosion of enactment, second-order effects of specialization and stockpiling of knowledge inventories would make the firm vulnerable to risk of losing it products to be *Valuable, Rare, Non-Imitable* and *Rare*, which are the conditions for sustainable returns through competitive advantage Barney [1991].

6.3 Recommendations

Based on the discussion of findings in the former sections, a set of managerial recommendations can be formulated, which also serves as the deliverable for the research objectives formulated in the first chapter. In this section, it is discussed how academic start-ups in university incubators can benefit from the marriage of open innovation and absorptive capacity and recognize the strategies it should take during the transition phase when the start-up matures and leaves the incubator.

6.3.1 Recommendation for Entrepreneurs

- **'Design Thinking' for enhancing Absorptive Capacity and Open-Innovation:** *Incorporating a working culture that prioritizes group based face-to-face brainstorming over series of individual meetings*

  Practitioner Point: This recommendation is based on the findings from the relationship between dimensions of Absorptive and Innovation.

  Compared to large-scale corporations, startups have a relatively small size of employees and this means that conducting brainstorming sessions is a practically feasible option. Hargadon [1996] conducted a study at the design firm 'IDEO' to understand the efficiency of brainstorming, and their research was particularly focused on how IDEO brainstorms to improve the quality of their knowledge acquisition, storage, retrieval, adaption and combination for the product designing. which from the view of our knowledge a resource based theory is utilisation of their absorptive capacity. According to the researchers(Hargadon [1996]), Face-to-face, relaxed and brainstorming improves the organisation's memory of technical solutions and also the personal growth of the participants. From absorptive capacity perspective, we can see such brainstorming activities as developing the dynamic capabilities of the firm as a whole and also contribute to the personal growth of the participants. Brainstorming sessions can be focused to improve the potential absorptive capacity of the firm to generate new ideas themselves for Opportunity Recognition and exploit it in the future with their realized absorptive capacity. This practice should be implemented in such a way that the academic startups become increasingly self-dependent on opportunity recognition themselves and gradually reduce their dependency on incubator support.

- **Strategic Renewal of Organization Management :** *To Balance Exploration and Exploitation of Knowledge as a Resource*

  Practitioner Point: This recommendation is based on the findings from the relationship between dimensions of Absorptive and Strategic Flexibility Product Development Re-

lated Performance.

The focus of this thesis was the strategic management of external knowledge resources using the dynamic capabilities of the firms in the form of ACAP. The findings of the Hypothesises formulated in this study suggested that the academic startups in the university incubators had an imbalance of PACAP and RACAP for the outcomes of competitive advantage (Innovation, Strategic Flexibility and Product Development Related Performance).

The dimensions of PACAP and RACAP can be seen as *exploration* and *exploitation* of knowledge as a resource respectively. Thus, it can be suggested that entrepreneurs can identify their difference in exploration and exploitation to develop their ACAP (PACAP+ RACAP). Kor and Mesko [2013] suggests strategies in which a balance in exploration and exploitation of resources can be made. Their strategies can be used here as a suggestion to the entrepreneurs to build their dynamic capabilities to benefit the most from open innovation and the prepare for the face of change after graduating from the university incubator.

Firstly, for our study and its findings, it can be recommended that benefits from Open Innovation, that is, first implementing open innovation through lower-order managerial actions and translating it to competitive advantage through higher-order absorptive capacity which is the dynamic capability of the firm can be achieved through *Configuration* and *Orchestration* of team dynamics by the CEO as discussed above.

Cohen and Levinthal [1990] argue that absorptive capacity is not simply the sum of absorptive capacities of its employees and different aspects of absorptive capacity should be considered distinctly for the entire organization's absorptive capacity as a whole ([Cohen and Levinthal, 1990], page 131). Additionally, from the *'Resource-Based View of firm*, the competitive advantage from the resources depends on the strategical management of the resources ([Amit and Schoemaker, 1993], [Barney, 1991], [Grant, 1996]). Therefore it becomes important for organizations to understand the managerial capabilities and structure to manage its absorptive capacity. Kor and Mesko [2013] studied the importance of *managerial* capabilities help in producing and new ways of revitalizing the firm to enhance its organizational dynamic capabilities by linking organizational capabilities to *dominant logic*. here dominant logic is defined as *"The way of managers to conceptualize their business and make critical decisions concerning resource allocation"* ([Kor and Mesko, 2013], page 235). The authors (Kor and Mesko [2013]) believe that a firm's reaction to dynamic capabilities or the *absorptive capacity* is shaped by the *top management team's absorptive capacity* and thus the recommendations are for the *CEO's executive team*.

Thus, Kor and Mesko [2013] identify two critical functions of the CEO to grow and mod-

ify the dynamic capability (absorptive capacity) of the firm which could help the academic start-up to benefit from the implementation of open innovation. These are:

1. Configuration and *reconfiguration* of the senior management team to build dynamic managerial capabilities and shape their absorptive capacity

   Kor and Mesko [2013] propose that the senior management can help shape the absorptive capacity by identifying, recruiting and bringing a together relevant bundle of *specialized* and *general* managerial skills. During this process, the CEO should consider the current strategy of the firm for aligning dynamic capability and the firm's dominant logic. This process of recruitment of a specialized senior team should be done after evaluating the current dominant logic of the firm and also after anticipating changes to it.

2. Supervising continued learning of the management team, or in other words, *Orchestration* of team dynamics

   Kor and Mesko [2013] relate the configuration of a senior management team to *orchestration of team dynamics* similar to a musical orchestra conductor. The job of a CEO should be able to complement generic skills and specific skills of the employees by an entrepreneurial judgment of which skill is to be used and when depending upon the current dominant logic of the firm. The CEO should supervise the team to produce an integrative, collaborative effort in harmony with each other's skills. This is in line with Cohen and Levinthal [1990] who argue that the absorptive capacity of a firm is not individual absorptive capacities of its employees but the absorptive capacities of organization as a collective entity, without which the individual absorptive capacities can be left atomized and deployed in isolation, which would not be the most optimal utilization of knowledge as a resource, as according to the knowledge-based view. thus, the CEO ability to balance and nurture absorptive capacities of the senior management team and the individual managers in a collaborative approach is essential for the firm's overall absorptive capacity and collective decision making for the firm.

   Furthermore, it can be seen that with the changing market and technological trends due to turbulent technological environments, the academic start-ups at the university incubator, Yes! Delft might have to continuously battle change in their dominant logic from time to time and especially during their growth process after they leave the incubator. The solution to this is given by O'Reilly III and Tushman [2008] who argue that dynamic capability of the firm is important for organizations to cope up with changes and continue to enjoy a competitive advantage and for this reason,

they should adopt a *ambidextrous* organizational structure.

The CEO should consider having a decentralized and collaborative organizational structure to promote configuration and orchestration. This is helpful for the academic start-ups to develop their own dynamic capabilities as Teece et al. [1997], Jansen et al. [2012] and O'Reilly III and Tushman [2008] propose that firms can maintain their ambidexterity by balancing their *exploration* and *exploitation*. For our study, we can argue that *exploration* and *exploitation* correspond to *Potential Absorptive Capacity* and *Realized Absorptive Capacity* respectively.

Secondly. Teece [2007] maintains that while *configuration* of knowledge resource is necessary to attain competitive advantage, it is necessary for the firms to consider the processes of configuration, learning and coordination as a collaborative effort through *orchestration*, using the processes of *Sensing, Seizing and Managing Threats*. This can be useful for the academic start-ups at Yes! Delft research in this study to handle their critical junctures as identified for their growth process.

Thus in this way, the organization management can be renewed keeping dynamic capabilities of the firm, entrepreneurial actions

6.3.2 Recommendations for Triple-Helix Model Stakeholders

- **Researching Organizational Paths & *Triggers* to Deliberately breaking of Organisation Paths after graduation from the incubator**

  Sydow et al. [2009] suggest that self-reinforcing dynamics are the factor that drive path-dependency and thus understanding the self-reinforcing dynamics (such as absorptive capacity in the context of our study) can help organisations to intentionally unlock their path dependencies. Lee [2012] suggests that organisations find it difficult to break their path dependencies due to their business strategies naturally being risk averse. Lee [2012]thus proposes that policy-makers should support the startups in incentives through policy in such a way that they are not too hesitant in transforming into risk-taking entrepreneurs.Lee [2012] adds that policy interventations that promote the temptation to take risks can help the startups in unlocking their path dependencies. In the words of Lee [2012], the government policy intervention to startups should be the stick of intervention and not the carrot of assistance (Lee [2012], page 105).

  Secondly, Sydow et al. [2009] suggest that policy makers can help the startups by introducing path-breaking interventions by understanding the drivers that enable path dependency. Policy makers can provide research incentives to the universities, like Delft Univer-

sity of Technology to understand the organisation paths of academic startups after their graduation from the incubator.

- **Facilitate Living Labs with a Higher Focus on Building Dynamic Capabilities of the Firm**

  "Living labs are seen as open innovation networks or platforms with strong user involvement, emphasizing the role of intermediaries coordinating the network partners involved in innovation". "Living labs are also defined more narrowly as a specific network organization connected to a real-life environment (physical place) with a strong involvement of user-groups in co-creation with researchers and producers." (van Geenhuizen [2016], page 81).

  van Geenhuizen [2016] suggests the concept of 'living Labs' can be promoted by universities and policy makers to enhance open innovation in the regional innovation systems through *boundary spanning* activities. If the startups from the incubator graduate and remian in the proximity of the university, it can be supported to provide benefits of open innovation through higher policy focus on living labs. Such living labs through their boundary spanning support and co-creation incentives can maintain a strong level of support to the development of dynamic capabilities of the academic startups after graduating from the incubator.

6.4 Limitations of the Study & Future Works

This study has several limitations that could be addressed through future works.

- **History effects**: The study was conducted through the data collected in the year 2013 and 2014, thus the time-scale effects of the research can be seen as a limitation of the study. However, this also means that the firms in the year 2013 and 2014 would have matured to a greater extent and a study on current circumstances can validate the claims made in this study.

  However, for future researchers this opens a new research direction for a longitudinal study by building a foundation of preliminary findings which can be built further with data from recent developments in the Yes Delft business incubator ecosystem.

- **Sample Size, Generalizability and self-reporting**: The data in the study was self-reported by the entrepreneurs in the academic startups at YES!Delft. This might have given rise to unwanted bias in the study because there are various biases related to self-reporting identified.

- **Patents as an Indicator of Innovation**: In this study the dependent variable *Innovation* for competitive advantage was quantified using number of patents, which has been observed as operationalization of 'Innovation' in various studies, however it is an old debate in the management science scholarship on reliability of patents as an indicator of innovation because not all innovations are necessarily patented and not all patents are necessarily commercialised. However, this also means that it can be true that the patents might not be commercialised at the time of response but the firms might consider exploiting these patents in the future.

- **Lack of moderating variables such as Activation Triggers**: In this study Zahra and George [2002]'s model of absorptive capacity as a dynamic capability of the firm was used but the conceptual model does not include moderation of *Activation Triggers* and *Social Mechanisms* which help in explaining competitive advantage through the use of external knowledge and absorptive capacity of the firm

- **Identification of Managerial Actions to Implement Open Innovation**: The managerial actions for open innovation were used according to Zobel [2017] but there is a need for identifying the managerial actions to implement open innovation which are specific to academic startups in the university incubators for a deeper understanding of open innovation in university business incubators and their effects on growth of startups.

- **Based on type of firm dominant logic**: This study considers the academic spin-offs in the university incubator as its unit of analysis in *aggregate* form and not based on the firms dominant logic, like Cleantech, Robotics, Blockchain etc. Further research can investigate the managerial actions of implementing open innovation and how an academic startup builds its dynamic capabilities based on the classification of the type of firms and their dominant logic.

6.5 Theoretical Contributions

The study hopes to have its contribution to the management literature.

- **Literature of Theory of Strategy Management and Entrepreneurship for the Academic Startups- Knowledge-Based View of the Firm.**

  In this study, we achieved insights into the strategic management of knowledge as a resource and the entrepreneurial strategies that academic startups in business incubators might need to improve their sustainable competitive advantage position. in particular,

through the dimensions of absorptive capacity- PACAP & RACAP, the study contributes to new insights into *exploration* and *exploitation* of knowledge as a resource.

- **Literature of Theory of Open Innovation** The study reconceptualizes the open innovation funnel beyond the innovation funnel. This, in particular, gives insights into the application of the open innovation strategies in understanding the externally the sourced in knowledge's relationship with the dynamic capabilities of the firm, through its *Absorptive Capacity*.

  The study employed the managerial actions to implement open innovation using the model put forth by Zobel [2017] which was used to study SMEs. This study found its application in the specific field of academic entrepreneurship and in addition to it introduced the dimension of ACAP- *transformation capacity*, which was not used in the model by Zobel [2017].

- **Theory of Innovation Systems and Growth of Academic Startups** The research findings of this study give insight into the growth of academic startups from a regional perspective (Delft). This is a contribution to the literature of innovation systems as the academic startups in business incubator play a significant role in being a locus of innovation and economic development.

6.6 Managerial & Policy Implications

This study aims to provide twofold managerial implications. First for policymakers in the *triple-helix innovation* system, and Second for the young startups that are housed in a university business incubator.

For *Policy Makers,* the study addresses the question that if the support provided through programs like *EU Horizon 2020* in its present design is reducing the efficiency of growth of academic startups or not. The findings of this study can be helpful in regional and national innovation systems beyond the regional innovation system of Delft. The study may be useful for concerned policy makers for flagship programs like *Horizon2020* (EuropeanCommission [2013]) to understand how support of dynamic capabilities of young startups play an equally important role as financial and political support. The findings may be beneficial for regional innovation systems to help reduce the mortality rate amongst newly graduated high-technology based startups after the graduate from the university business incubator and facilitate a proper growth for economic development. Further more, Startup Accelerators are a rapidly rising to become a global strategy phenomenon not only for developed economies like *Germany, United States, Netherlands* and *Japan* but for various Emerging Markets as well (Roberts and Kempner [2017]). Findings from

startup conglomerations like in Yes Delft put forth a different perspective than the traditional learning from the *Silicon Valley*.

For academic startups, the study helps young academic startups in business incubator to understand how their managerial processes of implementing *open innovation* build their dynamic capabilities, while they are at the university's business incubator, and subsequently how to face and strategically manage the change once they have graduated from the business incubator but continue with the same dominant logic of the firm. From our findings, academic startups at business incubators may find relevant insights into strategies to manage the implementation of open innovation in such a manner that they build their dynamic capabilities in the form of *absorptive capacity* existing in the form of its dimensions of PACAP and RACAP. The first implication concerns with *entrepreneurial actions to implement open innovation* . The theoretical framework based on Open Innovation and Absorptive Capacity built for this study was a hierarchical model where the lower order comprised of managerial actions to implement open innovation and the higher order comprised of the corresponding dimensions of absorptive capacity. The findings from **SQ-1** the data analyses delineated how the underlying entrepreneurial actions to implement open innovations build the dynamic capabilities of the firm in the form of absorptive capacity. These findings contribute written strategies in the form of contextual factors, which the academic startups in the university business incubators can use to balance their *exploration* and *exploitation* of knowledge as a strategic resource.

The second implication concerns with *strategic management of organizational structure.* The findings from the **SQ-2** suggested that due to path dependency, the experiences of the academic startups in the university business incubator will be an imprint on the genetic characteristics of the firm, or in other words the learning mechanisms during the time at the incubator will be carried forward as embedded in routines and actions of the organisation and will be followed during various circumstances of acquisition of new knowledge, assimilating the acquired knowledge and problem solving to transform the knowledge resources to exploit it for competitive advantage in their products and services. Thus, entrepreneurs of academic startups in business incubator should ensure their entrepreneurial commitment and the core team structure to stay consistent even after graduating from the university incubator. This would mean to develop strategies and incentives that help them retain the networks, important mentors, university support in the form of researchers and other related associations. Also, the findings from path depends also suggest that the academic startups should strive to renew their dynamic capabilities in order to avoid rigidity and reduced efficiency because of falling into a technological lock-in.

The third implication concerns with providing insights into support for decision making for strategically managing knowledge as a resource for competitive advantage and identifying areas of

risks due to changing circumstances of absence of university incubator support . From **SQ-3**, the relationships between dimensions of absorptive capacity and competitive advantage in the form of innovation, strategic flexibility and product development related performances delineated how the university incubator support is developing the dynamic capabilities of the firm. Thus, the based on the findings of this study, the academic startups can plan for the future growth strategies that helps them avoid the traps due to learning mechanisms, identify the areas of cushion support provided by the university incubator to avoid overconfidence and to avoid a myopic approach in the development of their products and services.

6.7 Reflections

- On the Research Project

  The master thesis project design helps one train oneself to be a researcher and the rigor motivates to explore new ideas and research territories but also due to the fact being a first time researcher in the field of management science, one can reflect on various aspects of the project which could have been done differently if the project were to be repeated again.

  The research project execution had a very high learning experience however due to the complexity and the nature of the topic, the experience was close to a never ending process as the field of technology economics is ever expanding. Unlike natural sciences, social sciences research depends to a great extent on operationalising of concepts which can be interpreted differently by different researchers. Due to the nature of the subject of this study, the available scientific literature is vast and keeps growing. Due to this a lot of excessive literature reviews were done which were not completely included and required in the research. If the project is repeated, one should define the research working definitions and stay firm to it. This helps in filtering out excessive literature review and preparing realistic research planning.

  Secondly, The project could have done better justice with making high practical recommendations. The project is completely done as a desk research and heavily relies on the data received. If time and access to first hand information could have been possible, the process would have been easier and with a higher impact. If the project is repeated, I would prefer to narrow down the scope of study for a even more refined research gap. Even though the study manages to find various implications for growth, the study is still tentative inferences and with the recent developments in the growth of Yes! Delft incubator post years 2015, doing this would have resulted in better contributions for practitioners.

  Thirdly, The conceptual model could have been made a slightly more complex with intro-

duction of various interaction effects that might have showed a new perspective on the dynamic capabilities of a firm in the university business incubator. Deeper result on representativeness of the population could have given better insights. For example, the conclusions could have been more impactful if we could have divided the sample based on distinction such as startups with higher-assimilation and lower-assimilation relationships with competitive advantage. In hindsight, I realize a lot of control variables could have significantly changed the inferences. The reporting of results could have been with better diagrammatic representations for the ease of the reader.

Lastly, in hindsight, one of the major changes I would have done to the execution of the project is to apply better open-innovation to the project itself by consulting with more research experts as the power of ideas can significantly improve quality and impact of research.

- Personal Reflections

  On a personal level, the research has trained me significantly on dealing with tools for data analysis for business research. As a researcher I got exposed to highly insightful seminal works on dynamic capabilities, open innovation, university business incubators and growth of startups. I believe such skills are transferable and can be utilised for various other dimensions of research studies as well, such as understanding the strategies for resource allocations in organisations and the effect of organisation structure on the growth and competitive advantage of the firm. I hope to have developed significant entrepreneurial skills that the degree program design and this thesis study exposed me to.

This page is intentionally left blank.

References

Acs, Z. J., L. Anselin, and A. Varga

2002. Patents and innovation counts as measures of regional production of new knowledge. *Research policy*, 31(7):1069–1085.

Ahuja, G. and C. Morris Lampert

2001. Entrepreneurship in the large corporation: A longitudinal study of how established firms create breakthrough inventions. *Strategic management journal*, 22(6-7):521–543.

Ambrosini, V., C. Bowman, and N. Collier

2009. Dynamic capabilities: an exploration of how firms renew their resource base. *British Journal of Management*, 20:S9–S24.

Amit, R. and P. J. Schoemaker

1993. Strategic assets and organizational rent. *Strategic management journal*, 14(1):33–46.

Barney, J.

1991. Firm resources and sustained competitive advantage. *Journal of management*, 17(1):99–120.

Bergek, A. and C. Norrman

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

Blank, S.

2013. Why the lean start-up changes everything. *Harvard business review*, 91(5):63–72.

Bughin, J. and J.-M. Jacques

1994. Managerial efficiency and the schumpeterian link between size, market structure and innovation revisited. *Research Policy*, 23(6):653–659.

Carrillo, F. J.

2015. Knowledge-based development as a new economic culture. *Journal of Open Innovation: Technology, Market, and Complexity*, 1(1):15.

Charles, D.

2003. Universities and territorial development: reshaping the regional role of uk universities. *Local Economy*, 18(1):7–20.

Chesbrough, H. and A. K. Crowther

2006. Beyond high tech: early adopters of open innovation in other industries. *R&d Management*, 36(3):229–236.

Chesbrough, H. W.

2006. The era of open innovation. *Managing innovation and change*, 127(3):34–41.

Christensen, C.

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

Cohen, W. M. and D. A. Levinthal

1990. Absorptive capacity: A new perspective on learning and innovation. In *Strategic Learning in a Knowledge economy*, Pp. 39–67. Elsevier.

Cooper, A. C.

1973. Technical entrepreneurship: what do we know? *R&D Management*, 3(2):59–64.

Davenport, T. H., L. Prusak, et al.

1998. *Working knowledge: How organizations manage what they know*. Harvard Business Press.

Deloitte

2019. Consumer-review-8-the-growing-power-of-consumers. https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/consumer-business/consumer-review-8-the-growing-power-of-consumers.pdf.

Dyer, J. H. and H. Singh

1998. The relational view: Cooperative strategy and sources of interorganizational competitive advantage. *Academy of management review*, 23(4):660–679.

Edquist, C.

2006. Systems of innovation: Perspectives and challenges. Pp. 181–208.

Etzkowitz, H.

2001. The second academic revolution and the rise of entrepreneurial science. *IEEE Technology and Society Magazine*, 20(2):18–29.

Etzkowitz, H. and L. Leydesdorff

2000. The dynamics of innovation: from national systems and "mode 2" to a triple helix of university–industry–government relations. *Research policy*, 29(2):109–123.

EUHorizon2020

n.d. Presentation material - european commission. https://ec.europa.eu/programmes/horizon2020/en/background-material.

EuropeanCommission

2013. Entrepreneurship 2020 action plan. reigniting the entrepreneurial spirit in europe. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52012DC0795&from=EN. Brussels.

Field, A.

2013. *Discovering statistics using IBM SPSS statistics*. sage.

Forbes

2018. Here are 10 genius quotes from warren buffett. https://www.forbes.com/sites/zackfriedman/2018/10/04/warren-buffett-best-quotes/. (Accessed on 08/06/2019).

GemeenteDelft

n.d. Vision on the future municipality of delft. https://www.delft.nl/bestuur-en-organisatie/delft-2040/visie-op-de-toekomst. (Accessed on 07/25/2018).

Grant, R. M.

1996. Toward a knowledge-based theory of the firm. *Strategic management journal*, 17(S2):109–122.

Hair, J. F., W. C. Black, B. J. Babin, and R. E. Anderson

2013. *Multivariate data analysis: Pearson new international edition*. Pearson Higher Ed.

Hair Jr, J. F., G. T. M. Hult, C. Ringle, and M. Sarstedt

2016. *A primer on partial least squares structural equation modeling (PLS-SEM)*. Sage Publications.

Hamel, G. and C. Prahalad

1990. Strategic intent. *Harvard Business Review*, 67(3):63–76.

Hargadon, A.

1996. Brainstorming groups in context: Effectiveness in a product design firm robert 1. sutton. *Administrative science quarterly*, 41(4):685–718.

Hartmann, D.

2014. Turning technology into business using university patents. *Technology Innovation Management Review*, 4(12).

Hitt, M. A., B. W. Keats, and S. M. DeMarie

1998. Navigating in the new competitive landscape: Building strategic flexibility and competitive advantage in the 21st century. *Academy of Management Perspectives*, 12(4):22–42.

Jansen, J. J., Z. Simsek, and Q. Cao

2012. Ambidexterity and performance in multiunit contexts: Cross-level moderating effects of structural and resource attributes. *Strategic Management Journal*, 33(11):1286–1303.

Jansen, J. J., F. A. Van Den Bosch, and H. W. Volberda

2005. Managing potential and realized absorptive capacity: how do organizational antecedents matter? *Academy of management journal*, 48(6):999–1015.

Jones, C. H. and A. Hill

2017. So you want to be a student entrepreneur? *Nature biotechnology*, 35(2):113.

Kahneman, D.

2011. *Thinking, fast and slow*, volume 1. Farrar, Straus and Giroux New York.

Kahneman, D. and A. Tversky

1977. Intuitive prediction: Biases and corrective procedures. Technical report, DECISIONS AND DESIGNS INC MCLEAN VA.

Khodaei, H., V. Scholten, E. F. Wubben, and O. Omta

2012. The impact of facilitators support on navigating critical junctures in high-tech academic spin-offs. In *Academy of Management Proceedings*. Academy of ManagementBriarcliff Manor, NY 10510.

Klein, P. G. and S. K. Klein

2001. Do entrepreneurs make predictable mistakes? evidence from corporate divestitures.

Kleinknecht, A.

1989. Firm size and innovation. *Small Business Economics*, 1(3):215–222.

Kogut, B. and U. Zander

1992. Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization science*, 3(3):383–397.

Kor, Y. Y. and A. Mesko

2013. Dynamic managerial capabilities: Configuration and orchestration of top executives' capabilities and the firm's dominant logic. *Strategic management journal*, 34(2):233–244.

Lane, P. J. and M. Lubatkin

1998. Relative absorptive capacity and interorganizational learning. *Strategic management journal*, 19(5):461–477.

Laursen, K. and A. Salter

2006. Open for innovation: the role of openness in explaining innovation performance among uk manufacturing firms. *Strategic management journal*, 27(2):131–150.

Lee, T.-k.

2012. Rethinking path dependency and regional innovation-policy inducedgovernment dependency: The case of daedeok, south korea. *World Technopolis Review*, 1(2):92–106.

Levinthal, D. A. and J. G. March

1993. The myopia of learning. *Strategic management journal*, 14(S2):95–112.

Levitt, T.

2004. Marketing myopia. *Harvard business review.*, 82(7/8):138–149.

Lockett, A., D. Siegel, M. Wright, and M. D. Ensley

2005. The creation of spin-off firms at public research institutions: Managerial and policy implications. *Research policy*, 34(7):981–993.

Mahoney, J. and J. Pandian

1990. The resource-based view of the firm. *Manuscript paper*.

Manley, K.

2002. The systems approach to innovation studies. *Australasian Journal of Information Systems*, 9(2).

Moore, D. A. and P. J. Healy

2008. The trouble with overconfidence. *Psychological review*, 115(2):502.

Mowery, D. C., J. E. Oxley, and B. S. Silverman

1996. Strategic alliances and interfirm knowledge transfer. *Strategic management journal*, 17(S2):77–91.

Nonaka, I.

1994. A dynamic theory of organizational knowledge creation. *Organization science*, 5(1):14–37.

Nonaka, I., R. Toyama, and N. Konno

2000. Seci, ba and leadership: a unified model of dynamic knowledge creation. *Long range planning*, 33(1):5–34.

OECD

2014. Oecd reviews of innovation policy netherlands.overall assessment and recommendations. http://www.oecd.org/sti/inno/netherlands-innovation-review-recommendations.pdf. (Accessed on 07/06/2018).

O'Reilly III, C. A. and M. L. Tushman

2008. Ambidexterity as a dynamic capability: Resolving the innovator's dilemma. *Research in organizational behavior*, 28:185–206.

Pattnaik, P. N. and S. C. Pandey

2014. University spinoffs: What, why, and how? *Technology Innovation Management Review*, 4(12).

Penrose, E. T.

1959. The theory of the growth ofthe firm. *New York: Sharpe*.

Peterson, C.

2000. The future of optimism. *American psychologist*, 55(1):44.

Porter, M. E.

1985. Competitive advantage: creating and sustaining superior performance. 1985. *New York: FreePress*, 43:214.

Roberts, E. B.

1991. *Entrepreneurs in high technology: Lessons from MIT and beyond*. Oxford University Press.

Roberts, P. and R. Kempner

2017. Startup accelerators have become more popular in emerging markets — and they're working. https://hbr.org/2017/10/startup-accelerators-have-become-more-popular-in-emerging-marketsand-theyre-work referral=03759&cm_vc=rr_item_page.bottom. (Accessed on 04/05/2018).

Russo, J. E. and P. J. Schoemaker

1992. Managing overconfidence. *Sloan management review*, 33(2):7–17.

Sanchez, R.

1995. Strategic flexibility in product competition. *Strategic management journal*, 16(S1):135–159.

Sekaran, U. and R. Bougie

2016. *Research methods for business: A skill building approach*. John Wiley & Sons.

Shimizu, K. and M. A. Hitt

2004. Strategic flexibility: Organizational preparedness to reverse ineffective strategic decisions. *Academy of Management Perspectives*, 18(4):44–59.

Shutyak, Y.

2016. Open innovation practice: a case study of university spin-offs. *Journal of Entrepreneurship, Management and Innovation*, 12(1):75–90.

Stevenson, H. H. and J. C. Jarillo

1990. A paradigm of entrepreneurship: Entrepreneurial management. *Strategic Management Journal*, 11:17–27.

Sydow, J., G. Schreyögg, and J. Koch

2009. Organizational path dependence: Opening the black box. *Academy of management review*, 34(4):689–709.

Teece, D. J.

2007. Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic management journal*, 28(13):1319–1350.

Teece, D. J., G. Pisano, and A. Shuen

1997. Dynamic capabilities and strategic management. *Strategic management journal*, 18(7):509–533.

Times, T.

2011. 'sometimes people don't know what they want until you show it to them' | the times. https://www.thetimes.co.uk/article/sometimes-people-dont-know-what-they-want-until-you-show-it-to-them-jsqmpd9nzcn.

Todorova, G. and B. Durisin

2007. Absorptive capacity: Valuing a reconceptualization. *Academy of management review*, 32(3):774–786.

Trott, P., V. E. Scholten, and D. Hartmann

2008. How university incubators may be overprotective and hindering the success of the young firm: Findings from a preliminary study. In *Engineering Management Conference, 2008. IEMC Europe 2008. IEEE International*, Pp. 1–5. IEEE.

van Geenhuizen, M.

2016. Living labs as boundary-spanners between triple helix actors. *Journal of Contemporary Eastern Asia*, 15(1).

Van Geenhuizen, M. and D. P. Soetanto

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

Vohora, A., M. Wright, and A. Lockett

2004. Critical junctures in the development of university high-tech spinout companies. *Research policy*, 33(1):147–175.

Wernerfelt, B.

1984. A resource-based view of the firm. *Strategic management journal*, 5(2):171–180.

Yahoo-Finance

n.d. Yahoo finance. https://finance.yahoo.com/. (Accessed on 7/5/2018).

Yes!Delft

n.d. Yes!delft | rvo.nl. https://english.rvo.nl/yes-delft. (Accessed on 10/24/2018).

Zahra, S. A. and G. George

2002. Absorptive capacity: A review, reconceptualization, and extension. *Academy of management review*, 27(2):185–203.

Zobel, A.-K.

2017. Benefiting from open innovation: A multidimensional model of absorptive capacity. *Journal of Product Innovation Management*, 34(3):269–288.

This page is intentionally left blank.

A

Yes Delft additional facts and figures

10 Delft-based startups to keep an eye on in 2019 and beyond

By **Bojana Trajkovska** - November 15, 2019

Delft is a rather small but typical Dutch town with many canals, bikes and students. But what makes Delft so interesting lately, is the growing number of tech startups it is producing. Supported by Delft University of Technology, which ranks as number one university in the Netherlands, and YES!Delft incubator, ranked among the top 5 of the world's best university incubators, Delft is starting to see its first batch of real startup successes. Here are 10 promising Delft-based startups to watch.

Hardt Global – Inspired by the Hyperloop idea by Elon Musk, Hardt Global is developing a hyperloop, an affordable, zero-emission, high-speed transportation. In essence, Hyperloop is an ultrafast "train" that can carry passengers in vacuum tubes from A to B at near speed of sound. This innovative means of transport has been developing since 2016 and in October 2019 the startup managed to raise a multi-million investment round to help them speed up the process.

Kitepower – Kitepower is reinventing wind energy with its mobile airborne wind energy systems. This TU Delft spin-off develops systems that use high-performance kites to leverage the energy of the wind and generate electricity. Founded by Johannes Peschel and Roland Schmehl in 2016, their systems use 90% less material while being twice as efficient as existing technology. Additionally, it uses less material than ground-based turbines and takes less than an hour to set up.

Inkless – Inkless has developed a printing technology which enables high-resolution black-and-white printing without the use of ink, on multiple substrates without any consumables or coatings. What started as a graduate student project at TU Delft, has turned into a successful startup backed by business angels, who support their idea of revolutionizing the printing industry by making cartridges and toners obsolete.

Nowi energy – Nowi is a pioneer in novel energy harvesting technology. Their innovative solution enables the capturing of ambient energy sources such as light, temperature gradients or radiofrequency, with the aim of converting and using it to power IoT devices. 7 patents, €3.5 million in seed funding, a partnership with Huawei and the prediction of 100bn connected devices by 2020 make it quite a good combination for Nowi.

Roadmap – Roadmap is an app designed to help de-stress business travelers. What it does is provides all the relevant details of their travels (flight, transportation options and hotel) into one, easily readable content accessible via the app. Moreover, it also suggests cool places to work, network, eat and have fun. Nike, Microsoft, Tommy Hilfiger, LinkedIn, Merck already use Roadmap to enhance the business travels of their employees.

Scoozy – Scoozy is a mobility startup founded in 2016 that has developed a four-wheeled, electric mobility scooter for people with difficulty walking. It has a driving range of up to 100 kilometers, as well as an active braking system, intuitive steering, an independent suspension and smart sensors. Their vision is to set a new standard for the mobility scooter, and backed by €1.2 million, they are getting close.

Warp – Warp VR was created to help organizations create immersive training scenarios using Virtual Reality (VR). Customize the scenario according to the company's needs, decide who is playing and get in-depth analytics in the end. The Dutch Fire Department, Tata Steel, KLM, Gazprom, BBC already use Warp to offer interactive 360°video VR learning experiences for their employees. In 2019 they won the Learning Innovation Award and Get in the Ring competition.

We4sea – The heart of We4sea is a performance monitoring platform based on a Digital Twin concept. Founded in 2016, We4Sea collects vast amounts of operational data of a ship, such as position, speed, heading and engine data and matches it with other data such as weather conditions, wave heights, currents and wind. Thanks to this, ships can optimize their use of fuel and the associated CO2 emissions and drastically improve efficiency.

Crescent Tech – Crescent Tech was founded in 2017 to bring to market the world's first purpose-designed wearable dual-camera headband dubbed Crescent Vision. Envisioned as equipment for precision surgical procedures, the headband captures high-quality images from a first-person perspective and can be shared with viewers watching on a desktop, tablet, smartphone or with VR glasses.

Physee – Physee is a manufacturer of solar-powered windows, called PowerWindows. They are patented and transparent windows that convert light into electricity. Proven to provide 50W per square meter, which can compensate for up to 75% of the energy consumption of buildings. Selected as a Technology Pioneer for the WEF, Physee raised €1.5 million in 2018 to accelerate the development of its sustainable building facade solutions.

By the way: If you're a corporate or investor looking for exciting startups in a specific market for a potential investment or acquisition, check out our **Startup Sourcing Service**!

Bojana Trajkovska

Bojana is a startup enthusiast from the Balkan region. Currently exploring the entrepreneurial community in Italy. Passionate reader and traveller.

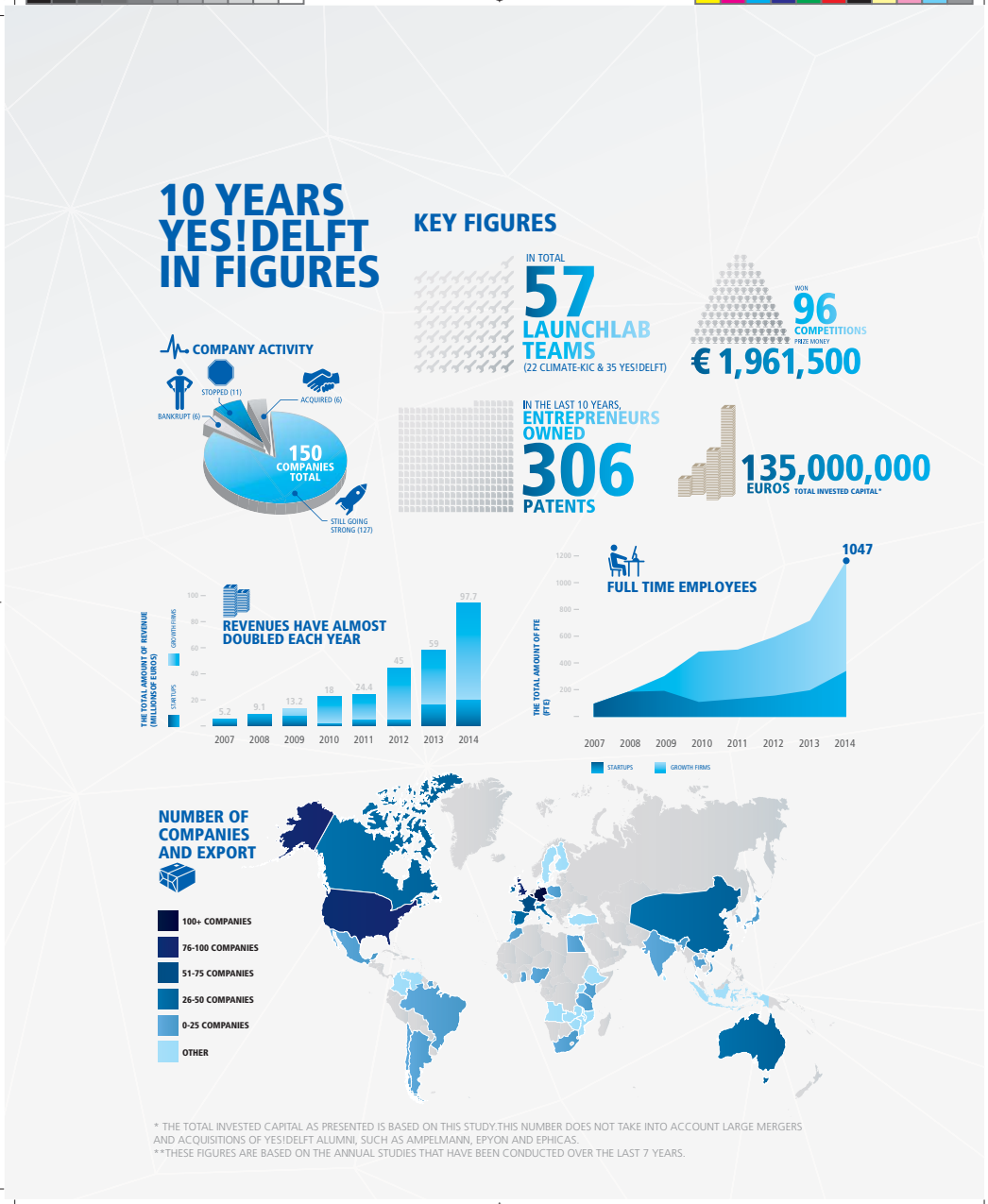


Figure A.0.1: Yes Delft Facts and figures

B

Data Questionnaire

B.1 Questionnaire for the Data as obtained from Delft Center Of Entrepreneurship, TU Delft

The following sections consists of the questionnaire set that was used to collect data and the collected data has been used in this study. Not all the questionnaire were used but the questions were compared with the conceptual model prepared in this study to identify questions that operationalise the independent and dependent variables for the data analyses.

Company information	
Founding date 1 – first registration at chambers of commerce	… /…. (month / year)
Founding date 2– first registration as Ltd at CoC	… /…. (month / year)
Founding date 3 – first time activities conducted (can be earlier than above)	… /…. (month / year)
CoC number + date	
City of registration	
Number of entities (incl. holding) as a Limited	
Other entity	
How many shares in the new firm (in %) do the founders own?	
How many shares in the new firm (in %) does the university/ institute own?	
In which branch are you active? BIC code	

Markets active				
In which of the following countries is the company active in terms of sales, purchasing collaboration?				
Europe EU:	Europe outside EU	America	Asia & Australia	Afrika
England	Norway	Verenigde Staten	China	Maroc
Ireland	Switzerland	Canada	India	Egypt
Germany	Else	Brazil	Australia	Kenia
Poland	…	Mexico	Japan	Tanzania
Belgium		Argentina	South Korea	Nigeria
France		Chili	Taiwan	South-Afrika
Spain		Suriname	Vietnam	Else:
Italy		Else:	Thailand	…
Greece		…	Else:	
Sweden			…	
Finland				
Else …				

Location	
The company is located in Delft	Yes / No
If yes, why did you settle in Delft?	Open
If no, what is the reason not to settle in Delft?	Open
Who is the prime decision maker in terms of firm location	
How important was the location of the co-founders in firm location choice?	
In the future we will stay in Delft	1 2 3 4 5 6 7
In the future we will locate at the science park	1 2 3 4 5 6 7
Being located in Delft gives us	
- … easy access to the knowledge being developed at the university how	1 2 3 4 5 6 7
- … easy access to the knowledge being developed at other companies how	1 2 3 4 5 6 7
- … an inspiring environment to innovate	1 2 3 4 5 6 7
- … a positive image on our activities	1 2 3 4 5 6 7
… a stronger reputation	1 2 3 4 5 6 7
… the opportunity to maintain social ties	1 2 3 4 5 6 7
… more chances for the firm to succeed how	1 2 3 4 5 6 7
… more ease to maintain an academic status	1 2 3 4 5 6 7

Intellectual Property	
How many patents (assigned or pending) owns the company?	
From these patents, how many are actively used by the company as of now?	
We are very satisfied about the transfer office in their role during the application	
How many patents has the company licensed or in participation with TuD?	
From these patents, how many are actively used by the company as of now?	
We are very satisfied about the transfer office in their role during the negotiations with TUD	1-7; na
How many patents has the company licensed or in participation with others?	
We are very satisfied about the transfer office in their role during the negotiations with others	1-7; na
Does the company have registered trademarks?	
Does the company have registered designs?	

Employees End 2010

Can you identify how many fte are working for you in each category?			
Owner + academic education	..fte	In a project[1] + academic education	..fte
Owner + higher education	..fte	In a project + higher education	..fte
Owner + lower education	..fte	In a project + lower education	..fte
Fixed employed[2] + academic education	..fte	Internship + academic education	..fte
Fixed employed + higher education	..fte	Internship + higher education	..fte
Fixed employed + lower education	..fte	Internship + lower education	..fte

Financial status end 2011	
Total revenues due to selling products and services in 2011	€
Estimated percentage of foreign revenues	%
Estimated percentage due to consultancy	%
Estimated percentage due to products sales	%
Estimated percentage due to licensing	%
	100 %
Expected revenues in 2012	
Expected revenues in 2013	
Expected revenues in 2014	
R&D expenditure in 2009	
R&D expenditure in 2011	
Expected R&D expenditure in 2013	
R & D full time employees (fte) in 2009	
R & D full time employees (fte) in 2011	
Expected R & D full time employees (fte) in 2013	
Subsidies	
STW	€
Guarantees	€
WBSO	€
Knowledge vouchers	€
Of which are used on research at TU Delft (%)	
Financial capital	
Family/Friends	€
Informals/Business Angels	€
Venture Capital	€
Bank (excl. Personal loans)	€
Personal loan invested in the company	€
Own money invested in the company	€
Other	€
Prizes won at competition ...	€

[1] Hired from outside for a project

[2] Contract with company for indefinite or temporal

Subjective performance		
Opportunity identification	How many business opportunities have you pursued (invested time and money) in the last 5 years?	
	How innovative are the solutions to the opportunities you identified	
	How many of these pursued opportunities were successful?	
	How many potential markets have you identified	
Market	How clear are the characteristics of prospective customer to you	
	We identified a variety of prospective customers	
	We have put a lot of effort in a preliminary market assessment	
	We have conducted a detailed market study	
Market readiness	We have done most of our product testing	
	We have conducted extensive customer tests	
	We have conducted trial production runs	
	We have established good relationships with our first customers	
Organization	We have clear roles for each of us in the management team	
	We have worked out our business model in detail	
	We have clear insights in our business and financial projections	
	We have clear product and process quality requirements and specifications	

Collaboration with Delft University of Technology				
With which faculties do you collaborate?				
	Using their scientific finding (IPR)	Using their expertise	Collaborate in research	Using students
3ME	❑	❑	❑	❑
LR	❑	❑	❑	❑
EWI	❑	❑	❑	❑
IO	❑	❑	❑	❑
TNW	❑	❑	❑	❑
CTiG	❑	❑	❑	❑
Bouwkunde	❑	❑	❑	❑
TBM-OTB	❑	❑	❑	❑
Which are the two most important faculties at the TuDelft that you collaborate with?				
1				
2				
With regards to the **first**, to which extent do the following statements apply (agree .. disagree)				
We intensively make use of a patent(s) developed at this faculty				1 2 3 4 5 6 7
We intensively do research with this faculty				1 2 3 4 5 6 7
We have written in a detailed contract our collaboration				1 2 3 4 5 6 7
We intensively make use of expertise among researchers at this faculty				1 2 3 4 5 6 7
What is the amount of money involved in the collaboration with this faculty?				
What is the total amount of money involved in collaborations with TuDelft?				
Using TuDelft facilities				
Last year we intensively made use of the industrial design equipment				1 2 3 4 5 6 7
We are very satisfied about the industrial design equipment				1 2 3 4 5 6 7
We make use of the industrial design equipment at internal tariffs				Yes / No
Last year we intensively made use of the wind tunnel				1 2 3 4 5 6 7
We are very satisfied about the use of the wind tunnel				1 2 3 4 5 6 7
We make use of the wind tunnel at internal tariffs				Yes / No
Last year we intensively made use of the DEMO				1 2 3 4 5 6 7
We are very satisfied about the use of DEMO				1 2 3 4 5 6 7
We make use of the DEMO at internal tariffs				Yes / No
Last year we intensively made use of other facilities at TuDelft				1 2 3 4 5 6 7
Which Facilities are these ?				

We are very satisfied about the use of …. (else)	Yes / No
We make use of ... (else) at internal tariffs	1 2 3 4 5 6 7

Incubation		
Do you rent space within Yes!Delft?		Yes / No
If yes, how much?		m2
	Office space	m2
	Work space	m2
	Storage	m2
If yes, how much?		m2
	Office space	m2
	Work space	m2
	Storage	m2
Would like to rent more space at Yes!Delft in 2012?		Yes / No
How much office space (m2) would you rent?		m2
How much work space (m2) would you rent?		m2
We have intensive contact with other tenants		1 2 3 4 5 6 7
Other tenants in Yes!Delft helped us		
1	.. to further develop our technology know-how and research	1 2 3 4 5 6 7
2	.. to get access to important labs, machines and equipment	1 2 3 4 5 6 7
3	.. to find expertise in the university	1 2 3 4 5 6 7
4	.. to synthesize scientific knowledge with an understanding of markets	1 2 3 4 5 6 7
5	.. to evaluate the appropriate market or applications for our technology	1 2 3 4 5 6 7
6	.. how to negotiate or convince clients	1 2 3 4 5 6 7
7	.. to think about the ways we can generate income	1 2 3 4 5 6 7
8	.. to think about building the management team and hire people	1 2 3 4 5 6 7
9	.. to get in contact with people in the industry	1 2 3 4 5 6 7
10	.. how to convince and contact financers, banks and VC	1 2 3 4 5 6 7
11	.. to write down our financial application	1 2 3 4 5 6 7
12	.. to write down our subsidy application	1 2 3 4 5 6 7
Incubation management in Yes!Delft helped us		
1	.. to further develop our technology know-how and research	1 2 3 4 5 6 7
2	.. to get access to important labs, machines and equipment	1 2 3 4 5 6 7
3	.. to find expertise in the university	1 2 3 4 5 6 7
4	.. to synthesize scientific knowledge with an understanding of markets	1 2 3 4 5 6 7
5	.. to evaluate the appropriate market or applications for our technology	1 2 3 4 5 6 7
6	.. how to negotiate or convince clients	1 2 3 4 5 6 7
7	.. to think about the ways we can generate income	1 2 3 4 5 6 7
8	.. to think about building the management team and hire people	1 2 3 4 5 6 7
9	.. to get in contact with people in the industry	1 2 3 4 5 6 7
10	.. how to convince and contact financers, banks and VC	1 2 3 4 5 6 7
11	.. to write down our financial application	1 2 3 4 5 6 7
12	.. to write down our subsidy application	1 2 3 4 5 6 7

Absorptive capacity

We frequently scan the environment for new technologies	1 2 3 4 5 6 7
We thoroughly observe technological trends	1 2 3 4 5 6 7
We observe in detail external sources of new technologies	1 2 3 4 5 6 7
We thoroughly collect industry information	1 2 3 4 5 6 7
We can quickly interpret changing market demands	1 2 3 4 5 6 7
New opportunities to serve our clients are quickly understood	1 2 3 4 5 6 7
We analyse various combinations of attributes for your products	1 2 3 4 5 6 7
We analyse different sequences for new product development and introduction	1 2 3 4 5 6 7
We regularly consider the consequences of changing market demands in terms of new products and services.	1 2 3 4 5 6 7
We record and store newly acquired knowledge for future reference	1 2 3 4 5 6 7
We determine how customers will use your technologies	1 2 3 4 5 6 7
Identifying different customer groups that might have an interest in your products	1 2 3 4 5 6 7
We have a clear division of roles and responsibilities	1 2 3 4 5 6 7
We easily implement technologies in new products	1 2 3 4 5 6 7
We have a common language regarding our products and services	1 2 3 4 5 6 7
We constantly consider how to better exploit knowledge.	1 2 3 4 5 6 7

Founders					
Who are the founders?	Name	.....	.....	.....	.....
Age at founding*	year	.... yr	.... yr	.... yr	.... yr
When (month/year) did the member join the spin-off?					
Gender					
Current function					
Lives in Delft					
Travelling time to YD					
Highest education	PhD MSc BSc MBA	❑ ❑ ❑ ❑ ❑	❑ ❑ ❑ ❑ ❑	❑ ❑ ❑ ❑ ❑	❑ ❑ ❑ ❑ ❑
What position did the founder had before founding the firm?	Student 1> graduated** Alumni*** TuD empl fixed TuD empl temp Other uni fixed Other uni temp Industry	❑ ❑ ❑ ❑ ❑ ❑	❑ ❑ ❑ ❑ ❑ ❑	❑ ❑ ❑ ❑ ❑ ❑	❑ ❑ ❑ ❑ ❑ ❑
Was the topic of master thesis similar to company topic?		Yes/No	Yes/No	Yes/No	Yes/No
Grade for master thesis					
Name faculty ****					
Before joining the start-up, how many	Start-ups was this person involved in				
	Years experience has this person in the same industry as the start-up is in				
	Years experience has this person in worked on research in the same technology of the start-up?				
	Years has this person been involved in the research related to the technology used by the start-up?				

* Founding: moment when one at least 1 person full-time was employed in the company
** jus graduated: less than 1 year after graduation
*** Alumni: more than 1 year after graduation
**** If not the TuDelft than please mention the name of the other university

Founders network

Most people discuss from time to time important issues with others, for example with family, colleagues etc. We ask you to give a maximum of 7 names of people who were important the start-up of the spin-off. It can involve a discussion on market, competition, finance, equipment and accommodation, etc.

Person	1	2	3	4	5	6	7
Age							
Gender							
What background has this person…							
Researcher at TUDelft	❑	❑	❑	❑	❑	❑	❑
Tecnology Transfer TuDelft	❑	❑	❑	❑	❑	❑	❑
Yesdelft	❑	❑	❑	❑	❑	❑	❑
Other start-up	❑	❑	❑	❑	❑	❑	❑
Industry							
Consultancy firm							
Family Friend							
Venture capital/ investor							
Other							
How intensive is the contact?	❑	❑	❑	❑	❑	❑	❑
Less than once a year	❑	❑	❑	❑	❑	❑	❑
At least every year	❑	❑	❑	❑	❑	❑	❑
At least every 6 months							
At least every month							
At least every two weeks							
At least every week							
How well do you know the person? Very well	❑	❑	❑	❑	❑	❑	❑
Somehow	❑	❑	❑	❑	❑	❑	❑
Very little	❑	❑	❑	❑	❑	❑	❑
How many years do you know this person?	_ _ yr	_ _ yr	_ _ yr	_ _ yr	_ _ yr	_ _ yr	_ _ yr
1. How did this person help you?							
Legal support; Legal/ institutional	❑	❑	❑	❑	❑	❑	❑
Network support ; Link to Customer, VC ; to other companies	❑	❑	❑	❑	❑	❑	❑
Financial support	❑	❑	❑	❑	❑	❑	❑
Accommodation support : Lab space, equipment, office	❑	❑	❑	❑	❑	❑	❑
Educating and training support: teaching, coaching	❑	❑	❑	❑	❑	❑	❑
Endorsements /reputation	❑	❑	❑	❑	❑	❑	❑

Relationships among the contacts in the external network

Can you mark the contacts that know each other?	1	2	3	4	5	6	7
Person 1		❑	❑	❑	❑	❑	❑
Person 2			❑	❑	❑	❑	❑
Person 3				❑	❑	❑	❑
Person 4					❑	❑	❑
Person 5						❑	❑
Person 6							❑

Communication in the founders team

To what extend do you agree or disagree with the following statements (Encircle 1 = completely disagree; 7 = completely agree)

Management team members thoroughly and sincerely discuss evaluate different alternatives	1 2 3 4 5 6 7
Discussion quality improves when all the management team members participate	1 2 3 4 5 6 7
Dissenting opinions are encouraged in the management team	1 2 3 4 5 6 7
The management team enjoys debating different ideas	1 2 3 4 5 6 7
We have short time decision making	1 2 3 4 5 6 7

Self efficacy

Please indicate how confident you think the founding team is in the following activities	not confident completely confident
Conceive a unique idea for a business	1 2 3 4 5 6 7
Identify market opportunities for a new business	1 2 3 4 5 6 7
Write a formal business plan	1 2 3 4 5 6 7
Raise money to start a business	1 2 3 4 5 6 7
Convince others to invest in your business	1 2 3 4 5 6 7
Convince a bank to lend you money to start a business	1 2 3 4 5 6 7
Convince others to work for you in your new business	1 2 3 4 5 6 7
Manage a small business	1 2 3 4 5 6 7
Grow a successful business	1 2 3 4 5 6 7

Level of commitment

Affective commitment:	
if this business idea is not successful, I am willing to go to work for someone else (reverse coded)	1 2 3 4 5 6 7
even if this business idea is not successful, I will never go to work for someone else	1 2 3 4 5 6 7
behavioral dimension of commitment:	1 2 3 4 5 6 7
there is no limit as to how long I would give maximum effort to establish my business	
my personal philosophy is to "do whatever it takes" to establish my own business	1 2 3 4 5 6 7
affective dimension of commitment	
starting a business is much more desirable than other career opportunities I have	1 2 3 4 5 6 7
if I start a business, it will help me achieve other important goals in my life	1 2 3 4 5 6 7
overall, my skills and abilities will help me start a business	1 2 3 4 5 6 7
I am confident I can put in the effort needed to start a business	1 2 3 4 5 6 7

Entrepreneurial orientation

The strategic posture scale

In general, the top managers of my firm favor . . .		
A strong emphasis on the marketing of tried and true products or services	1 to 7	A strong emphasis on R&D, technological leadership, and innovations
How many new lines of products or services has your firm marketed in the past 5 years?		
No new lines of products or services	1 to 7	Very many new lines of products or services
Changes in product or service lines have been mostly of a minor nature	1 to 7	Changes in product or service lines have usually been quite dramatic
In dealing with its competitors, my firm . . .		
Typically responds to actions which competitors initiate	1 to 7	Typically initiates actions which competitors then respond to
Is very seldom the first business to introduce new products/services, administrative techniques, operating technologies, etc.	1 to 7	Is very often the first business to introduce new products/services, administrative techniques, operating technologies, etc.
Typically seeks to avoid competitive clashes, preferring a 'live-and-let-live' posture	1 to 7	Typically adopts a very competitive, 'undo-the-competitors' posture
In general, the top managers of my firm have . . .		
A strong proclivity for low-risk projects (with normal and certain rates of return)	1 to 7	A strong proclivity for high-risk projects (with chances of very high returns)
In general, the top managers of my firm believe that . . .		
Owing to the nature of the environment, it is best to explore it gradually via timid, incremental behavior	1 to 7	Owing to the nature of the environment, bold, wide-ranging acts are necessary to achieve the firm's objectives
When confronted with decision-making situations involving uncertainty, my firm. . .		
Typically adopts a cautious, 'wait-and-see' posture in order to minimize the probability of making costly decisions	1 to 7	Typically adopts a bold, aggressive posture in order to maximize the probability of exploiting potential opportunities

Environment turbulence

To what extend do you agree or disagree with the following statements (Encircle 1 = completely disagree; 7 = completely agree).

Technological turbulence (Jaworski and Kohli, 1993)	
The technology in our markets is changing rapidly	1 2 3 4 5 6 7
Technological development in our market are rather minor	1 2 3 4 5 6 7
Technological changes provide big opportunities in our market	1 2 3 4 5 6 7
It is very difficult to forecast where the technologies in our markets will be in the next five years	1 2 3 4 5 6 7
A large number of new products in our markets have been made possible through technological breakthrough.	1 2 3 4 5 6 7
Market turbulence (Jaworski and Kohli, 1993)	
In our industry customers' needs change rapidly	1 2 3 4 5 6 7
In our industry technology change rapidly	1 2 3 4 5 6 7
In our industry market conditions change frequently	1 2 3 4 5 6 7

C

Data Handling

C.1 Data Cleaning and Missing Data

The raw data was received from Delft Center of Entrepreneurship. It was first examined for data cleaning and selection of sample. The process of data cleaning was followed as per Hair et al. [2013]. The missing data process follows four steps

Step 1: Identifying the type of missing data- ignorable or non-ignorable? The data was checked if the missing data was *ignorable* or non ignorable? The missing data is non-ignorable because the missing data is distributed at random and are from questionnaires which are a part of the research design. Thus, instead of ignoring the data, it should be imputed and rectified for data analysis.

Step 2: Identifying the extent of Missing Data

The data was checked for the extent of missing data by observing the pattern of missing data and quantity of missing data. The question asked is if the missing data is too low for imputation. The missing data is less than 10% for most cases, therefore it is under the acceptable limits.

Deletion: During the cleaning process, the cases with extremely high missing data were deleted for individual cases. No data was deleted for specific variables because the variable questions form an integral part of research design.

Step 3: Diagnosing the randomness of missing data The data is checked for if it is missing at random (MAR) or Missing completely at random(MCAR). It is observed that the data is missing at random (MAR) because, the missing data is due to the questionnaires and not because of intentional blank responses. For example, if a question is not applicable to an organisation, they marked it as 88888 or left it blank. However other applicable questions by the organisation had valid responses.

Step 4: Selecting the Imputation Method Imputation is the method of predicting the values of missing data based on the values of other valid data. The valid cases were selected after step 3 and data was imputed using the EM method. The EM method is used to estimate the means and the correlation of quantitative variables with missing values. The benefit of using EM method is that it is useful for scale type of quantitative data.

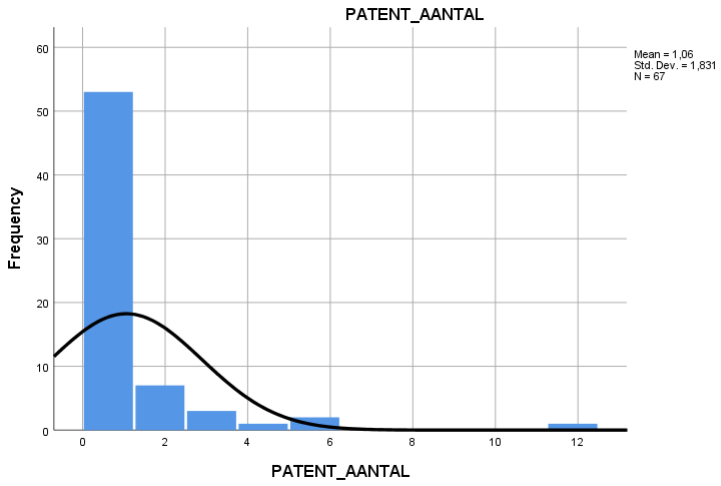


Figure C.1.1: Frequency distribution of Dependent Variable Patent_Aantal used for the construct *'Innovation'*

	Conversion_1	Conversion_2	Coordination_2	Ent_Orient_D	Ent_Orient_G	Ent_Orient_H	Ent_Orient_I	ExternalScanning_1	ExternalScanning_2	Integration	Internalisation_1	Internalization_2	Knowledge Management	PAT_Count_1	Progress_A	Progress_C	Progress_D	Progress_E	Progress_F	Recombining_1	Recombining_2	Resource Cognition_1	Resource Cognition_2	StrategicAssessment_1	StrategicAssessment_2
Conversion_1	1																								
Conversion_2	0.248	1																							
Coordination_2	0.538	0.289	1																						
Ent_Orient_D	-0.066	0.234	0.018	1																					
Ent_Orient_G	0.206	0.206	0.199	0.465	1																				
Ent_Orient_H	0.037	-0.129	0.029	0.164	0.386	1																			
Ent_Orient_I	0.096	0.104	0.07	0.402	0.714	0.497	1																		
ExternalScanning_1	0.415	0.137	0.468	0.097	0.394	0.133	0.299	1																	
ExternalScanning_2	0.481	0.382	0.503	0.183	0.452	0.169	0.359	0.625	1																
Integration	0.434	0.42	0.704	0.163	0.287	0.03	0.14	0.372	0.633	1															
Internalisation_1	0.467	0.482	0.707	0.025	0.138	-0.112	-0.028	0.368	0.409	0.513	1														
Internalization_2	0.606	0.262	0.612	0.098	0.217	0.068	0.146	0.283	0.423	0.423	0.704	1													
Knowledge Management	0.454	0.379	0.291	0.134	0.299	0.129	0.189	0.271	0.541	0.283	0.426	0.441	1												
PAT_Count_1	0.101	0.284	0.109	0.326	0.185	-0.04	0.055	-0.019	0.108	0.132	0.216	0.237	0.154	1											
Progress_A	-0.017	0.115	0.315	0.268	0.312	0.164	0.115	0.14	0.221	0.509	0.104	0.173	0.001	0.041	1										
Progress_C	0.325	0.273	0.486	-0.006	-0.036	-0.115	-0.128	0.26	0.188	0.404	0.384	0.255	0.219	-0.014	0.384	1									
Progress_D	-0.021	0.166	0.197	0.387	0.101	0.141	0.167	0.056	0.088	0.239	0.229	0.214	0.027	-0.001	0.42	0.204	1								
Progress_E	0.266	0.074	0.33	0.059	-0.051	-0.02	0.087	0.247	0.092	0.346	0.278	0.099	-0.006	0.038	-0.074	0.205	0.188	1							
Progress_F	0.068	0.114	0.333	0.158	-0.002	0.11	0.077	0.253	0.104	0.258	0.186	0.117	0.101	0.068	0.183	0.206	0.298	0.529	1						
Recombining_1	0.236	0.437	0.434	0.114	0.133	0.042	0.052	0.062	0.187	0.353	0.415	0.392	0.291	0.265	0.262	0.176	0.35	0.145	0.353	1					
Recombining_2	0.374	0.457	0.267	0.091	0.19	0.16	0.179	0.123	0.315	0.28	0.314	0.38	0.535	0.149	0.132	0.13	0.067	-0.041	0.137	0.393	1				
Resource Cognition_1	0.208	0.581	0.449	0.381	0.334	0.101	0.303	0.378	0.402	0.406	0.435	0.285	0.315	0.197	0.075	0.079	0.159	0.198	0.28	0.302	0.236	1			
Resource Cognition_2	0.388	0.462	0.413	0.345	0.44	0.224	0.378	0.385	0.4	0.339	0.294	0.316	0.265	0.166	0.194	0.19	0.037	0.251	0.3	0.383	0.543	0.518	1		
StrategicAssessment_1	0.522	0.292	0.489	0.049	0.4	0.064	0.335	0.521	0.774	0.482	0.293	0.457	0.409	0.042	0.168	0.118	0.057	-0.018	0.054	0.24	0.285	0.269	0.397	1	
StrategicAssessment_2	0.352	0.393	0.464	0.189	0.222	0.006	0.204	0.322	0.752	0.706	0.38	0.436	0.41	0.034	0.33	0.229	0.301	0.19	0.169	0.228	0.25	0.298	0.201	0.698	1

Table C.1.1: Collinearity Matrix, n=67

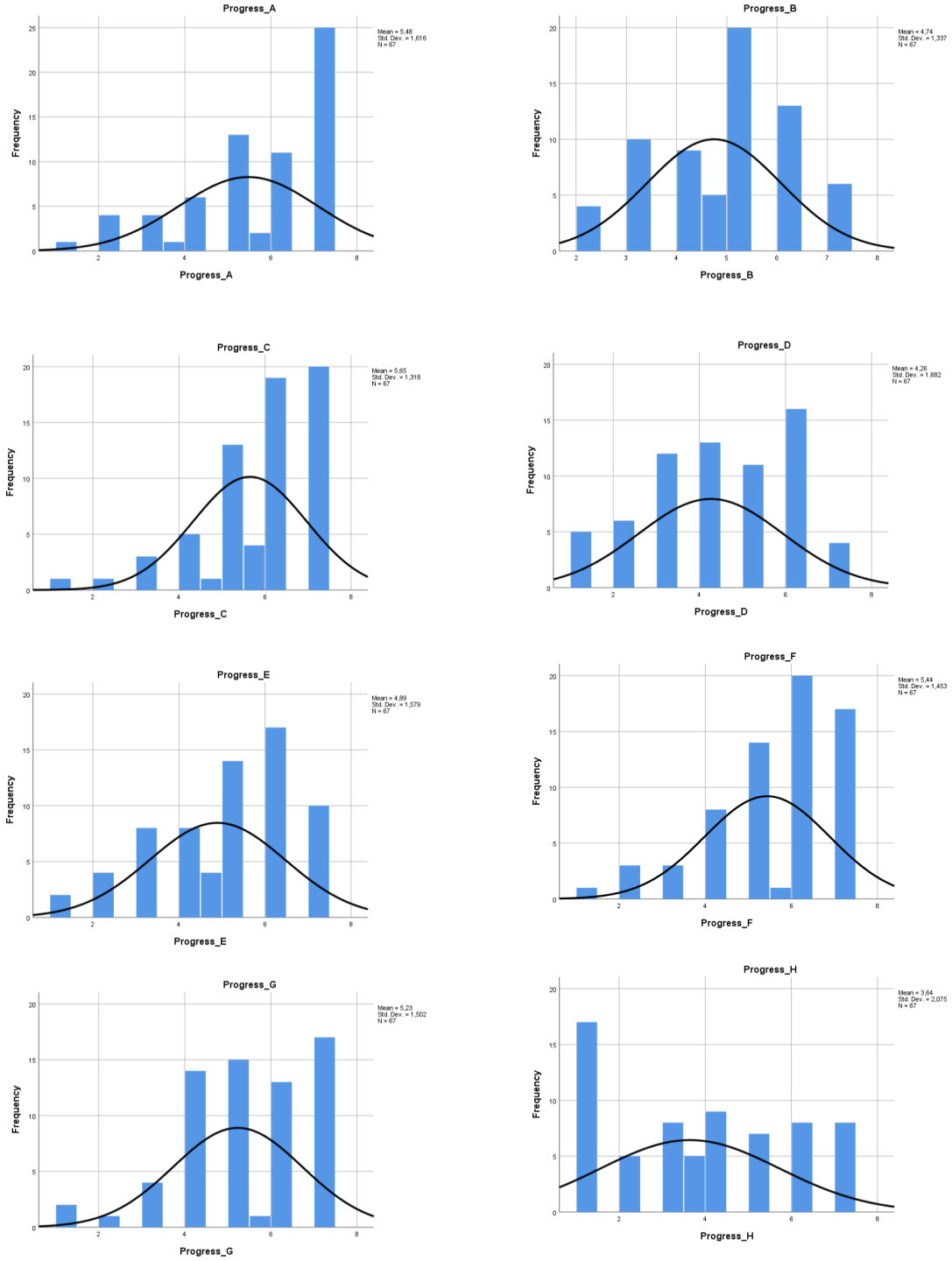


Figure C.1.2: Frequency Distributions of Variables *Progress_A-Progress_H* used for the construct Product Development Related Performance

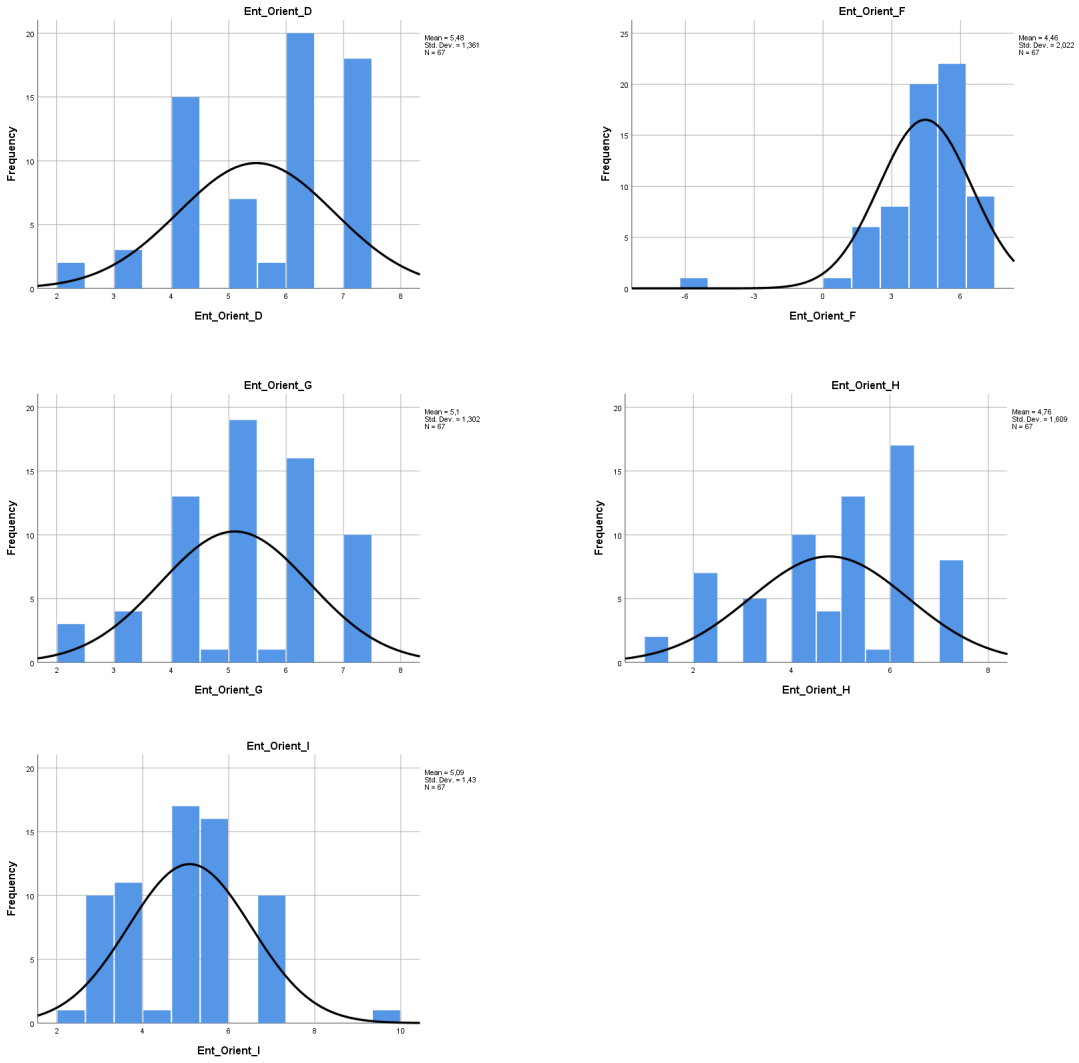


Figure C.1.3: Frequency Distributions of Variable Strategic Flexibility

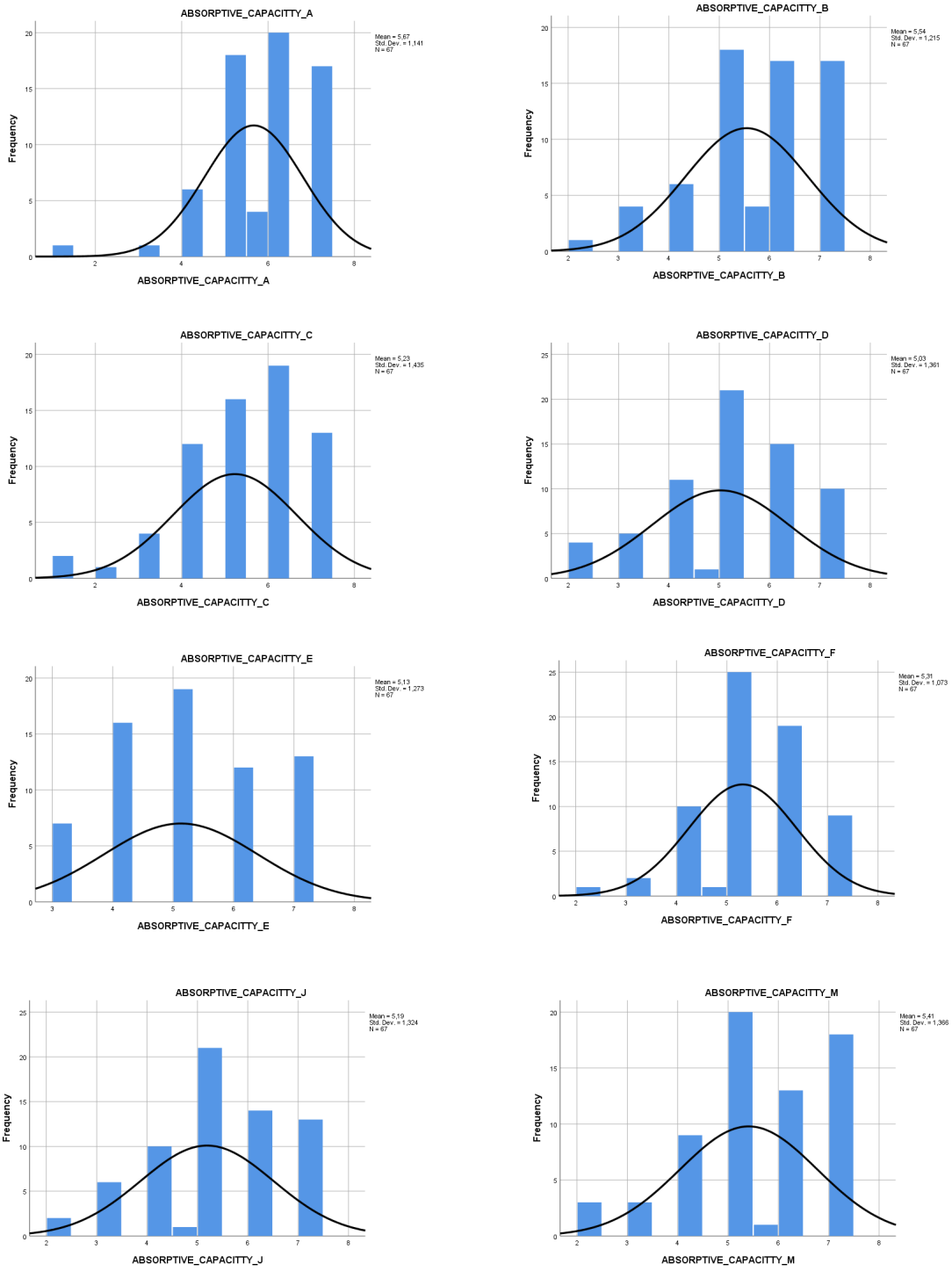


Figure C.1.4: Frequency Distributions of Indicator Variables of Construct Potential Absorptive Capacity

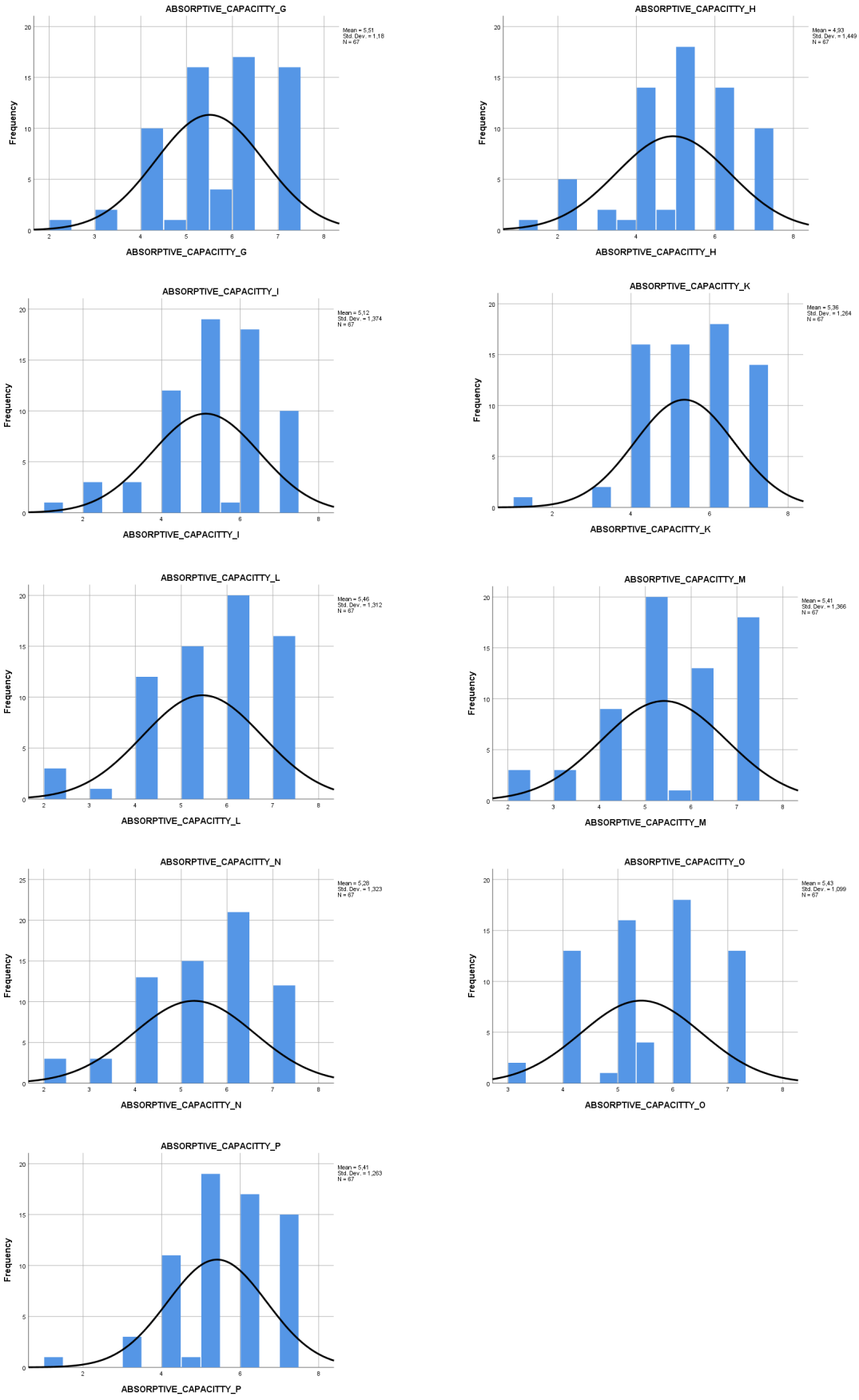


Figure C.1.5: Frequency Distributions of Indicator Variables of Construct Realized Absorptive Capacity

This page is intentionally left blank.