TUDelft

Roles of university, local government and industry played in the innovation network building and governance of Dutch university anchored Science Park

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Colophon

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Preface

This research is my final thesis of the master "Construction Management and Engineering" at the faculty of Civil Engineering and Geoscience, Delft University of Technology. The research is executed under the department of Management in the Built Environment at the faculty of Architecture, Delft University of Technology. The graduation thesis is submitted for partial fulfillment of the requirements for my master degree.

During my internship at Dongguan, China, I recognized that a successful science park can not only stimulates the innovation performance of on-park companies, but also facilitates local economy development. Therefore, I became interested in the innovation development of science parks. The master program "Construction Management and Engineering" provides an opportunity for me, who got a bachelor degree in civil engineering, to study such topics. Then, I chose to work on my thesis under the department of Management in the Built Environment without any hesitation.

This report mainly discusses about how can the university, municipality and companies play their roles in facilitating the innovative linkages building of on-park actors in order to stimulate innovation development. I hope the result of this research can help university anchored science parks promote their innovation network building and governance capability and innovative performance.

I learnt a lot during my graduation period. As a student without any background of urban development, I read lots of literature to mitigate the gaps. I enjoyed every failure and breakthrough. Thanks to Yawei Chen and Arie Romein who always support me and encourage me when I feel depressed. It is also my first time to do interviews, and the unreserved helps of interviewees make me feel warm and moved. All the pains and gains will become precious wealth in my life.

I would like to thank my graduation committee Ellen van Bueren, Yawei Chen and Arie Romein for their support and patience. They help me develop attitudes of rigorous in doing research and meticulous in details. In addition, I would like to thank my all interviewees for their time and input. It would not have been possible to finish this research without them.

2020 is a special year for everyone in the world because of covid-19. I hope the world will be better soon.

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Rui Cui
May 2020

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Summary

Introduction

The global economy has experienced a transformation from industrial economy to knowledge economy and knowledge intensive-industry has become a main contributor to economy growth (Smith, 2002). With the development of knowledge economy, innovation ecosystems emerged, and innovation districts, as localized innovation ecosystems, have been adopted as local and regional economic development strategies around the world (Morisson et al., 2018). Universities are important nodes of knowledge transfer processes and have many important resources. Since the late 1980s, several researches have been conducted to improve the importance of the development of technology campus, both in theory and in practice (Castells, 1985; Castells & Hall, 1994; Huang, 2013; Link & Scott, 2006). Nowadays, universities have pursued the role as an anchor institution to develop the local and regional economy and stimulate the innovation (Ehlenz, 2018). However, the success of a university anchored science park does not only depend on the single role of the university, but also the government and industry. Triple helices coordinate and cooperate together to achieve the common goals.

The success of a science park and also the on-park actors requires multi-stakeholder interaction and resources flow. Therefore, networks are essential for the innovation creation and stimulation process. Networks consist of nodes, connection and intensity of transfers of resources (Lambooy, 2004). It is important to create a vibrant environment where actors can easily build linkages with others. Actually, there are many researches have studied the linkages between on-park actors. They compare the performance between on-park firms and off-park firms in terms of *joint research, human mobility, sponsorship of research trials/project, knowledge sharing and partnership opportunities with other technology firms etc*. As large amount of literatures show, on-park firms always have a better linkage with universities, industry and government and to be more R&D intensive compared to off-park firms due to more resources can be used in the science parks (Lamperti et al. 2017; Leyden et al. 2008; Vásquez-Urriago et al., 2016; Lindelöf and Löfsten, 2004; Hung, 2012; Klerkx and Aarts, 2013; Malairaja and Zawdie, 2008).

However, there are certain numbers of researches argued that on-park actors are not facilitated by the science park to build innovative linkages. In order to create a better interaction environment for on-park actors, and give full play to the facilitator roles of science parks. There are two aspects should be considered, one is innovation network building and the other one is innovation network governance. Network building is related to the factors of breadth, density and proximity. And network governance should be considered in the aspects of stakeholder involvement, resources matching and allocation and decision making. Then, four dimensions are proposed where the university, municipality and companies play their roles in a practical way to contribute to the innovation network building and governance. They are Lands & Real Estate dimension, Brand & Community Building dimension, R&D Development dimension and Board Level.

The objective of this research is to provide a theoretical debate on whether innovation

network building and governance can influence innovative linkages building of on-park actors and build a conceptual framework of the roles of university, local government and industry played in the innovation network building and governance processes. In line with this objective, the main research question is:

"What roles can the university, government and industry play in the innovation network building and networked governance during the development of university anchored Science Park in order to create and stimulate innovation in Dutch practices? TU Delft Campus and Leiden Bio Science Park are selected as case studies."

Methodology
This research will be largely been carried out via literature review and case study. Two well-networked universities, TU Delft and Leiden University, are selected. The methodology of this research is a qualitative research, which aims to fill the research gap on the innovation network building and governance of a science park and provide the conceptual framework of the roles played by university, municipality and industry, and reconcile a variety of evidence into a singular structure which can highlight the critical features of the case studies and verify the conceptual framework. Semi-structured interview will be used to get an insight of TU Delft Campus and LBSP. Firstly, large amount of literature will be reviewed to find the basic information about innovation network building and governance and what roles do university, government and enterprise played in the innovation creation and stimulation process. Therefore, the conceptual frameworks can be provided. Then, Semi-structured interview will be given to the related officers, managers and researchers. It can help collect the data which is helpful for gain insight of how TU Delft Campus and LBSP perform. Finally, the conceptual framework will be verified and improved and some advice might be offered to the TU Delft Campus and LBSP on innovation network building and governance. The research design is presented in *figure 0.1*.
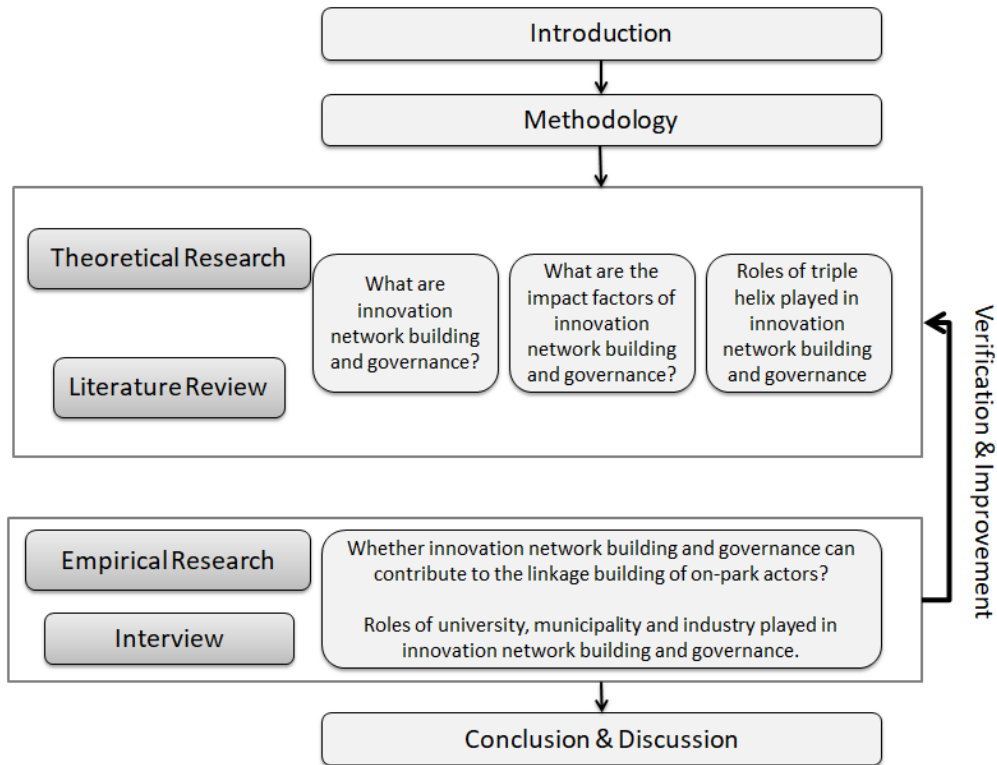
Figure 0. 1 Research design

Literature review

Literature review aims to understand the problem and illustrate the command of research area and to justify the research topic (Hart, 2018). Reviewing literature helps to gain insight of the concepts, theories and methods used in the research topic and also the controversies of the research area (Bryman, 2012). The literature review of this research is concentrated on the roles government, universities and enterprises play in the innovation creation and stimulation network and their strategies to improve connections between on-park actors. What is more, the basic information of TU Delft Campus and LBSP is also obtained via literature review. The outcome of literature review can be input for the next empirical research constructed in the two cases.

Case study

Two cases selected in this research are TU Delft Campus and Leiden Bio Science Park. Literature (Gemeente Delft, 2011) shows Delft had weak cooperation atmosphere and communication lines between public parties, business and science community. Therefore, TU Delft Campus is selected due to the potential problems of weak linkages building. Leiden Bio Science Park is selected because owf its high reputation. Therefore, some lessons might be learned. The comparison of two cases is shown as ***table 0.1***. The case studies are conducted through semi-structure interview.

Table 0. 1 The comparisons of two cases

	TU Delft Campus	**LBSP**
Type	University anchored science park	University anchored science park
Time	Started in 2005	Started in 1984

Initiator	TU Delft and municipality of Delft	Leiden University and municipality of Leiden
Specialized fields	High-tech development, including quantum, robotics etc.	Bio-technology and life science
On-park actors	200 start-ups, 35 SMEs and 10 corporate partners	150 companies, 4 health care organizations, 11 research institutes, 11 educational institutes and 28 other organizations
Controllers	TU Delft Real Estate Development	LBSP foundation, including the representatives of university, government and on-park companies.

SWOT Analysis

SWOT Analysis is a strategic planning and management tool and aims to build organizational and competitive strategy effectively (Gürel and Tat, 2017). SWOT Analysis helps to find the internal and external factors that influence the current and future performance of the organization. In this research, the SWOT Analysis is conducted to gain insight of the current performance of TU Delft Campus and LBSP on the four dimensions and what can be done by university, municipality and companies in the future to improve the four dimensions in order to promote the capabilities of innovation network building and network governance of the science parks. In addition, the results of SWOT Analysis can also give lessons to other university anchored science park because there might be some similar challenges or problems during the innovation development of other science parks or there might be some strength can be imitated by other parks.

Theoretical research

Innovation network building aims to develop an environment where actors can interact and cooperate with each other smoothly within the science park. Innovation network building requires 1) actors can be connected by social relationships or R&D connections; 2) actors recognise that they affect and are affected by other actors' behaviour; 3) there are various innovation related institutions and firms; 4) resources of on-park actors can be transferred organically (Parker, 2007; Chan et al., 2009). In order to meet these demands, there are several impact factors which can stimulate the innovation network building process. These factors are breadth, density and proximity. An overview of these factors is described in ***table 0.2***.

Table 0. 2 An overview description of factors of innovation network building

Factors	Description
Breadth	Actors with several resources (Knowledge, financial capital, human capital, built environment and regulation).
	All sizes of firms.
	Variety of firms and organizations covering full range of supply chain and providing interfaces for triple helices.
Density	Real estate development condition.
Cognitive proximity	Similar knowledge base between different innovative actors.
Socail proximity	Accessibility to other parties through social activities.
Organizitional	Cooperate with others under a hierarchical structure.

proximity	
Geographical proximity	Physical distance to the important partners.
Cognitive proximity	Similar knowledge base between different innovative actors.

Innovation network governance needs 1) negotiation and coordination in the innovation development; 2) steering actors' behaviour to achieve collective goals; 3) involving all related actors in decision making process 4) facilitating innovative resources matching and allocating processes. Innovation network governance can be seen as a measure to integrate the development of each separate actors and the development of science parks and facilitate the interactions and resources matching and allocation processes. Actually, there are several levels of governance from the science park level to regional and state level during the innovation development of a science park. The development of the science park is always in line with the local, regional and national development visions. The university, municipality and companies work together to set the goals of the science park development and steer the development directions of the science park through the policies, norms and other interventions. The innovation development processes are dynamic and sometimes accidental. Related stakeholders should be involved continuously and their resources are flowing under their coordination and negotiation. Then, there are three main aspects of the innovation network governance to make sure the governance is continuous and efficient during the changings. The first aspect is *stakeholder involvement*. The second aspect is *resources matching and resources allocation*. The last aspect is influences on *decision making processes*.

Four dimensions of innovation network building and governance
In order to contribute to the impact factors of innovation network building and governance, university, municipality and firms should work together in four main dimensions. They are Lands & Real Estate dimension, Brand & Community Building dimension, R&D Development dimension and Board Level. These four dimensions interwove with each other and support each other to build a better environment for innovation network building and governance.

Lands refer to the land ownerships. Land ownership is the prerequisite of the real estate development. Actors with the land ownership always have the strongest power in the real estate development of the science park. Real estate development is the foundation of the innovation development of the science park. Lands & real estate dimension can help to contribute to the breadth and density of the science park and also the geographical proximity and social proximity between on-park actors.

A strong brand helps to attract more actors to locate in and more partners to involve in the park development. With the development of the science park, more and more innovative actors will come to locate on the park. Community building is important for developing social relationships between on-park actors and promoting their knowledge and information exchange chances in daily life. Therefore, brand & community building can contribute to the breadth of the science park and social proximity and cognitive proximity between on-park actors.

R&D development dimension refers to the knowledge creation and transfer processes. The main tasks for triple helices in R&D development dimension are to create knowledge flow among on-park actors and contribute to the cognitive proximity between on-park actors. R&D development dimension requires the science park provide more opportunities for on-park actors to cooperate with each other in the knowledge creation and knowledge utilization.

The board level is the highest level in the operate structure of a science park. Therefore, the composition of the board level can reflect the powerful decision makers in the decision making processes of science park development.

Figure 0.2 describes the contributive relations between four dimensions and the impact factors of innovation network building and governance.
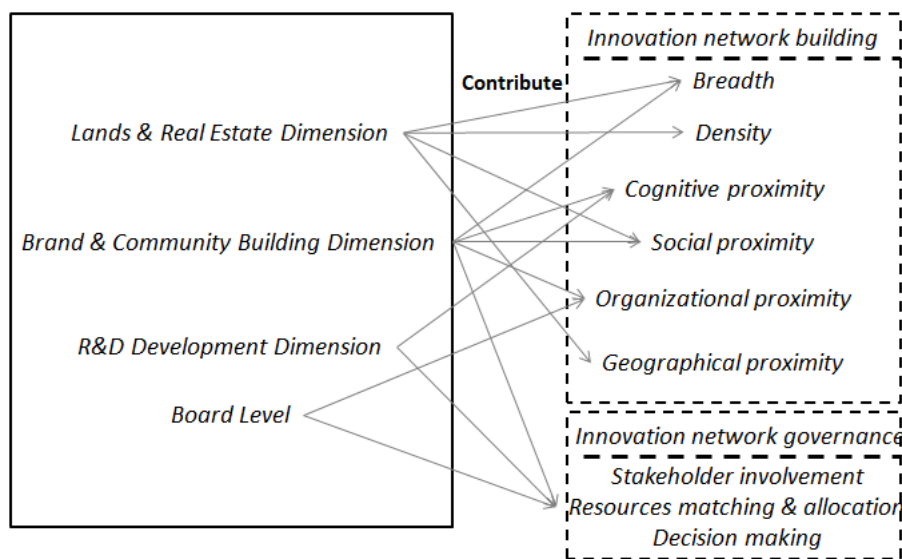

Figure 0. 2 Contributive relations between four dimensions and impact factors of innovation network building and governance

In order to investigate how to promote the capability of network building and governance of a science park, several impact factors are captured based on the literature reviews at first. Breadth, density and proximity influence the network building of the science parks and stakeholder involvement, resources management and decision making process impact the governance of innovation networks. Then, four dimensions are proposed where university, municipality and firms work together to contribute to the innovation development of the science park. The four dimensions are Lands & Real Estate dimension, Brand and Community Building dimension, R&D Development dimension and Board Level. University, municipality and industry play their roles in these dimensions to promote the capability of innovation building and governance of the science park. ***Figure 0.3*** elaborates the theoretical frame work of the innovation network building and governance of the university anchored science parks.
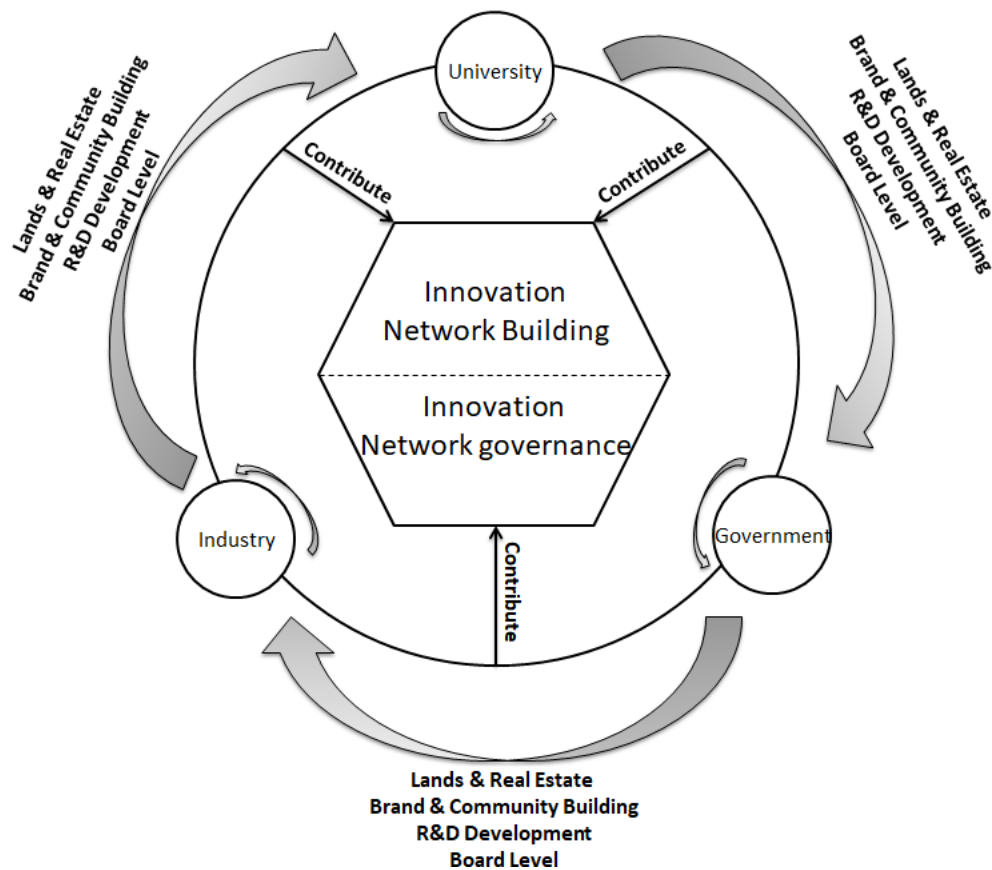
Figure 0. 3 Theoretical framework of innovation network building and governance

Synergy

Literature shows a contrast performance of on-park actors on the innovative linkages building. Many researches show that science parks can facilitate the innovative linkages building of on-park actors. However, there are still certain numbers of researches argued that science parks do not contribute to the innovative linkages building of on-park actors. Science parks as an intervention can facilitate the interaction and cooperation of on-park actors by creating a collaborative environment and stimulating resources flow. More interaction and resources flow can stimulate the innovation performance of the science park. Based on the study of two cases, some evidence can be found to verify innovation network building and governance can contribute to the linkages building of on-park firms. Theoretical part elaborates that innovation network building (breadth, density and proximity) and network governance (stakeholder involvement, resources management and decision making) can facilitate the interaction of different parties and stimulate the resources flow.

Innovation network building

There are three factors that influence the innovation network building. They are breadth, density and proximity. Results of TU Delft Campus show that on-park actors are influenced by the breadth, density and proximity to build innovative networks with others. In order to improve the capability of innovation network building, municipality and university should involve more industry partners to work on ***real estate development*** which can provide more working space for new residents and create proximity for in-park actors. What is more, ***community and brand building*** is at early stage and this also limits social connection between

different parties and also limits the attractiveness of the science park. Low social proximity can hinder the increase of cognitive proximity. For ***R&D development***, there are several PPP platforms, such as field labs and incubator, established on the Campus which attracts both on-park partners and off-park partners. It provides opportunities for different parties to interact with each other. Leiden Bio Science Park (LBSP) is more mature than TU Delft Campus on the infrastructure, real estate development and brand and community building because of longer development period. Therefore, it leads to the better performance of innovation network building of LBSP. There are more chances and more convenient for different parties to interact with each other and build their networks because the brand of LBSP can attract more impact actors and mature amenities and public transports makes better accessibility. More interaction will contribute more on innovative outputs.

Innovation network governance
Three aspects of innovation network governance are needed to be considered, stakeholder involvement, resources matching and allocation and decision making process. In order to achieve the development goals of university and local and regional goals, more stakeholders with important resources should be involved because most goals cannot be achieved in isolation. The ***stakeholder involvement*** processes also needs joint-effort of existed actors. ***Resources matching and allocation works*** aim to facilitate the resources flow among the actors and stimulate the innovation development. What is more, Networks are always established serendipitously and can be seen as a mechanism of coordination. Therefore, the ***decision making*** processes should be balanced under mutual interests of different parties. It should be also noticed that the governance not only happens on park level, but also beyond the park level and organizational level. It is a dynamic process and sometime occurs organically. Based on the results of two cases, some evidence can be found to verify innovation network building has positive impact on the linkages building of on-park actors and innovation development of the science park. LBSP is controlled by the foundation which consists of representatives of university, government and on-park firms. Therefore, every decision can be made under the balance of different parties. It makes all parties are willing to share their resources. TU Delft Campus does not involve so many industry partners in the decision making of park development. Therefore, the resources of these industry partners are not be used sufficiently. The networks are built organically and better resources matching can stimulate network building resources. However, both cases do not well in resources matching. Science parks are tools for the local and regional knowledge economy development. Therefore, TU Delft Campus and Leiden Bio Science Park are also in line with the local and regional development. The two parks are influenced by the local and regional interventions as well, such as policy, financial supports etc.

Conclusion
The objective of this research is to provide a theoretical debate on whether innovation network building and governance can influence innovative linkages building of on-park actors and build a conceptual framework of the roles of university, local government and industry played in the innovation network building and governance processes. The main research question of this study is ***"What roles can the university, government and industry play in the innovation network building and networked governance during the development of university anchored Science***

Park in order to create and stimulate innovation in Dutch practices? And how do the TU Delft campus and LBSP perform?" The research question is divided onto three sub-questions in order to answer this question step by step.

What are the innovation network building and innovation network governance?
Innovation network building means the science park should build an environment where innovative on-park actors build their connections with each other in innovation development organically. It aims to develop an environment where actors can interact and cooperate with each other smoothly within the science park. Innovation network building requires 1) actors can be connected by social relationships or R&D connections; 2) actors recognise that they affect and are affected by other actors' behaviour; 3) there are various innovation related institutions and firms; 4) resources of on-park actors can be transferred organically.

Innovation network governance means involving all parties in the collective goals achieving process and doing the resources matching work between actors. It needs 1) negotiation and coordination in the innovation development; 2) steering actors' behavior to achieve collective goals; 3) involving all related actors in decision making process 4) facilitating innovative resources matching and allocating processes.

What are the impact factors of innovation network building and innovation network governance?
Based on the features of innovation network building and governance, related literature was reviewed. According to the literature review, the conceptual model was proposed. The model consists of mainly seven factors: ***breadth, density, cognitive proximity, social proximity, organisational proximity and geographical proximity***. The previous six factors influence the innovation network building process. In addition to the impact factors of innovation network building, there are three main aspects of innovation network governance should be considered. They are ***stakeholder involvement, resources matching and allocation and decision making process***.

In order to contribute to these influencers in practical ways, four dimensions are proposed where university, municipality and companies work interactively. The four dimensions are ***Lands & Real Estate dimension, Brand & Community Building dimension, R&D Development dimension and Board Level***.

What roles do the university, municipality and industry play in the innovation network building and governance?
University, municipality and companies do not play single roles during the innovation network building and governance. According to their resources and interests, they do not only complement each other, but also play same roles together. ***Table 0.3*** shows an overview of the roles of university, municipality and industry played in the innovation network building and governance.

Table 0. 3   Overview of roles of university, municipality and industry played in innovation network building and governance

	Lands & Real Estate	Brand & Community	R&D Development	Board Level
University	-Lands owner; -Investor -Investment attractor.	-Brand designer; -Brand developer -Community builder; -Facilities supporter -Community user	-Knowledge producer; -Talents supporter; -Initiator of innovative public-private partnerships; -Technical facilities supporter; -Funds attractor	-Manager -influencer -User
Municipality	-Policy supporter; -Land owner; -Investor -Coordinator	-Brand co-designer; -Brand developer; -Living environment co-builder	-Investor; -Initiator of innovative platforms; -Funds attractors	-Manager -influencer -User
Industry	-Investor; -Developer -Driver of certain real estate development	-Facilities supporter; -Brand developer; -Community user.	-Facilities supporter; -Investor; -Driver of innovation networks according to companies' demands. -Knowledge producer	-Manager -influencer -User

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PART 1

RESEARCH INTRODUCTION

Chapter 1 Introduction

1. Introduction

In this chapter the background of the research and problem definition are addressed. Additional, the research goal, research question, research scope and research relevance are discussed.

1.1. Background of the research

The global economy has experienced a transformation from industrial economy to knowledge economy and knowledge intensive-industry has become a main contributor to economy growth (Smith, 2002). With the development of knowledge economy, innovation ecosystems emerged, which consist of many different moving parts, such as universities and research institutes, human capital, information technology infrastructure, financial capital, private sector, and government (Lawrence et al., 2019). Innovation districts, as localized innovation ecosystems, have been adopted as local and regional economic development strategies around the world (Morisson et al., 2018). One main purpose of establishing innovation districts is to develop innovation and turn innovation into added values. Nowadays, the capacity of industry to innovate becomes a main factor of national competitiveness (Porter, 1990). This capacity seems to depend on collective effort of the Triple helices- universities, industry, and governments (Etzkowitz, 2008). And the collaboration between universities, industries and government in which all parties collaborate will foster innovation and create wealth by realizing a sustainable innovative ecosystem (Etzkowitz & Leydesdorff, 2000).

Universities have many resources and play an essential role in the success of innovation districts. They can stimulate innovations by providing human capital and financial capital with future entrepreneurs, talented graduates, entrepreneurial professors, and seed capital for start-ups and can produce local knowledge spillovers to firms and have abilities to effect firms' location decisions (Morisson, 2014; Muscio et al., 2012). Since the late 1980s, several researches have been conducted to improve the importance of the development of technology campus, both in theory and in practice (Castells, 1985; Huang, 2013; Link & Scott, 2006). Nowadays, universities have pursued the role as an anchor institution to develop the local and regional economy and stimulate the innovation (Ehlenz, 2018). The term of anchor institution was coined by the Aspen Institute firstly as an urban institution with "significant infrastructure in a specific community which is unlikely to move" (Fulbright-Anderson, Auspos, & Anderson, 2001). Many articles have studied the positive effect of universities in the development of innovation districts and the interactions between technology campuses and cities (Culkin, 2016; Yun et al., 2018; Benneworth et al., 2007; Den Heijer 2011). University anchored science park provides proximity, technical, human and financial resources of the university and services for tenants. During the innovation creation and stimulation process, networks are built to create a cooperation and mutuality environment. In order to achieve the goal of stimulating innovation, the cooperation of universities, government and enterprises has become more and more important.

Networks building are essential in the innovation creation and stimulation process. Networks consist of nodes, connection and intensity of transfers of resources (Lambooy, 2004). In terms of nodes, this research focuses on three main actors,

university, local government and industry. Although Carayannis and Campbell (2009) have proposed 'Quadruple Helix model' which added the fourth factor, "media-based and culture-based public", the triple helices remain play the main roles in the innovation creation and stimulation. There are several reasons why roles of university, municipality and firms are chosen. Initially, government, universities and enterprises all can be the driver of an innovation district (Katz and Wagner, 2014). Government has lots of resources in the urban planning, for example government can provide lands, capital and regulations to stimulate local innovation activities (van der Veer, 2017). Universities provide energy for innovations with entrepreneurial professors, future entrepreneurs and talented graduates, and opportunities for start-ups (Morisson, 2014). What is more, industry is also an important node in the innovation creation and stimulation network. Literature shows that top 500 Firms make 80% of R&D expenditures, 71% of the results of technological innovation; and 62% of technology transfer takes place among them (Etzkowitz and Zhou, 2007). Corporations have platforms to utilization innovation products and transfer the innovation to commercial values (Etzkowitz and Zhou, 2007; Sarpong et al., 2017). Another important element is the connection between actors, which works as bridges for resources transfer. There are two types of linkage, the formal linkages and the informal linkages (Hobbs et al., 2017; Lecluyse et al., 2019). Only an appropriate strength of linkages maximizes the performance of the science park. Therefore, it is meaningful to investigate the roles that university, government and industry paly in the innovation network building and innovation network governance processes.

1.2. Problem statement

Science parks have been adopted as strategies of business support and technology transfer largely around the world (Lecluyse et al., 2019). The establishment of science parks aims to create knowledge spillovers and work as catalyst to stimulate regional and national economic growth (Zou and Zhao, 2014; Lecluyse, 2018; Hobbs et al., 2017). There are many researches have studied the linkages building of on-park actors. They compare the performance between on-park firms and off-park firms in terms of *joint research, human mobility, sponsorship of research trials/project, knowledge sharing and partnership opportunities with other technology firms etc*. As large amount of literatures show, on-park firms always have a better linkage with universities, industry and government and to be more R&D intensive compared to off-park firms (Lamperti et al. 2017; Leyden et al. 2008; Vásquez-Urriago et al., 2016; Lindelöf and Löfsten, 2004; Hung, 2012; Klerkx and Aarts, 2013; Malairaja and Zawdie, 2008). It leads to the positive influences on the output of science parks, such as the better performance in the development of new products, processes and technologies (Díez-Vial and Montoro-Sánchez, 2016; Díez-Vial and Fernández-Olmos, 2015). It shows that science parks contribute effectively to the innovation creation and stimulation and knowledge economic growth. Interestingly, although widespread perception of SPs as facilitators of linkages building of on-park actors and many empirical studies confirm this perception, considerable numbers of empirical studies have provided weak and even contradictory results. *Table 1.1* shows the literature review (empirical studies) of linkages between on-park actors. The paradox here is the contrast performances of sciences parks during their developments. As literature studies show the interaction between academia and on-park firms has positive effect on the innovation performance and Science Parks can be recognized as facilitators of linkages building

of on-park actors. However, the problem is there are many SPs do not perform as expected on facilitating interaction of on-park actors.

Table 1.1 Literature review of linkages between on-park actors

Findings	Author(s)
There is no evidence or weak evidence shows on-park firms perform better than off-park firms in terms of interaction with university and other firms.	Liberati et al. 2016; Malairaja and Zawdie 2008; Radosevic and Myrzakhmet 2009; Joseph 1989; Chan et al. 2010; Massey and Wield 1992; Qunitas et al. 1992; Bakouros et al. 2002
SP indeed facilitate the linkages building between universities and on-park firms.	Colombo and Delmastro 2002; Löfsten and Lindelöf 2002; Lindelöf and Löfsten 2004; Fukugawa 2006; Hung 2012; Vásquez-Urriago et al. 2016; Jongwanich et al. 2014
Firms pursue more innovation interactions with university and other firms tend to increase their innovative capacity and innovative outputs	Dı´ez-Vial and Montoro-Sánchez 2016; Dı´ez-Vial and Fernández-Olmos 2015; Hu 2008；Martńez-Cañas et al. 2012

Some reasons can be found in the literature, 1) Unfamiliar with each other; 2) No enough trusts between actors; 3) Shortage of policy support; 4) No common goals; 5) Cultural differences; 6) Weak built environment; 7) Insufficient diversity (Eva Mará Mora Valentń, 2000; Klerkx and Aarts, 2013; Huang et al., 2012; Chan et al., 2010). Those reasons can be summarized as weak network building and weak network governance. *Network building* means attracting enough actors with useful resources and making sure they are connected by ties and social relations and they affect and are affected by the behavior of other actors. *Network governance* as a form of governance must play a role in steering, setting direction and influencing behaviors (Parker, 2007). Networks always requires some extent of interactions among participants and the network governance focuses on the allocating resources and coordinating actors' behaviors across the network as a whole (Provan and Kenis, 2008). Network governance is full of negotiation, steering, decision making and coordination (Parker, 2007). The innovation creation and stimulation process in a Science Park needs both network building and network governance. Each helix of triple helices plays important roles in innovation network building and network governance of SPs.

1.3.   Research goal and main research question

The objective of this research is to provide a theoretical debate on whether innovation network building and governance can influence innovative linkages building of on-park actors and build a conceptual framework of the roles of university, local government and industry played in the innovation network building and governance processes. Verification will be conducted through TU Delft Campus and Leiden Bio Science Park. Finally, advice on improvement of two cases would be offered if there are some shortcomings or expected development directions found. In order to realize this goal, 3 progressive sub-goals are developed: 1. Understanding the concept of innovation network building and governance; 2. Understanding the impact factors of innovation network building and governance; 3. Gaining insight of how university, municipality and industry play their roles in building the innovation networks and

governance.

Understanding the concept of innovation network building and governance
The main objective of this study is to provide a theoretical debate on whether innovation network building and governance can influence innovative linkages building of on-park actors and build a conceptual framework of the roles of university, local government and industry played in the innovation network building and governance processes. Therefore, it is important to learn the concept of innovation network building and innovation network governance. It helps to assess whether the science park is working on the innovation network buildings and governance or if there are any challenges in the innovation network building and governance.

Understanding the impact factors of innovation network building and governance
It is meaningful to know the impact factors or aspects that should be considered of innovation network building and governance. Only understanding these influencers, the strategies on facilitating innovation network building and governance can be offered. After learning about these factors, the ways or dimensions to stimulate the innovation network building and governance can be proposed.

Gaining insight of how university, municipality and industry play their roles in building the innovation networks and governance
After understanding how to stimulate innovation in science parks from the networks perspectives, it is more specific for learning how the roles of university, municipality and firms played. Investigating the roles of university, municipality and industry play provides a better understanding of how to enhance synergy and achieve collective goals for both policy makers and users in the science park. Before investigating the detailed strategies of promoting interaction and cooperation environment, a conceptual framework is made.

To achieve these three goals, the main research question of the research is:

> *"What roles can the university, government and industry play in the innovation network building and networked governance during the development of university anchored Science Park in order to create and stimulate innovation in Dutch practices? TU Delft Campus and Leiden Bio Science Park are selected as case studies."*

1.4. Research scope

This research focuses on the university-anchored science park in the Netherlands, since many technology campus programs have been established in the Netherlands, but not much research about the relationships and cooperation between the actors has been conducted so far. Besides, there is several university-anchored science parks still in the early stages in the Netherlands, thus the lessons learned from the cases can be applied to other developing technology campuses.

The scope of this research focuses on the Anchor University, local government (municipality) and on-park firms. However, it does not mean that only the mentioned actors will be discussed. Innovation networks always include the off-park

universities, organizations and companies and also the regional and national government. These off-park actors and regional or national government will also be discussed to some extent, but not as the main focus.

The cases selected in this research contain two cases by field work in the Netherlands. They are TU Delft Campus and Leiden Bio Science Park. As top universities in the Netherlands, TU Delft and Leiden University have respectively developed the TU Delft Campus and the Leiden Bioscience Park. The TU Delft Campus lies to the southeast of the city center. They are by far the largest knowledge cluster in the city. Apart from the faculties of TU Delft, the area is also home to branches of the HE colleges Haagse Hogeschool and Hogeschool Inholland, research institutions like TNO and Deltares, various companies and the incubator YES!Delft (Maarten, 2016). It mainly focuses on high-tech innovation, such as robotics, optics and so forth. Leiden Bio Science Park is regarded as the leading life sciences cluster in the Netherlands (Curvelo Magdaniel, 2016). LBSP is fully focused on biomedical life sciences and offers opportunities for both start-ups and established companies (Curvelo Magdaniel, 2016).

The theoretical frame works are proposed through literature review and the two cases are studied through semi-structured interviews with science park managers, government officers, managers of on-park companies and university officers.

1.5. Relevance

The expected outcome of research is to find how university, government and industry play their roles in the innovation network building and governance. Based on the literature review and multiple case studies of TU Delft Campus and LBSP, the findings from both theoretical and empirical will be combined to sketch the roles of university, local government and industry played in the innovation creation and stimulation process. What is more, some improvement strategies and advice will be offered for the TU Delft Campus and LBSP. The relevance of this research can be discussed on two ways, and the social relevance and scientific relevance will be discussed shortly.

Social relevance
Understanding the roles of university, government and industry play in the innovation network building and governance can benefit the innovation creation and stimulation process, because in that case university, local government and industry have a better understanding on what they can provide for innovation and how to cooperate with other actors in order to maximize the innovation creation and stimulation. What is more, actors can learn each other better, because they gain knowledge on each actor's role played. Therefore it will be easier for them to find the suitable approaches to interact with others and build the innovation creation and stimulation network.

Scientific relevance
There are many science parks are not as successful as they are expected due to the weak innovation network building and network governance. Although there are many researchers studied the linkages between on-park actors, most of them proposed the assessment criteria and assessed the performance of the science park.

How the university, local government and industry play their roles in the innovation network building and governance of a science park is still lacking. Therefore, this research proposes the theoretical framework of how the university, local government and industry involved in the innovation network building and governance of the university anchored science park. This can fill part of the research gap.

PART 2

THEORETICAL RESEARCH

Chapter 2 Theoretical Research

2. Theoretical research

This chapter describes the theoretical framework that will be used as basis for the field work conducted in the next chapter. Literature about the characteristics of innovation ecosystem, definition of science parks, innovation network, factors and strategies to improve innovation network building and governance in science parks and roles of university, municipality and firms is reviewed. Firstly, an overview of innovation contributors in the science parks is provided. Then, the characters and impact factors of innovation network building and governance in science parks are investigated. Based on the characteristics and the impact factors, four dimensions are proposed to contribute to the innovation network building and governance. Finally, the roles of university, municipality and firms s will be proposed.

2.1. Innovation

Knowledge based economy has become an essential part of global competing cities and promotes contemporary global markets (Carrillo, 2004). During the last two decades, the focus of global economy has shifted from industrial economy to knowledge economy. Therefore, cities and their economies aim to be more innovative and competitive, and knowledge based urban development (KBUD) becomes a more effective urban planning approach (Florida, 2005). KBUD focuses on sustainable urban and economy development, and involves interpretation of value dynamics, capital systems, urban governance, development and planning (Yigitcanlar, et al., 2008). KBUD stimulates urban and economic development with the help of integrating technical knowledge, market knowledge and human knowledge, and provides urban development clusters with a strong spatial relationship (Lever, 2002, Carrillo, 2004; Yigitcanlar et al., 2008). This pushes cities and regions to form a more creative area, and become sites of self-induced and self-centred innovation, economy development (Yigitcanlar, et al., 2008, Segbers, 2007). Creative environment is one of fundamental aspects of KBUD policy (Yigitcanlar et al., 2008). Innovation plays an important role in creating value and sustaining competitive advantage, and is considered as the life blood of corporate survival and growth (Zahra and Covin, 1994; Baregheh et. al., 2009). Stimulating innovation becomes an important task for urban developers and policymakers under knowledge based urban development. Baregheh et al. (2009, p.1334) formulated a general definition of innovation: 'the multi-stage process whereby organizations transform ideas into new/improved products, service or processes, in order to advance, compete and differentiate themselves successfully in their marketplace'. It is obviously that innovation relies on the multi-actors cooperation and interaction rather than a single linear process (Simmie, 2001). Therefore, networks are built to deal with problems of innovation.

Innovation ecosystems are networks of people and organizations working interactively to cultivate ideas into successful enterprises (Lawrence et al., 2019). This system focuses on the dynamics of the complex relationships that are formed between actors and entities in order to stimulate technology development and innovation (Jackson, 2011). Innovation ecosystems are the foundations of innovation districts (Lawrence et al., 2019).

There are several contributors that influence the innovation performance in an innovation ecosystem. Based on the literature, there are six main contributors and they are actors, financial capital, human capital, built environment, knowledge and regulation (Rabelo et al., 2015; van der Veer, 2017; Jackson, 2011). The detailed elaborations are shown as *Table 2.1*.

Table 2. 1 Contributors to innovation performance (Rabelo et al., 2015; van der Veer, 2017; Jackson, 2011)

Contributors	Explanation
Actors	Government, universities, industry, supporting institutions and specialised people, entrepreneurs, financial system, customers and civil society, and their social and economic relationship.
Financial capital	Capital flow can be used in the innovation ecosystem. It can be provided by public or private investors.
Built environment	The built environment consists of built forms to shelter, define and protect activities and can be seen as an enabler of activities performed by society, organizations and individuals. There are two scale levels namely the urban area level ranging from city to district level and the building level ranging from building block to infill, its interiors design.
Regulation	Laws and rules that frame the innovation ecosystem functioning and innovation environment.
Knowledge	Existing supporting theoretical foundations, tacit and explicit, formal, informal and specialised knowledge that are used, generated (and eventually organised and managed), made available, and learned along the innovation value chain
Human capital	People with various skills and knowledge, such as scientists, businessmen, qualified workers and managers, take advantages of their strength to stimulate innovations.

2.2. Science parks

A Science park is one form of urban innovation districts. Science parks have been adopted as strategies of business support and technology transfer largely around the world (Lecluyse et al., 2019). The establishment of science parks aims to create knowledge spillovers and work as catalyst to stimulate regional and national economic growth (Zou and Zhao, 2014; Lecluyse, 2019; Hobbs et al., 2017). Large amount of studies were conducted to learn the principle of technology science parks, and give some definitions.

One of the broadest definitions was proposed by UNESO (Hobbs et al., 2017).

The term "science and technology park" encompasses any kind of high-tech cluster such as: technopolis, science park, science city, cyber park, hi tech (industrial) park, innovation centre, R&D park, university research park, research and technology park, science and technology park, science city, science town, technology park, technology incubator, technology park, technopark, technopole and technology business incubator.

United Kingdom SP Association (UKSPA) describes the term "Science Park" as (Lecluyse et al., 2018):

A "business support and technology transfer initiative that: (1) encourages and supports the start-up and incubation of innovation-led, high-growth, knowledge-based businesses; (2) provides an environment where larger and international businesses can develop specific and close interactions with a particular center of knowledge creation for their mutual benefit; (3) has formal and operational links with centers of knowledge creation such as universities, higher education institutes and research organizations"   (UKSPA, 2017).

The American Association of University Research Parks (AURP) gives a definition of university Science Park as:

A property-based venture, which: master plans property designed for research and commercialization; creates partnerships with universities and research institutions; encourages the growth of new companies; translates technology; and drives technology-led economic development.

International Association of Science Parks and Areas of Innovation (IASP) also gave a definition of Science Park, which is described as:

A Science Park is an organization managed by specialized professionals, whose main aim is to increase the wealth of its community by promoting the culture of innovation and the competitiveness of its associated businesses and knowledge-based institutions. To enable these goals to be met, a Science Park: stimulates and manages the flow of knowledge and technology amongst universities, R&D institutions, companies and markets; facilitates the creation and growth of innovation-based companies through incubation and spin-off processes; and provides other value-added services together with high quality space and facilities.

The common interpretations of those definitions are 1) knowledge-based and innovation-led, 2) require interaction and cooperation between actors to create and stimulate innovation, 3) aim to transfer research to commercialization. In conclusion, a "Science Park" is a localized innovation ecosystem that takes advantages of each actor's resources to transfer research to commercialization for their mutual benefits.

2.3.   Innovation network building and governance

Network building is essential in the innovation creation and stimulation process. Networks consist of nodes, connection and intensity of transfers of resources (Lambooy, 2004). It means that networks can be utilized as a tool to deal with the multi-actors process, such as the innovation creation and stimulation process. Actually, there has been a shift from the single-actor, rational-analytic manner of policy making to a multi-actor process-oriented way, and it is also called the shift from government to governance (Hajer and Wagenaar, 2003). The word governance focuses on a high level of cooperation during the processes of governing, decision making and policy making (Van Bueren, et al., 2003). Networks are considered as a prominent role of governance. A network can be defined as variety actors with variety goals, interests and resources depend on each other for realizing their goals (De Bruijn and Ten Heuvelhof, 2018). According to De Bruijn, and Ten Heuvelhof, the characteristics of a network are variety, mutual dependencies, closeness to

hierarchical signals and dynamic (De Bruijn, and Ten Heuvelhof, 2018).

Therefore, there are two main tasks for the innovation development of a science park. The first task is building innovation networks in order to take advantage of all resources of actors to stimulate the interaction and cooperation between innovative actors. Nodes of innovation networks are several actors who are involved in the innovation process, and their connections consist of physical connections and relational connections. In addition to the innovation network building, another task is the governance of these networks. The innovation processes are complicated and dynamic, so the governance can help to stimulate the problems solving processes and promote the opportunities of interaction and cooperation for actors in different innovation networks and stimulate the resources flow as well.

In this section, the concepts of innovation network building and innovation network governance are described. In addition to the concept, the impact factors and aspects that should be considered are also illustrated.

2.3.1. Innovation network building

Innovation network building aims to develop an environment where actors can interact and cooperate with each other smoothly within the science park. Innovation network building requires 1) actors can be connected by social relationships or R&D connections; 2) actors recognise that they affect and are affected by other actors' behaviour; 3) there are various innovation related institutions and firms; 4) resources of on-park actors can be transferred organically (Parker, 2007; Chan et al., 2009). In order to meet these demands, there are several impact factors which can stimulate the innovation network building process. These factors are breadth, density and proximity.

Breadth and density

Breadth means the science park accommodates variety of firms and organizations with required resources. There are several important nodes should be involved in the innovation ecosystems of science parks. From the perspective of resources, the first node is knowledge producer, such as university, research institutes and several R&D companies. Secondly, human capital support is also important, and university always provides most of the talents in the university anchored science park. What is more, actors who have abilities to contribute to the built environment are essential because built environment affects the accessibility, mobility and quality of life. Financial capital is another important resource, and in a university anchored science park, financial is always supported by the large investors and public funds. Lastly, during the development of the science park, regulation and policy always have impacts as well. From the perspective of firm size, breadth means firms from start-ups to large corporates. The start-up is defined as *"an organization formed to search for a repeatable and scalable business model"* (Blank, 2010). With the development of start-ups, they become to the scale-ups which have higher market validated business model (Lyu, 2019). From the functional perspective, companies are better to cover full range of supply chain. In addition, some public-private partnerships are also needed which work as interfaces between public and private sectors in order to stimulate the interaction between them.

Density refers to the real estate development of the science park. High real estate development level makes the science park more vibrant and can also provide more working spaces for the new tenants. However, it does not mean the higher density is better. The living comfort and functional real estate development should also be considered. ***Table2.2*** provides overview criteria of breadth and density of the innovation network building.

Table 2. 2 Overview of criteria of breadth and density

Factors	Criteria
Breadth	Actors with several resources (Knowledge, financial capital, human capital, built environment and regulation).
	All sizes of firms.
	Variety of firms and organizations covering full range of supply chain and providing interfaces for triple helices.
Density	Real estate development condition.

Proximity

Network theory has been integrated into the proximity framework and the proximity framework can benefit the development of networks (Balland, 2012). Proximity is kinds of closeness between actors and the closeness benefits the development and adoption of innovation (Knoben and Oerlemans, 2006). Boschma (2005) proposed five proximity dimensions, cognitive proximity, social proximity, institutional proximity, organizational proximity and geographical proximity. Then, Balland, Boschma and Frenken extend this framework to include the co-evolutionary dynamics between proximity and knowledge networks in the context of innovation (Balland et al., 2015). Correspondingly, five co-evolution processes were proposed, learning, decoupling, institutionalization, integration and agglomeration (Balland et al., 2015). In addition to the framework proposed by Boschma, Knobe and Oerlemans (2006) also proposed three types of proximity, and they are geographical proximity, technical proximity and organizational proximity. This research uses the combination of dynamic proximity framework developed by Balland et at. and the framework proposed by Knobe and Oerlemans, and discern four main proximity dimensions. They are geographical proximity, cognitive proximity, social proximity and organizational proximity.

Cognitive proximity is defined as the extent to which two actors share the same knowledge (Nooteboom, 1999). Actually, knowledge is created and transferred among different organizations and this process requires the diverse combination and complementary capabilities of heterogeneous agents within and between organizations (Nooteboom, 2000). There are always existing knowledge gap between organizations when the ideas or results of an innovation proposed. Therefore, cognitive proximity is required for enhancing the absorb capability of new knowledge. The learning and sharing knowledge processes are not only stimulate knowledge creation and interpretation, but also provide a better communication environment (Boschma, 2005). However, it does not mean that much more cognitive proximity is better because innovation requires dissimilar, complementary bodies of knowledge, and cognitive proximity may lead to lock-in effect for the reason that routines may obscure the views of organizations on new knowledge and new markets possibilities (Boschma, 2005). What is more, competitors are unwilling to share the information which may increase their own

risks (Cantwell and Santangelo, 2002). In conclusion, an appropriate cognitive proximity enables better communication among each actor and more efficient learning process. A certain extent of cognitive proximity between competitors can also stimulate innovation by promote the competitiveness.

Social proximity focuses on the socially embedded relations between actors (Boschma, 2005). These relations based on the trust and this kind of proximity enables more exchanges of tacit knowledge (Maskell and Malmberg, 1999). Social proximity provides an environment where actors are willing to share their information based on the mutual trust, thus benefiting the interactive learning process and innovation creation and stimulation. However, too much social proximity may lead to lock-in and an underestimated risk of opportunism, thus impacting interactive learning negatively due to overload trust (Boschma, 2005). These kind of personal relations are generated from past experience and common goals in the future, which will glue the actors together based on the trust and friendship (Balland et al., 2014). Therefore, certain level of social proximity can stimulate innovation creation and stimulation through the high willingness of cooperation and interaction.

Geographical proximity mainly refers to the physical distance between the actors or the spatial vicinity of actors' physical location (Balland et al., 2014). Short distances enable people gather much easier and more frequency. It also provides the face-to-face opportunities for actors to communicate with each other. Localized indeed closeness facilitates the exchanges of information and tacit knowledge and face-to-face communication increases the reliability. The knowledge–intensive organizations are always driven by the opportunities for knowledge networking at the local level (Knoben, 2011). From the perspective of science parks, agglomeration not only provides the geographical proximity, but also gives the on-park companies reputation (Lecluyse et al., 2019). Therefore, it stimulates both innovation creation and financial capital flows. Moreover, in the society of today, not only physical geographical proximity makes sense, but the internet proximity can also facilitate the information sharing and knowledge learning, more effective but less reliable. The developments of localized knowledge networks can optimized the knowledge creation and transfer processes and also increase attractiveness of financial capital.

Organizational proximity is defined as the extent to which relations are shared in an organizational arrangement, either within or between organizations (Boschma, 2005). According to Boschma (2005), organizational proximity is reflected in a hierarchical governance structure, and this can ensure the ownership rights, such as intellectual property and sufficient rewards for the investments in new technology (Boschma, 2005). Although too much organizational proximity can reduce the flexibility and lead to bureaucracy, no organizational proximity can also impede the innovation creation and stimulation process because of the uncertainty and opportunism. Actually, the process of innovation creation is an organic process which does not need too much control. But a loose organizational proximity will guarantee the process develop more healthy.

Sometimes proximity is emerged spontaneously, but governance is still needed to make sure the types and strength of proximity are appropriate. *Table 2.3* describes

each dimension of proximity.

Table 2. 3 Overview of the description of proximity

Linkage strength	Type	Description
Proximity	Cognitive proximity	Similar knowledge base between different innovative actors.
	Socail proximity	Accessibility to other parties through social activities.
	Organizitional proximity	Cooperate with others under a hierarchical structure.
	Geographical proximity	Physical distance to the important partners.

2.3.2. Innovation network governance

The concept of governance appeared in the 1980s, which refers to the governing processes undertaken by a government or network, whether over a tribe, family, informal or formal organizations, and through norms, language or laws (Bevir, 2012). Governance focuses more on social practices and activities rather than the state and institutions (Bevir, 2012). There are more diverse actors and organizational forms involved in the governing processes. There has been a shift from government to governance, which is often associated with the declining power from direct government control to more indirect control via diverse actors (Tallon, 2013).

Nowadays, the top-down control mechanisms are always not so useful because there are more and more interaction and cooperation among different actors to achieve collective goals. Network governance as a form of governance must play a role in steering, setting direction and influencing behaviors (Parker, 2007). Networks always requires some extent of interactions among participants and the network governance focuses on the allocating resources and coordinating actors' behaviors across the network as a whole (Provan and Kenis, 2008). It is the process of involving multi-stakeholder and resolving multiple interests and of negotiation and compromise rather than hierarchy and confrontation (Tallon, 2013).

Therefore, innovation network governance is needed to *1) negotiation and coordination in the innovation development; 2) steer actors' behaviour to achieve collective goals; 3) involving all related actors in decision making process 4) facilitating innovative resources matching and allocating processes*. Innovation network governance can be seen as a measure to integrate the development of each separate actors and the development of science parks and facilitate the interactions and resources matching and allocation processes. Actually, there are several levels of governance from the science park level to regional and state level during the innovation development of a science park. The development of the science park is always in line with the local, regional and national development visions. The university, municipality and firms work together to set the goals of the science park development and steer the development directions of the science park through the policies, norms and other interventions. There are also several agencies which substitute the government to involve in the development of the science park, such as InnovationQuarter which is a regional economic development agency for the

Province of Zuid-Holland.

The innovation development processes are dynamic and sometimes accidental. Related stakeholders should be involved continuously and their resources are flowing under their coordination and negotiation. Then, there are three main aspects of the innovation network governance to make sure the governance is continuous and efficient during the changings. The first aspect is stakeholder involvement. The second aspect is resources matching and resources allocation. The last aspect is influences on decision making processes.

Stakeholder involvement
In order to achieve the development goals of university and local and regional goals, more stakeholders with important resources should be involved because most goals cannot be achieved in isolation. The stakeholder involvement processes also needs joint-effort of existed actors. According to the interests and demands of the development goals, actors negotiate and coordinate with each other to decide who are welcome to join in the network and who are not welcome. Then, some strategies, such as offer some resources or set a broaden goals etc., will be used for engaging new powerful stakeholders in order to achieve the collective goals.

The development of university anchored science parks is always in line with the goals of local and regional development and also the visions of the university. Therefore, university, municipality and firms work together with each other in several levels to decide and facilitate the stakeholder involvement processes. On park development level, the stakeholder should be involved based on the visions of park development and demands of on-park actors. Above the science park, the city also has a development vision. Therefore, municipality of the city always participates in the park development and helps to engage more powerful stakeholders who have impact on both park and city development. Industry can also influence the stakeholder involvement process and help to facilitate the involvement of new actors under the negotiation and coordination with other stakeholders.

Innovative resources matching and allocating works
As table 3.1 shows, there are five elements of innovation ecosystem establishment. In order to build a vibrant innovation ecosystem, these resources are required to be used efficiently. Therefore, resources matching works and allocating works are important for the innovation development of a science park and also for the city development. Networks are always established based on complementary resources. Good innovation network governance always stimulates the resources matching and allocation processes. On park development level, the park manager and on-park actors should learn about what each other is doing and whether there is a chance to cooperate others in certain research area. For example, a database about the topics of each actor can be established and updated regularly. In addition, during the innovation development of on-park actors, the external resources and regional and national support are also important. With the ambitions of city development, triple helices interact in several levels to match the resources, thus facilitating the resources flow among the actors.

Resources matching and allocation works aim to facilitate the resources flow

among the actors and stimulate the innovation development. On the park level, strategies can increase the connections between diverse actors should be used, such as formal and informal R&D activities. Informal R&D activities are organized by to provide more opportunities for on-park actors to interact with each other on certain R&D topics. Informal activities mainly work as social events and in order to stimulate the communication and interaction between actors who are interested in similar topics. Formal R&D activities aim to set goals among actors, who are willing to participate in certain joint-research or other R&D development programs. These activities are organized by board of the science park based on the resources matching works. Sometimes there are also regional or national government-led research programs. There should be some steers on the on-park actors to cooperate with others based on their same goals. Science parks as part of the city and nation also contribute to the city development. Triple helices do not only interact within the science park, and on-park actors also have the ambitions on the local, regional, nation and even international development. Therefore, the interfaces between triple helices are important for them to interact with each other and share their resources. Interfaces means the platforms for the interaction of triple helices, such as incubators, collaboration center and so forth. On the park level, these interfaces provide opportunities for on-park actors to gather together and contribute to the innovation development based on each one's resources. Beyond the park level, the interfaces attract regional and national government and companies to participate in the science park innovation development. In addition to the platforms within the science park, the science park itself can be seen as the interface for external actors. Triple helices above the science park also connect with the science park or the platforms within the science park to achieve their collective goals.

Decision making

In order to make better decisions, the voices of all actors should be heard. Governance can be seen as a process of decision making and ruling throughout all related actors (Bevir, 2012). Networks are always established serendipitously and can be seen as a mechanism of coordination (Provan and Kenis, 2008). The purpose of building networks is to share resources and achieve collective goals. Innovation network governance requires coordination and negotiation between all parties to stimulate the network building processes. Therefore, the prerequisite is that the voices of all actors can be heard. There are several governance strategies, such as regular meetings or other feedback mechanisms, to make sure the networks are under control dynamically. In addition to the on-park actors, the innovation network governance is under several levels. Regional and national government and agencies also participate in the innovation network governance. They support the science park development through the policies and financial supports according to the regional and national development vision and national technology demands. Their voices and behaviors are also essential for the innovative development of the science park.

Actually, the decision making processes are influenced on several levels. On park level, university, municipality and firms collaborate with each other to make decisions on the innovation development of the science park and coordinate with each other for the resources using. However, the science park as a knowledge economy development strategy of city and region, the decision making processes are always influenced by the external actors. In the same way that on-park actors

should develop synergistically with the park, the park should also develop synergistically with the city.

In conclusion, the performance of innovation network governance of a science park can be assessed on these aspects: *1) whether the stakeholder involvement processes are facilitated; 2) whether there are resources matching and allocation work done; 3) whether related stakeholders are involved in the decision making processes and influenced by the decisions.*

2.4. Four dimensions of innovation network building and governance

In order to contribute to the impact factors of innovation network building and governance, university, municipality and firms should work together in four main dimensions. They are Lands & Real Estate dimension, Brand & Community Building dimension, R&D Development dimension and Board Level. These four dimensions interwove with each other and support each other to build a better environment for innovation network building and governance.

2.4.1. Lands & Real Estate dimension

Lands refer to the land ownerships. Land ownership is the prerequisite of the real estate development. Actors with the land ownership always have the strongest power in the real estate development of the science park. What is more, there would be some changes of land ownership in order to stimulate the development of the science park.

Real estate development is the foundation of the innovation development of the science park. Actually, real estate development mainly refers to the built environment of the science park. There are three main roles of the real estate development in a science park. The basic role of real estate development is supporting the park users as working or living places. The second role of real estate development is proving diverse urban amenities, such as central public facilities, restaurants etc., which facilitate the interaction between the actors. The third role is helping to attract more human capital or companies to locate on the park because of the vitality and high quality of life.

It can be concluded that lands & real estate dimension can help to contribute to the breadth and density of the science park and also the geographical proximity and social proximity between on-park actors.

2.4.2. Brand & Community Building dimension

Brand is very essential for the development of the science park. Only a science park with strong brand, there will be more and more powerful companies or organizations and human capitals are willing to come. What is more, a strong brand can also help on-park actors to attract public or private investment which can stimulate the innovation processes. Another impact of strong brand is making a common sense among on-park actors which helps to contribute to the organizational proximity.

With the development of the science park, more and more innovative actors will

come to locate on the park. Therefore, community building is important for developing social relationships between on-park actors and promoting their knowledge and information exchange chances in daily life. Because of the social connections between the actors, their mutual trust can be promoted. Due to the more trust between each other, they are willing to share their knowledge and cooperate with each other.

Therefore, brand & community building can contribute to the breadth of the science park and social proximity and cognitive proximity between on-park actors.

2.4.3. R&D Development dimension

R&D development dimension refers to the knowledge creation and transfer processes. The process of innovation needs the continuous ideas, knowledge transfer and new projects (Ferraris and Grieco, 2015). Ideas, knowledge and new projects always originated from market force, technical force, government force and staff creativity (Ya and Rui, 2006). Universities, research institutes and cooperation's R&D departments, here defined as U-R-C circle, act as the engine of innovation and transfer their knowledge to industry directly and indirectly. Initially, each actor in U-R-C circle has its own professional human capital and potential study fields. The research actors should be bound tightly by certain strategies, such as personal mobility, information shared and qualified built environment in regional level. People flow can introduce knowledge from one sphere to another, thus sparking the collaborative activities and promoting inter-organizational understanding (Etzkowitz and Zhou, 2007). There is no doubt that qualified built environment can active such communication and mobility. Apart from personal mobility, some result-oriented information also can be shared via internet or somewhere else. The information is designed to support innovative regions and may include government policies, funding sources; cutting edge research results from universities and their implications for new technologies and industries; collaboration needs from industry (Etzkowitz and Zhou, 2007).

Research results only have limited value without being transferred into utilization. Literatures show that there are two ways to transfer knowledge to industry, one way is cooperating with firms' R&D departments directly and following the order of marketing-technology-R&D-production-marketing; the other way is transferring knowledge with the help of supportive platforms, such as incubators and accelerators, and establishing spin-offs and start-ups to utilize knowledge (Etzkowitz and Zhou, 2007; Tanimoto, 2012). *Figure2.2* shows the knowledge flow in the innovation creation and utilization process.
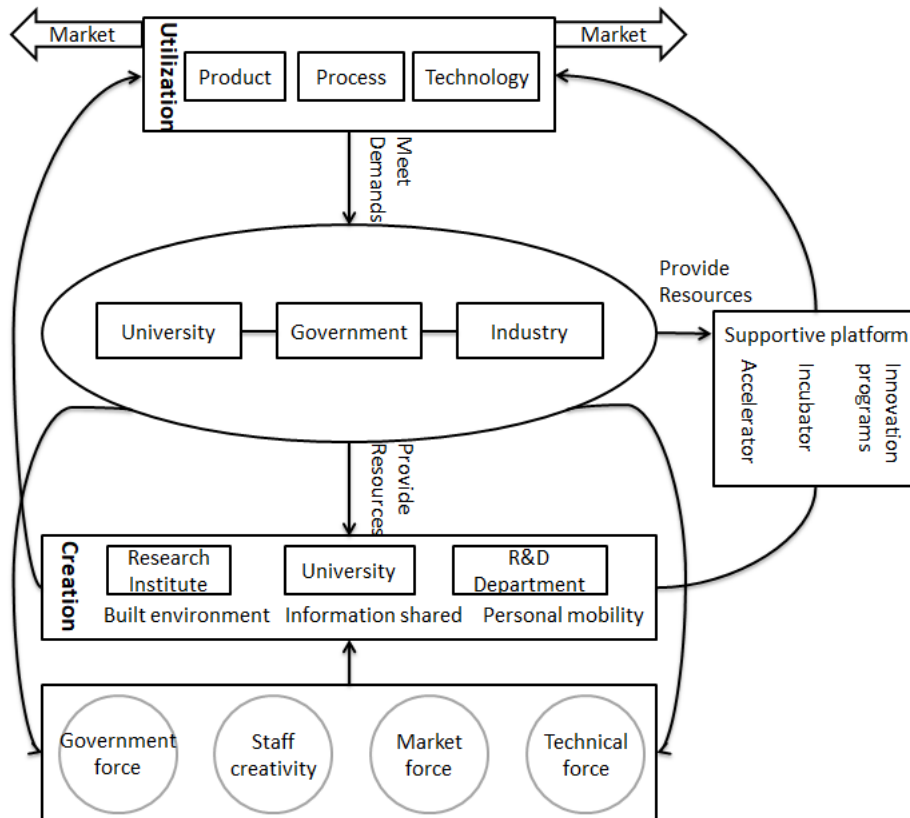
Figure 2. 1 Knowledge flow in the innovation creation and utilization

Therefore, the main tasks for triple helices in R&D development dimension are to create knowledge flow among on-park actors and contribute to the cognitive proximity between on-park actors. R&D development dimension requires the science park provide more opportunities for on-park actors to cooperate with each other in the knowledge creation and knowledge utilization. What is more, some innovative resources matching works also need to be done by the science park management team.

2.4.4. Board Level

Most of science parks have a management office taking responsibilities of the daily affairs of Science Park. Some of the offices belong to the university and some belong to the foundations. According to the literature, most of the university anchored science parks are managed by the university directly in the Netherlands. However, Leiden Bio Science Park is managed foundation which consists of six stakeholders. The board level is the highest level in the operate structure of a science park. Therefore, the composition of the board level can reflect the powerful decision makers in the decision making processes of science park development.

According to the literature, there are five university anchored science park in the Netherlands. *Table 2.4* shows the controller of each science park (Magdaniel, 2016).

Table 2. 4 Controllers of university anchored science park in the NL

Science Park	Controller
TUE Science Park	-Eindhoven University of Technology Real Estate Management

Drienerlo Campus University of Twente & Kennispark Twente	-University Twente
Science Park Amsterdam	-The Amsterdam Development Corporation, which is on behalf of the university of Amsterdam and the City
TU Delft Campus	-TU Delft Real Estate Development
Leiden Bio Science Park	-Leiden Bio Science Park Foundation

2.4.5. Conclusion

University, local government and industry should involve in the construction of these four dimensions because of the impact of these dimensions on the innovation network building and governance. Lands & real estate dimension can help to contribute to the breadth and density of the science park and also the geographical proximity and social proximity between on-park actors. Brand & community building can contribute to the breadth of the science park and social proximity and cognitive proximity between on-park actors. R&D development dimension requires the contribution to the cognitive proximity between on-park actors and the governance of the innovation networks and influence the stakeholder involvement and resources flow. Board level determines the decision-making structure of the science park. *Figure 2.2* describes the relations between four dimensions and the impact factors of innovation network building and governance.
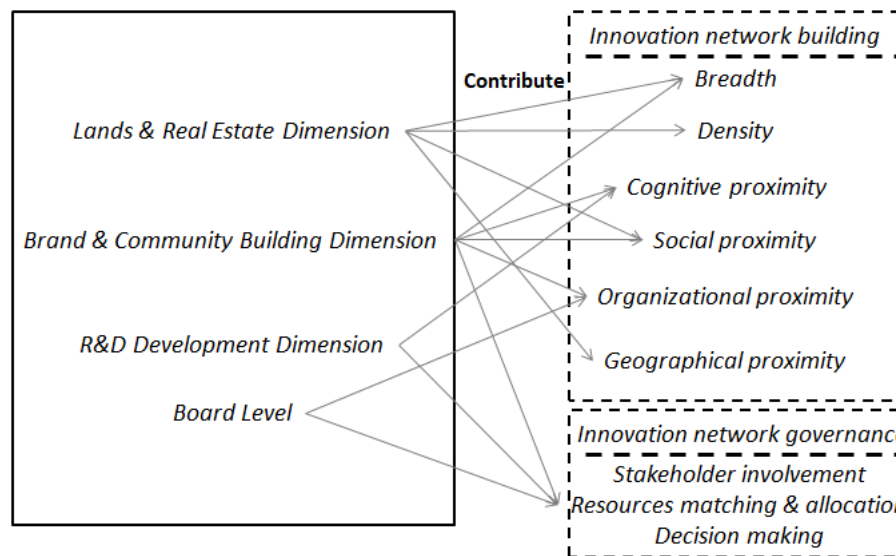
Figure 2. 2 Relations between four dimensions and impact factors of innovation network building and governance

2.5. Roles of university, municipality and industry in innovation network building and governance

The Silicon Valley innovation ecosystem is one of the most successful ecosystems in the world, triple helices is considered as the secret of Silicon Valley formation and development (Etzkowitz and Zhou, 2017). The triple helices systems are defined as a set of components, relationships and functions (Ranga and Etzkowitz, 2013), which is illustrated as *Figure 2.3*.
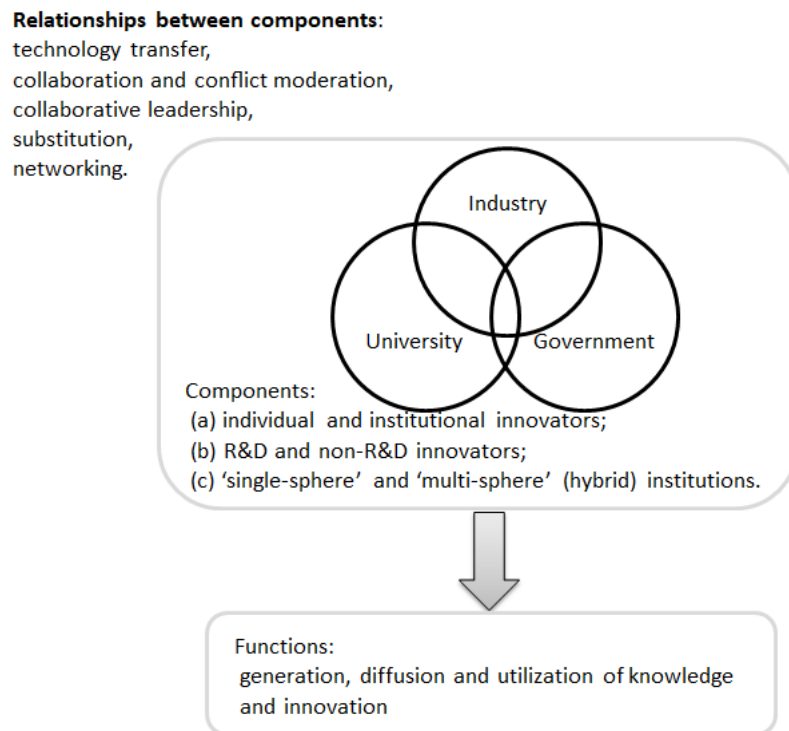
Figure 2. 3 The conceptual framework of Triple helices system (Ranga and Etzkowitz, 2013)

Actually, there are not only three actors in an ecosystem, and Carayannis and Campbell have proposed 'Quadruple Helix model' which added the fourth factor, "media-based and culture-based public" (Carayannis and Campbell, 2009). However, university, government and industry remain play main roles in the building, operating and stimulating process of an innovation ecosystem. It is because universities, government and industry have main power, resources and interests.

University always plays as knowledge producer, government always plays as policy maker and industry always plays as innovation tester and user. However, the innovation creation and stimulation processes are dynamic and the roles of university, municipality and industry are changing over time. The triple helices not only play single role and just provide their resources, they also take responsibility for managing connections between them in order to achieve mutual interests. Therefore, gaining insight of roles of university, municipality and industry play in the linkages building is meaningful for understanding the innovation networks development in science parks. Actually, the networks building processes are the resources matching process and collective goals achieving process. In order to benefit their mutual interests, triple helices need to create a qualified environment for them to share resources. Therefore, before investigating the roles of university, municipality and industry played in the innovation network building and governance, it is meaningful to learn about the resources of triple helices. After learning about the resources of triple helices, the roles of university, municipality and industry will be proposed in lands & real estate dimension, brand & community building dimension, R&D development dimension and board level.

2.5.1. Resources of university, government and industry

Resources of the university

The role of universities has evolved from mainly focusing on teaching and education to be a part of Triple helices. Nowadays, universities held various roles in the innovation districts development: they are centre of knowledge and innovation; they are roles as anchor institutions with vested interests in neighbourhoods; they are major employers and landholders and so forth (Ehlenz, 2018). In order to find what the roles universities play in the process of stimulating innovation in an innovation district, the resources they have should be invested first.

In the personal level, universities have qualified researchers and professional equipment. Taking advantage of the professional researchers and education in a university, many cutting-edge technology can be invented and lots of qualified workers can be produced (Wolters, 2010). In the building level, universities have buildings and space for students and researchers to communicate and do experiment. In the innovation ecosystem level, universities have leaderships, for example, the case of University of Twente shows that universities have power to establish a series of departments or schemes to stimulate innovation, such as a technology-transfer office, student entrepreneurship schemes, an open innovation centre and so forth (Benneworth, 2007). What is more, universities not only own original human capital, but also attract qualified researchers continuously, as well as the ability to attract financial investment (Murphy, 2011; Perry et al., 2009). Apart from those tangible resources, universities also have some intangible resources, such as reputation, stability. As an important node in the innovation ecosystem network, universities are considered as a network mobilizer (Magdaniel, 2012; Benneworth, 2007). The framework of universities' resources is illustrated as *Table 2.5*.

Table 2. 5 The framework of university's resources

Resources	Explanation
Knowledge	-Patents; -Innovation products & processes; -Lectures; -Creativity of staffs; -Innovation environment for scientists.
Human capital	-Researchers; -Officers; -Students; -Future entrepreneurs; -talented graduates.
Physical assets	-Lands; -Workplace; -High-tech equipment/ laboratory; -Infrastructure amenity.
Financial resources	-Attract subsides and investments; -Entrepreneurial activities; -Tutor fee
Networks	-Work experience with industry & government; -Co-patenting network; -R & D network; -Formal alliance; -Joint adventure

Others	-Reputation; -Policy; -Stability

Resources of the government

Government can be divided into several levels, such as national government, regional government and local government. Although this research focuses on the local government (municipality), some basic information of national government should also be studied. The national government always promote the ideas, in another words, ideas mean the technology or innovation development directions steered by the government (Benneworth, 2007). The national government will provide subsidies and policies to develop certain innovation areas. Actually, the government on state level only works on the surface level, while local government contributes more to the local innovation activities. The cases of Barcelona, Boston, Medellin and Singapore show that the mayor's office and the municipal departments are the primary instigators in deciding to create an innovation district (Morisson, 2015). Local government can provide lands, capital and regulation to stimulate local innovation activities (van der Veer, 2017). What is more, local infrastructure is wwwwdplanned and constructed by local government. Proximity, accessibility and availability are important factors to influence innovation activities occurrence. Although there are few people with qualified expertise in certain research area, they indeed have people with qualified management skill. It is helpful for the policies making and public-private alliances building. There are also some intangible resources, such as city branding and the reputation of local government. *Table 2.6* shows the framework of government's resources.

Table 2. 6 The framework of Government's resources

	Resources	**Explanation**
National level	Regulation	-Law systems; -Land use plan;
	Knowledge	-Research directions
	Financial capital	-Subsidies; -Public venture capital; -Funding.
Local government	Knowledge	-Long-term city strategy; -Policy for developing knowledge economy.
	Human capital	-Skilled managers; -Officers.
	Physical assets	-Lands; -Infrastructure
	Network	-Formal alliance; -Joint adventure; -Innovation programs.
	Regulation	-Regulatory plan; -Permits; -Public land use.

Resources of the industry

Industry is an important node in the innovation network. Literature show that top 500 Firms make 80% of R&D expenditures, 71% of the results of technological innovation; and 62% of technology transfer takes place among them (Etzkowitz and

Zhou, 2007). Corporations have platforms to utilisation innovation products and transfer the innovation to commercial values (Etzkowitz and Zhou, 2007; Sarpong et al., 2017). Those corporations who need innovation will also provide funding to develop innovation. Not only money, many firms also set up R&D department to stimulate innovation. Although corporations do not have so many expertise researchers they have many experienced businessmen and they are sensitive to the business environment. What is more, some big firms also have leadership, such as Huawei in China; they have ability to product high tech products and ability to active local economy. Therefore, local government acts in concert with their requirements and provides many benefits for Huawei. ***Table 2.7*** shows the framework of resources of industry.

Table 2. 7 The framework of Industry's resources

Resources	Explanation
Knowledge	-R & D departments; -Familiar with market demands
Human capital	-Researchers; -Skilled workers; -Experienced businessmen.
Physical assets	-Laboratory; -Specific equipment (Verify innovation or mass production); -Workplace.
Financial capital	-Venture capital; -Commercial lending; -Credit loan; -R&D investment.
Networks	-Work experience with university & government; -Own business network; -Co-patenting network; -R & D network; -Joint adventure; -Formal alliance.
Others	-Reputation; -Products.

2.5.2. Roles of university, municipality and industry in four dimensions

Due to limited research has been conducted for investigating the roles of university, government and industry played in the innovation network building and governance, this section mainly based on the resources of university, municipality and firms obtained from literature and their interests obtained from literature.

For universities, their primary interests in science parks are commercializing their research results, thus broadening their financial resources, and providing a larger labor market for researchers and students (Júnior et al., 2015; Benneworth, 2007; Geuna and Muscio, 2009). For local governments, they want to develop local economy and generate more jobs (Júnior et al., 2015). For industry, although there are many different categories of companies, the main interests of them are 1) improving R & D abilities; 2) accessing qualified human resources and research equipment; 3) enjoying the favorable policy; 4) earning money (Benneworth, 2007; Geuna and Muscio, 2009; Júnior et al., 2015). Understanding their interests can provide a better understanding on the reason why they want to involve in the

innovation network building and governance.

Considering the resources and interests of university, municipality and firms, the roles of university, municipality and firms played in the innovation network building and governance are described as following:

In lands & real estate dimension, university and municipality are the main land owners. They have power to sell or lease the lands to other parties. Although both university and municipality own the lands, the main land owner of a university anchored science park is university. Based on the *The Spatial Planning Act* of the Netherlands, municipality also has legislative power in the special planning and gives permits to the new construction. Industry mainly plays its roles as the real estate developer and investor.

In brand & community building dimension, university and municipality are the main initiators of a university anchored science park. Therefore, they always play their roles as brand designer and brand developer at the early stage. With the development of the science park, the reputation of some successful companies or organizations will have an impact on the brand. For community building, university plays main roles in the community building and organizing several events. In addition, municipality also works together with university to build higher quality of life on the science park, such as urban amenities. On-park firms are the users of the park and some of them are also willing to provide their facilities for the community.

In R&D development, university, government and industry work interactively to stimulate the innovation creation and innovation utilization. University, government and industry work in isolation or jointly to establish the research organizations, such as big research institutes, different faculties or labs in the university and R&D departments in the firms. The triple helices also establish the supportive platforms, such accelerators, incubators and innovation programs interactively in order to stimulate the innovation utilization process. Knowledge creating and transfer can be illustrated in three phases. Firstly, knowledge is created based on the staff creativity and the interests of government, industry and university, which can be described as government force, market force and technical force to the knowledge creation. Then, the knowledge is transferred to the utilization phases directly or indirectly through supportive platforms. Finally, it could be regarded as a successful innovation process if the outputs meet the demands of the scope of university, government and industry. Actually, some goals of each actors cannot be achieved only though the resources of themselves and there are also some conflicts between each actors.

On the board level, most of university anchored science parks are managed by the university and municipality. Only Leiden Bio Science Park is an exception, which is managed by the foundation. The foundation consists of the representatives of university, municipality and on-park firms Therefore, in most cases, universities play the roles as decision maker and municipality is the strongest influencer. In LBSP, all parties are involved in the decision making process.

Table 2. 8 Overview of roles of university, municipality and firms played in innovation network building and governance

Lands &	Brand &	R&D	Board

	Real Estate	**Community**	**Development**	**Level**
University	-Lands owner; -Investor	-Brand designer; -Brand developer -Community builder; -Facilities supporter	-Knowledge producer; -Talents supporter; -Initiator of innovative public-private partnerships; -Technical facilities supporter; -Funds attractor	-Manager
Municipality	-Policy supporter; -Land owner; -Investor	-Brand co-designer; -Brand developer; -Living environment co-builder	-Investor; -Initiator of innovative platforms;	-Influencer
Industry	-Investor; -Developer	-Facilities supporter; -Brand developer; -Community user.	-Facilities supporter; -Investor; -Driver of innovation networks according to companies' demands. -Knowledge producer	-Park user

2.6. Conclusion

A reason why some of the on-park firms do not perform better than off-park firms as they should do in terms of interaction with other parties is the weak innovation network building and governance of the science park. This chapter proposes the theoretical framework of how can university, municipality and industry play their roles in practical ways to contribute innovation network building and governance of the science park. In order to investigate how to promote the capability of network building and governance of a science park, several impact factors are captured based on the literature reviews at first. Breadth, density and proximity influence the network building of the science parks and stakeholder involvement, resources management and decision making process impact the governance of innovation networks. Then, four dimensions are proposed where university, municipality and firms work together to contribute to the innovation development of the science park. The four dimensions are Lands & Real Estate dimension, Brand and Community Building dimension, R&D Development dimension and Board Level. University, municipality and industry play their roles in these dimensions to promote the capability of innovation building and governance of the science park. *Figure 2.4* elaborates the theoretical frame work of the innovation network building and governance of the university anchored science parks.
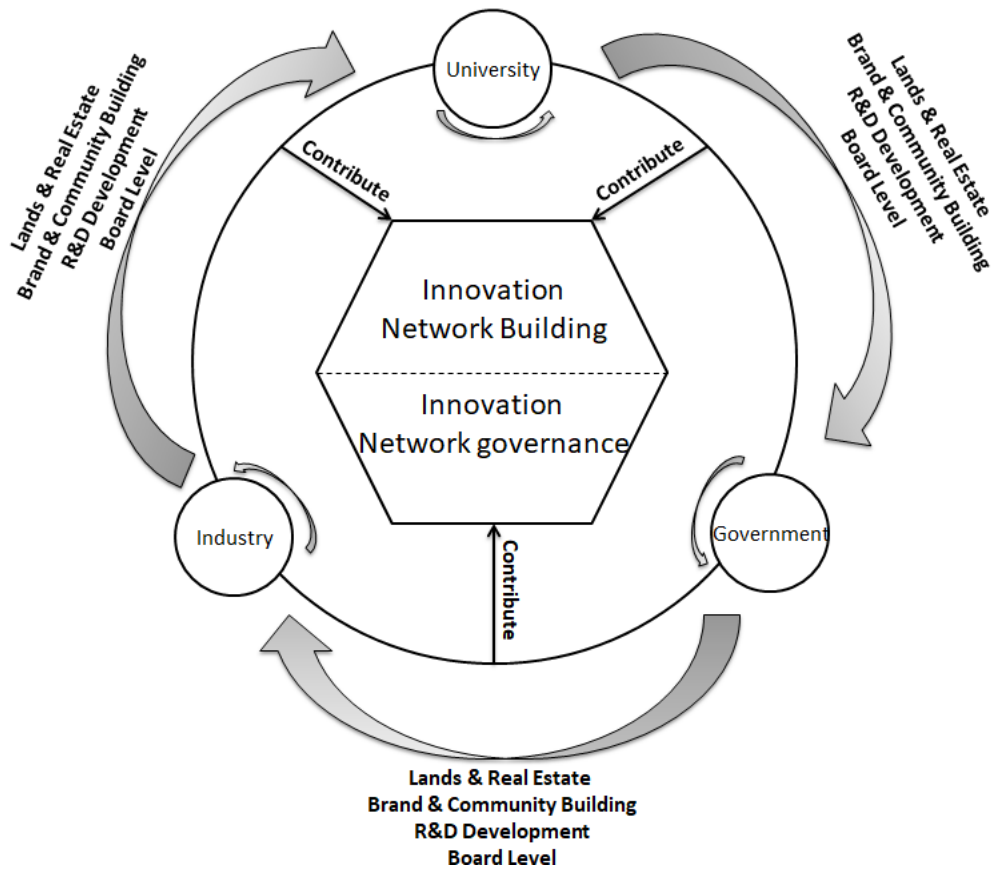
Figure 2. 4 Theoretical framework of innovation network building and governance

PART 3

METHODOLOGY

Chapter 3 Research Design and Methodology

3. Research design & methodology

In the previous chapter, the background of research, problem statement, research question and relevance have been discussed. This chapter illustrates the methods and strategies that will be used to investigate the roles of university, municipality and industry played in the innovation network building and governance.

The research objectives and sub-questions will be discussed at first, followed by the research design and research methods.

3.1. Research objectives

The objective of this research is to provide a theoretical debate on whether innovation network building and governance can influence innovative linkages building of on-park actors and build a conceptual framework of the roles of university, local government and industry played in the innovation network building and governance processes. The objective can be extended as sub-objectives step by step:

Building a theoretical frame work:
a. To understand the concept of innovation network building and governance;
b. To understand impact factors of the innovation network building and innovation network governance ;
c. To gain insight of how university, municipality and industry play their roles in the innovation network building and governance.

Theory testing; structuring the case analysis:
a. Evaluate the performance of two cases;
b. Test whether innovation network building and governance influence linkages building of on-park actors;
c. To provide advice on improvements of two cases.

In order to achieve the research goals, the whole research question is divided into two parts. The first part is building a theoretical framework based on the literature review. The extensive framework will show what roles the university, government and industry play in the innovation network building and innovation network governance. The other part is the case study part.

The main research strategies are shown as *Figure 3.1*.
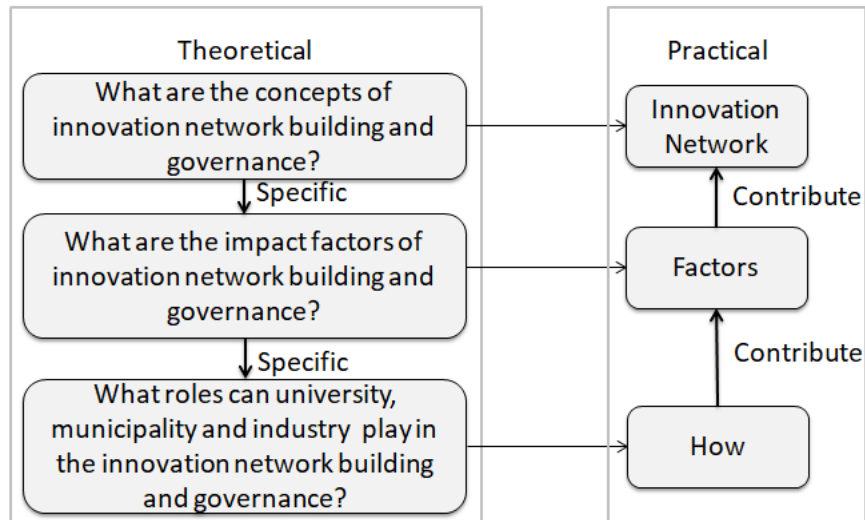
Figure 3. 1 The main research strategies

3.2. Research sub-questions

The research question is divided into 4 sub-questions in order to achieve the research objectives step by step. What is more, the purpose, method of data collection and expected outcomes are also given.

SQ1. *What are the innovation network building and innovation network governance?*
✓ Purpose: This question will help to provide an overview of the definitions of innovation network building and governance, including the features of each one.
✓ Data collection: Literature review.
✓ Expected outcomes: Provide the clear features of innovation network building and governance.

SQ2. *What are the impact factors of innovation network building and governance?*
✓ Purpose: This question will give an insight view of how to contribute to the innovation network building and governance.
✓ Data collection: Literature review and interview with the officers, mangers of university, government and enterprises.
✓ Expected outcomes: List the impact factors of innovation network building and governance.

SQ3. *What roles can university, municipality and industry play in the innovation network building and governance?*
✓ Purpose: This question can help to gain insight of how university, municipality and industry use their resources to promote the capacities of innovation network building and governance.
✓ Data collection: Literature review and interview with the officers, mangers of university, government and enterprises.
✓ Expected: List the roles of university, municipality and industry play in the innovation network building and governance.

SQ4. *What are strength, weakness, opportunities and threats in innovation creation and stimulation network of TU Delft Campus and LBSP?*
- ✓ Purpose: This question will find the current interaction performance and potential development directions of TU Delft Campus and LBSP.
- ✓ Data collection: Literature review and interview with the officers, mangers of university, government and enterprises.
- ✓ Expected outcomes: Improve the conceptual framework and give advice on two cases.

3.3. Research design

This research will be largely been carried out via literature review and case study. Two well-networked universities, TU Delft and Leiden University, are selected. The methodology of this research is a qualitative research, which aims to fill the research gap on the innovation network building and governance of a science park and provide the conceptual framework of the roles played by university, municipality and industry, and reconcile a variety of evidence into a singular structure which can highlight the critical features of the case studies and verify the conceptual framework. Semi-structured interview will be used to get an insight of TU Delft Campus and LBSP. Firstly, large amount of literature will be reviewed to find the basic information about innovation network building and governance and what roles do university, government and enterprise played in the innovation creation and stimulation process. Therefore, the conceptual frameworks can be provided. Then, Semi-structured interview will be given to the related officers, managers and researchers. It can help to collect the data which is helpful for gain insight of how TU Delft Campus and LBSP perform. Finally, the conceptual framework will be verified and improved and some advice might be offered to the TU Delft Campus and LBSP on innovation network building and governance. The research design is presented in *Figure 3.2*.
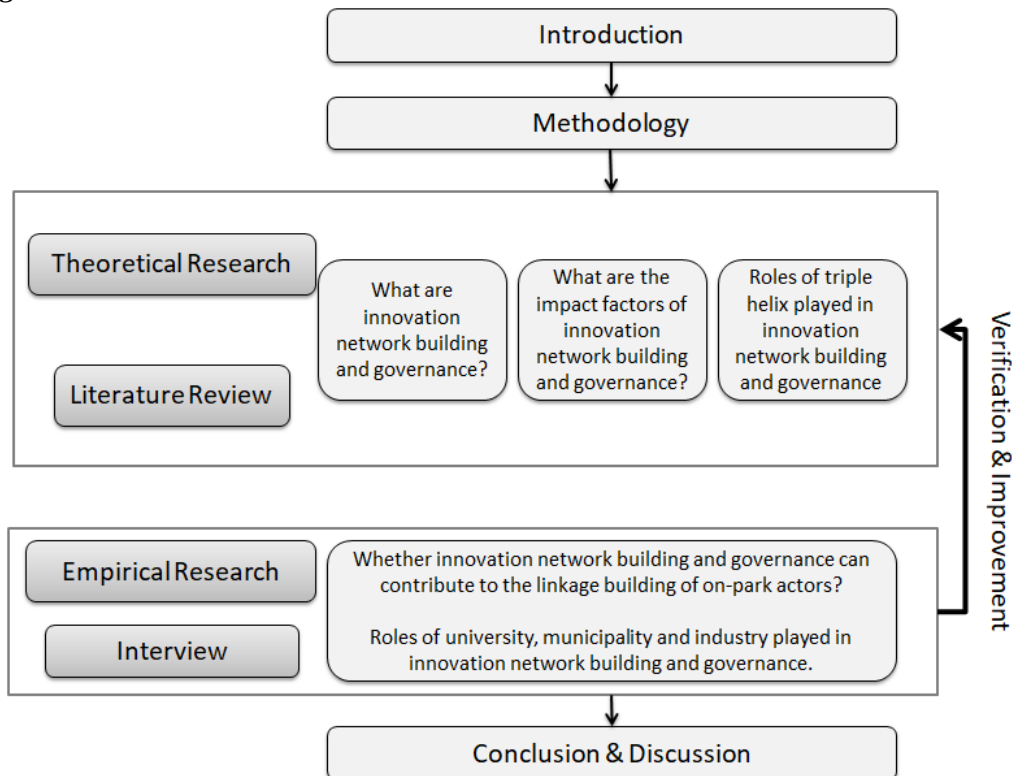
Figure 3. 2 The research design

3.4.   Research methods

Research methods are techniques used for collecting data (Bryman, 2012). In this research, literature review and semi-structured interview are used in order to achieve the research goals. The research methods will be described in the following paragraphs.

3.4.1. Literature review

Literature review aims to understand the problem and illustrate the command of research area and to justify the research topic (Hart, 2018). Reviewing literature helps to gain insight of the concepts, theories and methods used in the research topic and also the controversies of the research area ((Bryman, 2012). What is more, a literature review is a logical structured literature study rather than a simple summary, and it requires clear and organizational links between every part (Randolph, 2009).

The literature review of this research is concentrated on the roles government, universities and enterprises play in the innovation creation and stimulation network and their strategies to improve connections between on-park actors. What is more, the basic information of TU Delft Campus and LBSP is also obtained via literature review. The outcome of literature review can be input for the next empirical research constructed in the two cases. After analyzing, the strategies of building innovation networks and the conceptual framework of innovation creation and stimulation will be concluded.

3.4.2. Case study

A case study is a research method involving close and detailed examination of the research topic, so called case, and its associated contextual conditions. According to Eisenhardt & Graebner (2007), multiple case studies allow a wider discovering of theoretical evolution and research questions. When the suggestions are more intensely grounded in different empirical evidence, this type of case study can create a more convincing theory. Two cases selected in this research are TU Delft Campus and Leiden Bio Science Park. Literature (Gemeente Delft, 2011) shows Delft has weak cooperation atmosphere and communication lines between public parties, business and science community. Therefore, TU Delft Campus is selected due to the potential problems of weak linkages building. Leiden Bio Science Park is selected because of its high reputation. Therefore, some lessons might be learned. The comparison of two cases is shown as *table 3.1*.

Table 3. 1 Comparison of cases with criteria

	TU Delft Campus	**LBSP**
Type	University anchored science park	University anchored science park
Time	Started in 2005	Started in 1984
Initiator	TU Delft and municipality of Delft	Leiden University and municipality of Leiden
Specialized fields	High-tech development, including quantum, robotics	Bio-technology and life science

	etc.	
On-park actors	200 start-ups, 35 SMEs and 10 corporate partners	150 companies, 4 health care organizations, 11 research institutes, 11 educational institutes and 28 other organizations
Controllers	TU Delft Real Estate Development	LBSP foundation, including the representatives of university, government and on-park companies.

3.4.3. Semi-structured interviews

Semi-structured interview is most often used in the social sciences as a kind of research method. During the semi-structured interview, interviewers do not need to follow a strict formalized list of questions. There are often many open-ended questions and allowing for discussions, it is therefore always better than tape-record interviews which need to be lured down afterwards for analysis (Cohen & Crabtree, 2006).

In this research, the semi-structured interviews are conducted with local official, managers & related researchers in TU Delft Campus and LBSP. The interview aims to gain insight of how the university, local government and industry contribute to the innovation network building and governance and whether innovation network building and governance can contribute to the linkage building of on-park actors. The list of interviewees is shown as *table 3.2*.

Table 3. 2 List of interviewees

	TU Delft Campus		**LBSP**
Interviewee 1	Staff from Real Estate Development	**Interviewee 10**	Science park manager
Interviewee 2	Staff from Valorisation center	**Interviewee 11**	Staff of science park office
Interviewee 3	Field labs manager	**Interviewee 12**	Luris (TTO)
Interviewee 4	3M	**Interviewee 13**	Real Estate Department of Leiden University
Interviewee 5	Exact	**Interviewee 14**	Centre for Human Drug Research
Interviewee 6	Researcher	**Interviewee 15**	PLNT (pre-incubator)
Interviewee 7	Yes!Delft (incubator)	**Interviewee 16**	Municipality of Leiden
Interviewee 8	Brand manager		
Interviewee 9	Municipality of Delft		

3.4.4. SWOT analysis

SWOT Analysis is a strategic planning and management tool and aims to build organizational and competitive strategy effectively (Gürel and Tat, 2017). SWOT Analysis helps to find the internal and external factors that influence the current and future performance of the organization. In this research, the SWOT Analysis is

conducted to gain insight of the current performance of TU Delft Campus and LBSP on the four dimensions and what can be done by university, municipality and industry in the future to improve the four dimensions in order to promote the capabilities of innovation network building and network governance of the science parks. In addition, the results of SWOT Analysis can also give lessons to other university anchored science park because there might be some similar challenges or problems during the innovation development of other science parks or there might be some strength can be imitated by other parks.

The SWOT Analysis of this research is conducted based on the performance of each park on Lands & Real Estate dimension, Brand & Community Building dimension, R&D Development dimension and Board Level. Besides learning about how the university, municipality and industry play their roles on the four dimensions, some advice will be offered for the future development of two science parks. *Figure 3.3* shows the conduction of SWOT Analysis.
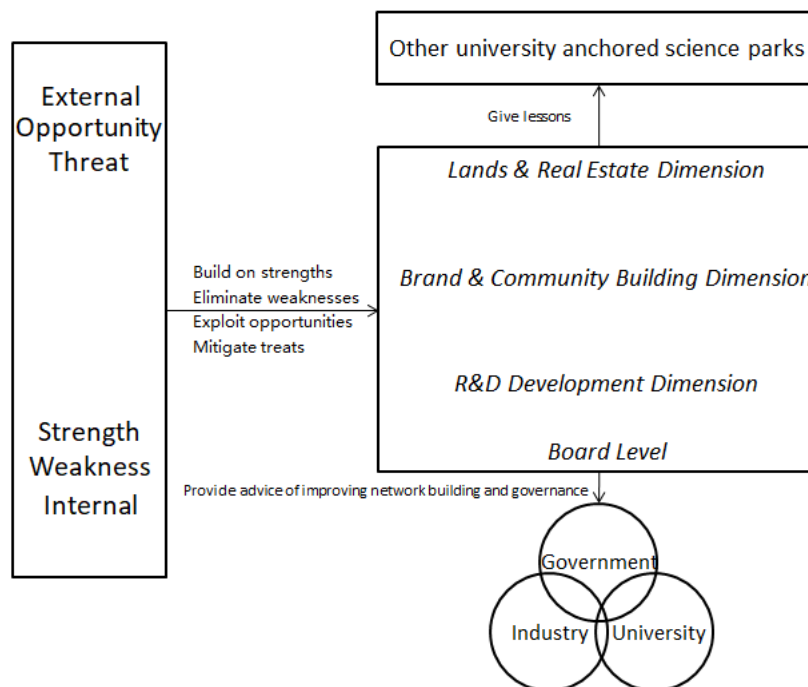
Figure 3. 3 SWOT Analysis

PART 4

EMPIRICAL RESEARCH

Chapter 4 TU Delft Campus

4. TU Delft Campus

In the previous chapter, related literature has been examined to gain insight the roles of university, municipality and industry played in innovation networks building and governance. In this chapter, the field work is conducted in TU Campus to gain insight of the performance of each helix. The empirical research is conducted in the form of semi-structured interview, including science park managers, on-park company managers and key persons at the universities and municipalities. The empirical research findings are compared to the theoretical results, and advice will be offered based on the results of empirical research.

The structure of this chapter is as following, an overview description of TU Delft Campus is introduced at first. Then, the performances of innovation network building and network governance are illustrated based on the interview of representatives of the three helices and the theoretical framework. After that, a SWOT analysis is conducted based on the feedbacks of the interviewees the advices to the Science Park are offered following the SWOT analysis.

4.1. Case description

Delft is a medium-sized city in the Netherlands, which lies between two large cities, The Hague and Rotterdam. In order to adapt the long-term and complex urban challenges, such as education, healthcare, climate change, energy supply and so forth, Delft city council proposed the perception of Smart City Delft as an approach to ensure the city ready for the future development. Knowledge economy plays an important role in the Smart City development, and now City of Delft is considered as a knowledge-based city due to its academic institutes and knowledge-intensive companies. Therefore, the vision of developing knowledge economy was proposed by the city council. The city council has shifted from incidental investment to structural investment in the knowledge economy and they want to create jobs take advantages of knowledge economy. TU Delft, as one of the top university in Netherlands, plays an important role in the knowledge economy development of Delft.

TU Delft was founded in 1842 as a Royal Academy and located in the inner city. In 1861-1865, the school gradually moved to the TU Delft district and broadened its vision as a new Poly-tech school. TU Delft was publicly funded by the Netherlands government until 1995 when the ownership of this polytechnic was transferred by law to the institution. Technopolis Delft and campus Delft has become the largest knowledge cluster in Delft, which is known as part of Technological Innovation Campus Delft (TIC Delft) networks, and now the Technopolis and Campus are called as TU Delft Campus as the whole. TU Delft Campus is developed by the collaboration of municipality of Delft and TU Delft, which aims to stimulate university-industry interaction (Den Heijer, 2011).

The Master Plan 1.0 of TIC Delft was proposed by the municipality of Delft and developed together with TU Delft. This master plan aimed to create optimal conditions for the growth of the knowledge economy in Delft and make a substantial

contribution to stimulate the innovation power of region Rotterdam-Delft-Leiden. TU Delft Campus as the most important nodes of TIC networks locates in the southeast of city centre. With the area of 161 hectares and owned by TU Delft, there are more than 250 companies and organizations locate on TU Delft Campus, varying from start-ups to the international head offices (Source: Official website). There is a clear division between Campus North and Campus South, and the majority of the firms are located in Campus South (Interviewee 6, 2020). The map of TU Delft Campus is shown as *figure 4.1*. The Science Park focuses on high-tech innovation, such as robotics, optics and so forth. Home to TU Delft, the Science Park takes advantages of 8 faculties with 5200 staff, 25000 students and many facilities. TU Delft has also set up several PPP (public-private-partnership) programs to foster innovation and create opportunities for science that would not have existed otherwise (Source: Official website). Several innovative public private partnerships, such as RoboVally and Qutech headquarters lead the TU Delft Campus a unique position in the Netherlands.
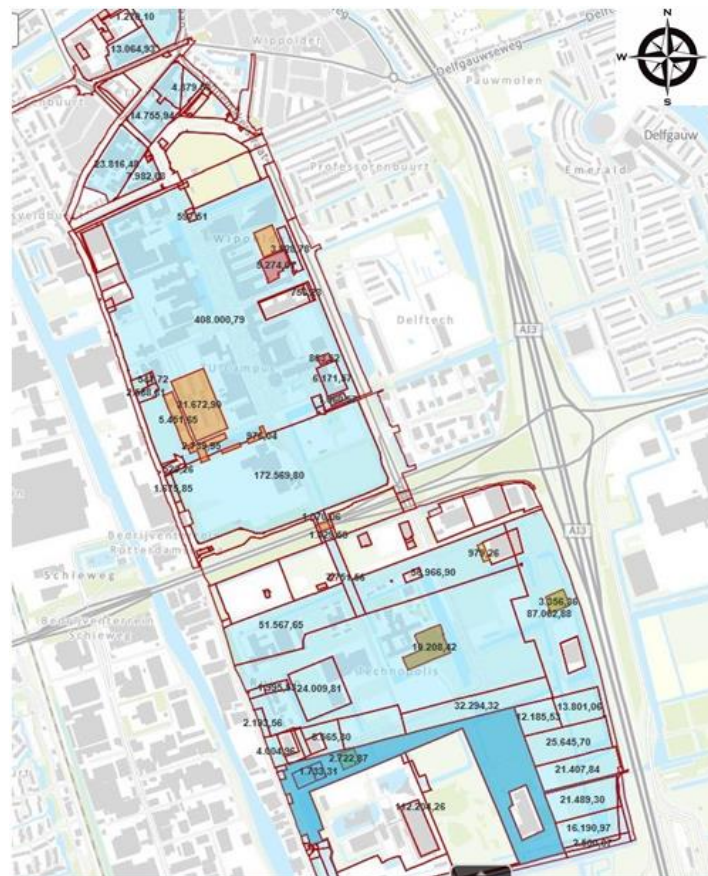
Figure 4. 1 TU Delft Campus

Development vision

Knowledge economy plays important roles in the Smart City development. TU Delft Campus plays its roles as the biggest partner in the new innovation, and municipality of Delft works together with Technology University in range of fields, such as quantum, robotics etc., which aims to stimulate local economy by developing high-tech industry (Interviewee 9, 2020). What is more, municipality of Delft also works together with Technology University in the digital infrastructure development, such as 5G, to contribute to the vision of Smart City Delft.

TU Campus labelled as a next-level innovation campus aims to develop radical and complex innovation and create a vibrant innovation ecosystem for the full range of high-tech firms, varying from SMEs to international head offices. From the municipality point of view, TU Delft Campus should play both local roles as the local innovation stimulator and regional roles as the regional knowledge economy centre, thus attracting more investment and jobs to Delft (Maarten, 2016). From the university point of view, TU Delft Campus aims to create knowledge spillovers between university, research institute and industry in order to facilitate the knowledge creation, knowledge transfer and knowledge commercialization.

TU Delft Campus mainly focuses on the development of high-tech industry, including robotics, quantum and nanotechnology, aerospace engineering and biotechnology. The Science Park offers several innovation ecosystems for start-ups and small business, such as the incubator Yes! Delft and also provides working spaces and even lands for new tenants to locate on the Campus. The trend now for the TU Campus is *Growing Together*, which becomes the goal of TU Campus to build co-creation community. TU Delft works together with the municipality of Delft and Campus residents on the common goal: impact for a better society and a true Home of innovation.

Development stage

In 2004, the Dutch government announced that universities also were to fulfil the mission relating to the knowledge transfer in order to benefit society next to the education and research missions. This is also called valorisation. Therefore TU Delft launched valorisation programme and this laid the foundation of TU Delft valorisation profiles. In order to create a better environment for developing knowledge economy, Technopolis Innovation Park Delft was started in 2005 by TU Delft and municipality. At the same time, the PPP incubator Yes! Delft was established by TU Delft, TNO and the municipality. Yes! Delft is becoming one of the most famous incubators in Europe now. In 2012, Delft city council established TIC network, including TU Delft and 12 knowledge partners. It aims to bring them together to invest in Technology Campus Delft. The connections between university and municipality and also the industry have increased since then. In 2016, Technopolis was changed its name as TU Delft Campus, and Campus South and Campus North were integrated together. What is more, there are many PPP field labs have been established in recent 5 years. An overview of key events of TU Delft Campus is shown as *table 4.1*.

Table 4. 1 An overview of key events of TU Delft Campus

Year	Event
2004	Dutch government announced a third mission of university- role of valorisation.
2004	TU Delft launched valorisation programme
2005	Technopolis Innovation Park Delft was started by TU Delft and municipality.
2005	Yes! Delft (incubator) was established by TU Delft, TNO and municipality.
2012	Delft city council established TIC network
2013	The Faculty of Applied Sciences' move to the south of the campus

2015	RoboVally was established
2015-2020	8 field labs are established
2016	Brand TU Delft Campus was used

At the current stage, there are more than 200 companies locating on the Science Park and most of them are start-ups and SMEs. There are also several large companies locating on the Park, such as Applikon Biotechnology, VSL, Exact and 3M. The Science Park has developed greatly since years ago. The cooperation environment and communication lines between university, public and private sectors were weak as the TIC Master Plan 1 mentioned (Municipality of Delft, 2011). With the years developing, the connection between university and municipality increases. Nowadays TU Delft has regular meetings with municipality of Delft once a month to discuss the development of the Science Park.

Although the Science Park improves a lot, it still has not reached an advanced development stage due to the low density and no strong enough brand. There are large green fields on the south of Science Park which are waiting to be developed. Currently, TU Delft Campus is focusing on the real estate development, residents attracting and branding.

4.2. Innovation network building and governance

With the vision of building a vibrant innovation ecosystem where university and companies varying from start-ups to international head offices can be supported to grow together and to stimulate innovation, Technology University also focuses on the innovation network building and tries to optimise the governance. Based on the theoretical framework proposed previously, the performance and strategies of TU Delft Campus in terms of innovation network building and network governance are discussed.

4.2.1. Innovation network building

Based on the theoretical framework, there are two main factors affect innovation network building of the Science Park. The first one is breath and density which refer to the numbers of company and entrance criteria of Science Park. The second one is proximity, which includes cognitive proximity, social proximity, institutional proximity, organizational proximity and geographical proximity.

Density and Breadth
TU Delft Campus accommodates 245 companies, including 200 start-ups, 35 small and medium-sized enterprises (exclude start-ups) and 10 corporate players. Several large companies, incubators and research institute with strong innovation resources, such as 3M, ABB, Exact, Microsoft, Yes! Delft, TNO and so on, paly unique roles in the innovation development of the Science Park. TU Delft Campus The number of companies has increased from 219 to 245 in the last five years, and the number of jobs has increased from 11000 to 12000. The Science Park also has an ambition to reach the goals of 325 companies and 15000 jobs in the next five years. *Figure 4.2* shows the increase trends of companies and jobs from 2015 to 2025.
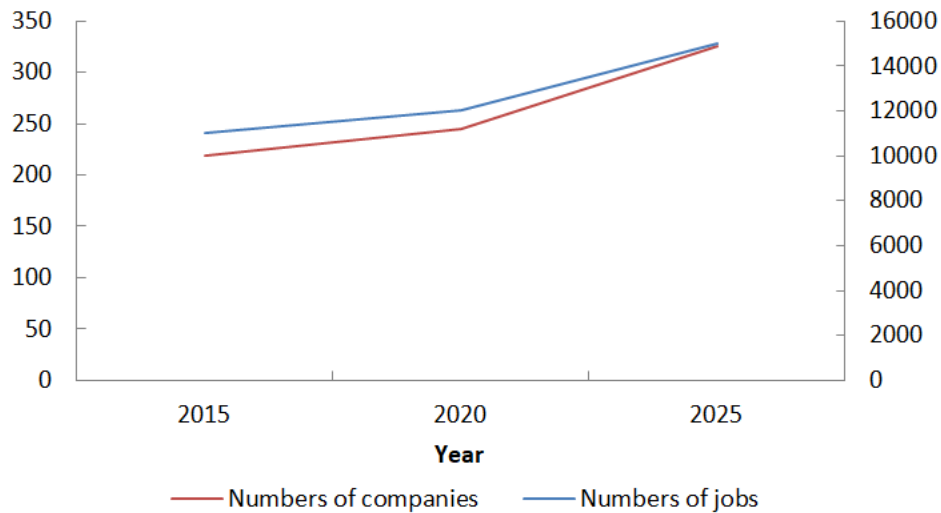
Figure 4. 2 Increase trends of companies and jobs

There is wide range of innovation institutions, including university, research institutes, high-tech companies varying from start-ups to large firms, locating on this Science Park. There are also several public-private-partnership interfaces, such as field labs, pre-incubators, incubators, for university, government and industry to interact in the innovation development.

However, the building capacity of TU Delft Campus is 500000 m^2, and the about 400000 m^2 of the total lands have not been used. Most of the unused lands locate on the Campus South. The Campus north is more crowded than the Campus South. It means that the density of Campus is still low for the Park development, especially the south of Campus. It seems that there are more than 200 companies locating on the Park, but around 200 companies are start-ups and mainly locate in the buildings of Yes! Delft, RoboVally and so forth. The Science Park is facing a real estate challenge which leads to the shortage of working place for new residents. TU Delft is working together with municipality of Delft and some investors to mitigating real estate weakness. ***Table 4.2*** shows some of the Science Park development from 2016 to 2019, and also the development plantings from 2020 to 2025.

Table 4. 2 An overview of the Science Park development from 2016-2020

2016-2019	2020-2025
-ABB: commercial building with research facilities	-Echo: energy neutral educational building TU Delft
-Holland Particle Therapy Centre: an innovative research and treatment centre for proton therapy	-ESP Lab: Electrical Sustainable Powerlab TU Delft
-Pulse: energy neutral educational building TU Delft	-Faculty of Applied Physics: new TU Delft faculty building
-RoboValley headquarters: the place for researchers and entrepreneurs to cooperate in the field of robotics	-Next!Delft: accelerator building
-Sports & Culture facilities: upgrade and expansion	-Oldelft: commercial building and research facilities
-YES!Delft Labs: a second YES!Delft building including offices and research labs	-Pavilion: restaurant on the southern part of the campus
-Faculty of Applied Sciences: new TU	-TNO MEC Lab: commercial building and research facilities
	-Quantum Delft: public-private innovation cluster

Delft faculty building

Proximity

It is not easy to describe proximity with mathematical data. Therefore, the descriptions of proximity are based on the interview results and are divided into four aspects.

Cognitive proximity

In order to build similar knowledge bases, TU Delft Campus has strict entrance criteria to ensure the companies are working on the similar research fields with university and other on-park firms. What is more, TU Delft also set up eight innovative public private field labs which can increase the knowledge sharing and promote the cognitive proximity between field lab users.

We want the companies fit for our brand and to assess what the companies do to impact our brand. You can imagine that if a company locates here and works on clear technology and impacts for a better society. It is beautiful. We want to relate to the companies who are working on the high technology, such as robotics, optics and so forth. What is more, we will assess whether the companies are already collaborating or potential to collaborate with the science theoretical design of university, field labs and start-ups (Interviewee 2, 2020).

We have several field labs which help to attract companies to work in a higher TRL (technology readiness level), because most of them are not willing to invest in the fundamental research, except some big firms, such as Microsoft. There are many organizations and companies collaborate and invest in the field labs to test and learn what happens. The field labs facilitate the innovative interaction between knowledge institutes and companies (Interviewee 2, 2020).

TU Delft Campus also accommodates Yes! Delft, one of the most successful incubators in Europe. Most tenants of Yes! Delft come from TU Delft and they have close connections with TU Delft in terms of R & D development. Tenants within Yes! Delft can also learn from each other due to the similar development fields and geographical closeness.

We have around 200 start-ups in Yes! Delft and 75%~80% of start-ups are from TU Delft. They have their personal connections with TU Delft, for example the graduates connect with their supervisors. We also have more than 30 industry partners working together to support innovation (Interviewee 7, 2020).

What is more, students are always connected with on-park firms. For example, 3M provide some workshops for students and they can learn from each other. It is also a channel to create cognitive proximity between student and industry which help them to create better ideas or produce innovative product. Exact always invests TU Delft students and cooperate with TU Delft Master and Ph.D. programs and TU Delft always invite some lecturer from Exact to give lectures, which can help to create cognitive proximity and bridge the gap between scientific and practise.

Social proximity

The community manager of TU Delft Campus works on the community building,

which aims to building a vibrant innovation ecosystem. There are several social events organised by the Science Park in order to make tenants familiar with each other and develop their social relationships, such as Highlight Festival, TU Delft Research Exhibition, Community Drinks & Insights, muliple Cafés by Fieldlabs, and the Dies Natalis. The Science Park also provides bookshops, food courts and coffee shops for residents to meet and develop social relationships with each other. The challenge now is that there are not any central public meeting spaces, which cannot attract users from whole campus.

> *Looking at the situation at Delft there is a clear divide between Campus Noord and Campus Zuid. The majority of the firms are located in Campus Zuid and the walkability between to the areas is somewhat low. Moreover, there are not any large common facilities such as a central restaurant or meeting area that attracts users from all around the campus (Interviewee 6, 2020).*

Organizational proximity

As described in the previous section. There are 245 companies locating on the park, including 200 start ups which are mainly accommodated by Yes! Delft and the field labs. Although they do not belong to the same headquarter, they indeed organised by the each innovation organizations and share the information, knowledge and facilities with other tenants. The field labs belong to Valorisation centre of TU Delft, and these field labs often have field labs meeting together. What is more, all the on-park actors are connected to the Board of Science Park and cooperate with the Board. Therefore, the knowledge and innovation interaction are much easier within each innovation organization. However, the challenges now are that the development of these innovation organizations and also some on-park companies and the development of Science Park are not sufficiently synchronous and the proximity should also be controlled at certain level.

> *Actually, I do not think we make much contribution to the Science Park development now. We focus more on the regional development and we care more about the innovation ecosystem development of ourselves (Interviewee 7, 2020).*

> *We have connections with the Science Park. We support the places for meetings of municipality, Science Park developer and some companies. It is also a chance for us to show our products and seek cooperation. However, we are self-sufficient and do not need many supports from the university (Interviewee 4, 2020).*

> *We have field labs meetings and learn about what exactly happen in different field labs. The Valorisation centre tries to make actors together and has a long term vision. But we want our field labs can work more independently. Imagine that the university is just like a tank, and it is strong but slow. We need more flexibility, chances and progress. Sometimes, it may become too independent, so we need to balance (Interviewee 3, 2020).*

Geographical proximity

The Science Park is still in the early phase of development and there are large amount of green fields. As mentioned in the previous section, four fifths of lands still need to be developed in current stage. The low density of Campus South determines the low geographical proximity. The accessibility between the Campus

North and Campus South is somewhat weak now. Students seldom go to Campus South due to most of education activities are held in Campus North, although Faculty of Applied Science and Aerospace locate on the Campus South. There are indeed some online websites and platforms for on-park actors to interact with each other, but more chances should be provided for face-to-face communications.

The interfaces between university, municipality and industry, such as Yes! Delft, can somehow mitigate the geographical weakness. Because students, researchers, companies and government have many chances to interact with each other in such platforms. People come to these platforms to seek cooperation opportunities and also bring their resources. What is more, the urban amenities also help to contribute to the geographical proximity, such as path, public shared facilities etc. However, there is also a division between the north of Campus and the south of Campus. In the north of Campus, the accessibility and mobility are higher than the south of Campus.

> *I don't think the distance between Yes! Delft and the university is a big problem. Because the graduates have connection with their supervisors in university and they can keep in touch on line or set meetings. Our shareholders also come to Yes! Delft regularly and our partners always come here to have a discussion as well (Interviewee 7, 2020).*

With the real estate development, some infrastructure should be established to make sure the accessibility. For example, walkability between Campus North and Yes! Delft is somehow low. Therefore, some strategies should be proposed to tackle this challenge.

> *Mobility is a challenge now. It is not convenient enough to get to Campus from the train station, for example the Yes! Delft. And we will make it as easy as possible (Interviewee 9, 2020).*

Conclusion

This section mainly talks about the breath and density of TU Delft Campus and also the proximity within the Science Park. TU Delft Campus accommodates more than 200 high-tech companies varying from start-ups to international head offices and also many research organizations. There are several actors with the resources of knowledge, financial capital, human capital, regulation and built environment on the Campus. However, the innovative nodes are not enough for building innovation networks due to the shortage of strong R&D firms, and there are also few services companies locating on the Campus. Most of lands in the Campus South have not been developed. The low density of the Campus South makes the Science Park look less vibrant and leads to a low accessibility to this area, but the situation is becoming better during the development of the Park. In conclusion, TU Delft Campus has breath of innovation related actors, but it is not enough for building a vibrant innovation ecosystem where on-parks actors interact with each other smoothly. It also needs to improve density of Campus South. TU Delft Campus provides several interfaces, such as coffee shops, field labs etc., which help to create proximity for actors. However, more urban amenities should be built on the south of campus. *Table 4.3* provides an overview of the factors of network building in TU Delft Campus.

Table 4. 3 Overview of network building factors in TU Delft Campus

	Current strategies	Challenges
Breadth	-Attract high-tech firms who are fit for the Park brand. -Improve urban amenities, such as path, restaurant etc. -Take care of the composition of the innovation ecosystem where also accommodates services firms and other firms in supply chain; -Establish other facilitating organizations, such as PPP platforms and training centres.	-Science Park is at the early phase of brand building; -There is no enough work space for new residents
Density	-Develop real estate to offer more workplace; -Attract more scale ups and large firms; -Retain start-ups.	
Cognitive proximity	-Set several PPP field labs; -Establish pre-incubator, incubator and accelerator which focus on certain topics; -Strict entrance criteria; -Workshops between student and on-park firms; -Support several public places for actor to exchange knowledge and information.	-More R & D events are needed to increase the interaction chances for the on-park actors.
Social proximity	-Organize Several social events; -Support several public places for actors to develop social relationships.	-Lack central common facilities.
Organizational proximity	-Many start-ups are managed by the same innovation organization; -Field labs belong to the Valorisation centre of TU Delft; -All on-park actors are managed by the Board of Science Park	-More resources matching works are needed to stimulate the innovation interaction between actors from different organizations. -The field labs can be operated more independently in order to promote flexibility and development progress.
Geographical proximity	-Develop infrastructure, -Develop urban amenities.	-Campus South needs to be more accessible.

4.2.2. Innovation network governance

This section describes the performance of innovation network governance in the TU Delft Campus. Innovation network governance aims to involve all innovation

related parties with in the Science Park in decision making process and steer actors' behaviour for achieving collective goals. Actually, from the perspective of innovation, it is hard to steer the development directions and results due to the high uncertainty. However, good governance can provide more opportunities for them to interact with each other, thus stimulating innovation creation and development, rather than they build innovation network organically. According to the theoretical framework, the assessment is based on *1) whether the stakeholder involvement processes are facilitated; 2) whether there are resources matching and allocation work done; 3) whether related stakeholders are involved in the decision making processes and influenced by the decisions*.

TU Delft Campus was initiated by TU Delft and municipality of Delft. The university controls the park and manages all on-park actors and works together with these partners to build a better Science Park. However, the Campus now is focusing on the infrastructure development, brand building and community building due to the development phase of TU Delft Campus.

Stakeholder involvement
TU Delft is the controller of the science park and the collaboration department takes responsibilities for seeking and involving new tenants. The university also has the strongest power to decide who are welcome to the science park. But the university is not the only one actor in the stakeholder involvement process. Municipality of Delft also cooperate and coordinate with TU Delft to search and invite more powerful actors due to the common goals of the university and city development (Interviewee 9. 2020). TU Delft Campus is an important node of TIC innovation network of Delft and an essential player of "Smart City" construction of Delft. Therefore, the university not only focuses on the development of the science park, but also has many negotiations and coordination with the municipality to involve more actors who have impact on both science park and city development.

Although the university and municipality work together on stakeholder involvement, there are not enough strategies to facilitate this process. Except start-ups who want to depend on the successful incubators of TU Delft Campus, there are not many companies are willing to locate on the Campus due to the high cost (Interviewee 2, 2020; Interviewee 3, 2020). The Campus has not been distinguished enough in local area. Therefore, the university and municipality are better to propose more policies or strategies to involve more powerful actors and the firms or organizations that have impact on the park and city development can also be involved in stakeholder involvement process.

Municipality has a list of companies, but most of these companies are not useful for the university (Interviewee 3, 2020).

It is worth thinking that why actors are willing to choose locate on the Campus rather than elsewhere in Delft, although these places are also near to the university. We should think about that. (Interviewee 2, 2020)

Innovative resources matching and allocating works
Stimulating resources flow among the actors is an important task of innovation network governance. It requires joint-effort of all the triple helices to make

contributions. In order to break the boundaries of triple helices, there are several public-private partnerships, such as incubator and field labs, set up by the university and other public sectors. These interfaces connect on-park actors and off-park actors. Therefore, the university, municipality and industry in several levels interact with each other in these PPP platforms. On park level, the university and municipality always discuss the demands and development direction of the filed labs and their roles for the park and local knowledge economy development. Beyond the park, there are many industry partners involved in the innovation network building of field labs and incubators. They participate in the decision making process of the organization development. Triple helices can negotiate with each other to achieve some agreement and set rules or norms for the organization development and also influence the policy making on park level and even local and regional level. Taking advantages of these PPP platforms, triple helices in several levels can interact with each other much easier and transfer their resources more smoothly.

However, there are not many innovative facilitating activities on park level. Few formal and informal R&D activities are organised on the science park. Moreover, few innovative resources matching works have been done within the science park. The PPP platforms always focus on a higher level than the park development and innovation networks are limited between the on-park actors.

> *It makes sense to organize some R&D events, such as training programs, workshops, if the actors have same objectives. 3M is experiencing a re-organization, so we focus on our daily works now. I think we will focus more on the ecosystem years later. Actually, you can also see that this Park is still a little bit empty now (Interviewee 4, 2020).*

> *We have field labs and incubators to attract innovative actors. We cooperate with municipality and industry partners to manage these organizations. But there are not many works done between on-park actors (Interviewee 2, 2020).*

Decision making
TU Delft is the owner of the science park, but not the only decision maker of the science park. As mentioned in the previous section, TU Delft Campus is part of TIC innovation network of Delft and an important actor of "Smart City", the park development is also in line with the city development. The university and municipality have regular meeting to discuss the park development based on their mutual goals. In addition, there are several interfaces for the triple helices, and besides the university and other public sectors, industry partners also involve in the decision making processes of these organizations. These interfaces provide the opportunities for university, municipality and industry, and they work together for stimulating innovation under negotiation, coordination and mutual influences. For example, the main stakeholders of Yes! Delft are TU Delft, TNO and municipality of Delft, and there are also 30 industry partners. These industry partners will come to the building and contact with managers, stakeholders or incubator users.

> *TU Delft has regular meetings with municipality of Delft once a month to talk about what are needed, and how is developing. At current stage, on-park firms are not involved in the decision making process of park management and*

innovation development (Interviewee 9, 2020).

However, on the park development level, the triple helices do not interact in innovation development fully. On-park actors mainly connect with the board on infrastructure and amenities level rather than innovation networks building.

Actually, there are few things which are important here to organize regular meetings. In a practical way, we mainly works on the park management, for example, are there enough car park spots, is here safe and so on. Because they are on the Park, we need to together with their facility managers to improve our facilities and environment. The facility managers of companies are connected with our real estate developers. We do not organize so much R & D events because it is not the first priority now. A lot of works still need to be done (Interviewee 2, 2020).

In conclusion, TU Delft Campus is working on attracting high-tech companies, real estate development, building brand and community, which are benefit for the innovation network building. Although there is a certain degree of park governance, the science park is still weak in innovative network governance at current stage due to the insufficient stakeholder engagement strategies, not enough resources matching and allocation works and not all related stakeholders involved in innovation decision making processes. The first priority of TU Delft Campus is seeking the strategies about branding campus and attracting more powerful actors. After building a better environment for the innovation network building, good innovation network governance can help to develop innovation more effectively and efficiently. ***Table 4.4*** shows the overview performance of TU Delft Campus on innovation network governance.

Table 4. 4 Overview performance of TU Delft Campus on innovation network governance

Factors	Performance
Stakeholder involvement	-University works with municipality to engage stakeholders based on mutual interests; -Engagement strategies still need to be improved and power of industry should be involved.
Resources matching and allocation	-Triple helices interact with in the PPP platforms, and goals are always related to the organizational, local and regional development; -Resources within the science park are not flowing sufficiently.
Decision making	-There are several level interventions because the park development is always in line with the city development. University, municipality and some external firms influence the decision making processes; -On-park actors have limited power on making decisions of science park innovation development.

4.3. Roles of university, municipality and industry in innovation network building and governance

Based on the theoretical framework, there are four dimensions, lands and real estate

dimension, community dimension, R & D dimension and board level, that the triple helices should involve in to provide a better environment for innovation networks building and governance innovation networks. This section mainly discusses about the roles of university, municipality and industry played in the four dimensions to create innovation networks building environment and governance innovation networks.

4.3.1. Lands and Real Estate dimension

Lands ownership determines the structure of real estate development, and further determines the breadth and density of the Science Park. TU Delft owns most of the land at the TU Delft Campus, and makes contracts for ground lease with parties that want to build (Interviewee 1, 2020). There hasn't been a change of ownership for a very long time except some exceptions made in the past. An overview of the landownership (in Dutch: eigendom) on campus is shown as *figure 4.3*.
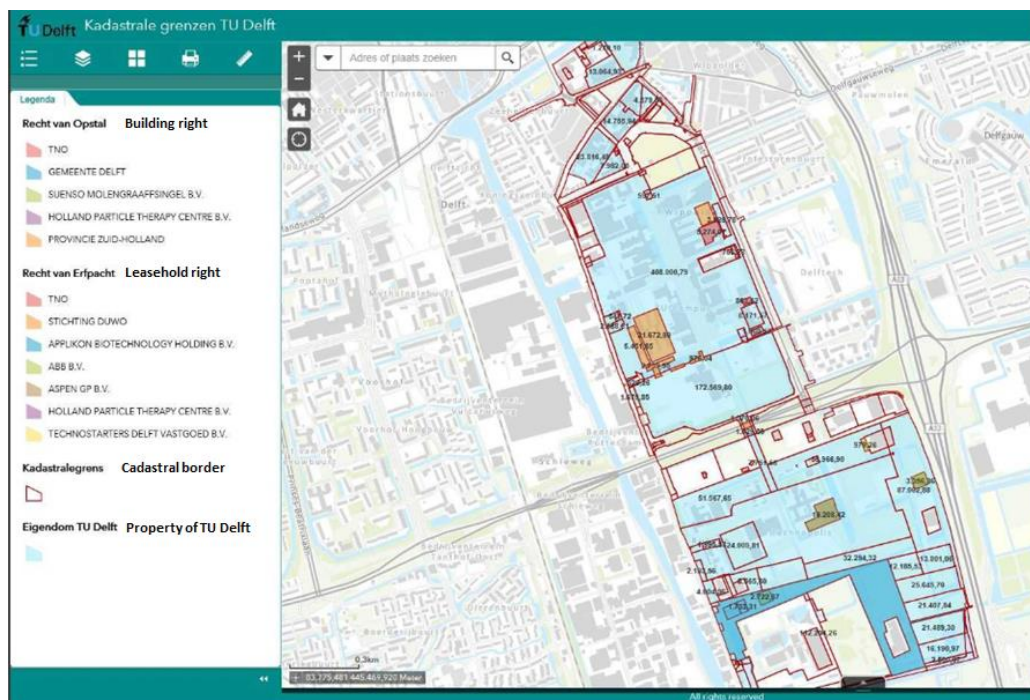
Figure 4. 3 Overview of landownership on Campus

As shown in the picture, the owners of the buildings of Exact, 3M, Datacentre Group, Radex and the former TNO building at Stieltjesweg (now student housing and public amenities) also own the land. What is more, public institutions Haagse Hogeschool, Hogeschool Inholland, Deltares and VSL/NMi own the land.

TU Delft sells redundant real estate to keep the portfolio affordable. It's sold for the highest bid (like Gele Scheikunde) or to a partner of TU Delft so they become inhabitants of TU Delft Campus (like Mijnbouwkunde). In these cases the land is sold as well because the university slowly moves southward. In the centre and southern part of the campus we want to be in control so we don't sell but lease the land (Interviewee 1, 2020).

Although some exceptions, TU Delft remain own the most of lands and has strongest power to decide who are welcome to the Campus. During the

development of TU Delft Campus, there are not many land ownership changes and the university is not allowed to sell lands for commercial using according to the policy of university and municipality (TU Delft real estate). In most common ways, university leases the lands and together with industry and municipality to develop the real estate. This section mainly describes how the triple helices play their roles in the real estate development, the influence of real estate development on innovation network buildings and also the challenges that TU Delft Campus facing now.

Roles of university, municipality and industry in the real estate development
University is the land owner and has power to decide the lands use of the campus. This also empowers university to set the entrance criteria of the Science Park. Municipality of Delft works close to TU Delft on the Science Park development, because municipality and TU Delft have common goals to develop this area as a high-tech buzz. Municipality gives permits for new buildings and helps to improve the surrounding infrastructure. What is more, the municipality of Delft sometimes also support some investment to develop the real estate of TU Delft Campus. However, due to the policy that university cannot sell their lands for commercial using and constructing buildings is not the duty of university and government also has limited capital for investing real estate development in Netherlands, a large amount of investment should be attracted from external investment. The main role of industry in real estate development of the Science Park is financial supporter, and no doubt that they need profit. Therefore, the university, municipality and industry should cooperate with each other to contribute to the real estate development of TU Delft Campus.

University as the land owner becomes the driver of attracting proper actors and also the manager of this Science Park. University sets the policies that leasing the lands or selling redundant lands to develop this Science Park.

TU Delft remains owner of the land at the TU Delft Campus, and this is policy of TU Delft. Real estate developers/ investors lease land for 99 years (in Dutch: erfpacht) and pay the annual rent (in Dutch: erfpachtcanon) at once prior to the start of the lease. TU Delft leases land to developers/ investors at a market conform price level. The revenue of leased land benefits the land exploitation (in Dutch: grondexploitatie) for a certain area/ part of the campus (Interviewee 1, 2020).

We also want to attract some large firms who are able to build some clean and sustainable buildings. Imagine that a high-tech firm with sustainable building, it really impacts our brand (Interviewee 2, 2020).

Municipality of Delft is another important actor in the Science Park real estate development. Although the lands are owned by university, real state cannot be developed without the permits of municipality. Municipality also have legislative power on the spatial planning which affect the accessibility and attractiveness of the Science Park. What is more, municipality also invests some capital to develop real estate on Campus.

The municipality is responsible for spatial planning and gives permits. What is

more, municipality also supports partial capital investment for the real estate developing. We have continuous discussion with the university to decide to develop new buildings and new faculties. The real estate development of the Science Park should be in line with the special plan (Interviewee 9, 2020).

Industry becomes the major investor in the Science Park real estate development. Some companies choose to build their own building on the Science Park. However, most companies have limited resources to build their own buildings. Therefore, external investment should be attracted. For example, ASR Science Park Fund, which consists of large insurance companies, university and other investors (TU business relation), invests lots of money in the real estate development of TU Delft Campus.

TU Delft Campus has its investment partners, such as ASR Science Park funds, and they invest for the real estate development (Interviewee 9, 2020).

We invest this building and also own the land. The building is shared with Exact and construction company (Interviewee 5, 2020).

There will be a new building next to Yes! Delft, which is financed by ASR and a little bit by the municipality of Delft and TU Delft leases the land (Interviewee 9, 2020).

Figure 4.4 shows the roles of university, municipality and industry in real estate development briefly.
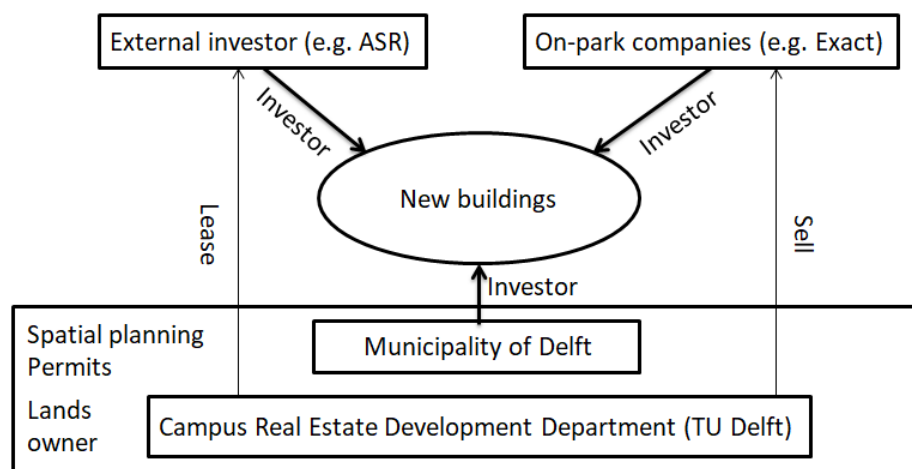
Figure 4. 4　Real estate development on TU Delft Campus

In conclusion, there could be mainly three types of real estate development on TU Delft Campus. Firstly, the university sells the lands to developers and the company becomes part of community. Secondly, the university lease the lands and several large companies invest to build new buildings and then become part of community. And the most common one, the university leases the lands and external investors invest on new buildings for earning rent fees. Therefore, the main roles of university are land owner, decision maker, investment attractor. The main roles of municipality are legal supporting, decision influencer, coordinator, and investment attractor. The main role of industry is investor and developer. ***Table 4.5*** illustrates the overview of university, municipality and industry play their roles in the TU Delft Campus real estate development.

Table 4. 5 Roles of   university, municipality and industry in lands & real estate dimension

	Type 1	Type 2
Configuration	-University sells the lands; -Investors & developers develop real estate; -Lands ownership is transferred	-University leases the lands; -Investors & developers develop real estate; -Investors & developers build buildings for earning rent fee.
Roles of university	-Land owner; -Decision maker; -Investment attractor.	
Roles of municipality	- Policy supporter; -Decision influencer; -Investment attractor; -Coordinator.	
Roles of industry	-Investor and developer	

Add values of Lands & Real Estate dimension
At current development stage of TU Delft Campus, it is meaningful to develop real estate. As described in the previous sections, TU Delft Campus is still a little empty now and cannot offer enough working space for new residents. Developing real estate means offering more working places for start-ups who are willing to continue their business on the Campus after becoming scale-ups and new residents.

Real estate development helps to increase the density of Campus South and make the Campus South area look more vibrant. Firstly, geographical proximity can be promoted by developing real estate, because more density more accessible for actors. However, it does not mean more density is better, because high density may affect comfortable. Secondly, social proximity may also be promoted because actors have more chances to communicate with each other. Thirdly, there are high chances to promote cognitive proximity between actors due to the geographical proximity and social proximity and strict entrance criteria of the Science Park.

In conclusion, real estate development is the basis for attracting innovation partners because working place is essential for actors, especially for start-ups and SMEs, to locate on Campus. Most of companies are not willing to build their own buildings due to the expensive costs. However, only enough high-tech companies with R & D departments locate on the Campus and have chances to interact with each other in terms of innovation, the performance of innovation creation and stimulation of the Science Park can be promoted. Therefore, real estate development is a prerequisite for stimulating innovation.

Challenges
Due to the early development phase, the real estate challenge for TU Delft Campus is that there are not many investors are willing to invest for building new buildings without land ownership. TU Delft campus is working on branding the Science Park and attracting more innovation partners to locate on Campus. Only the Science Park is attractive enough, then actors will come and investors are willing to invest for making profits.

4.3.2. Community and brand building dimension

TU Delft Campus is committed to create an environment where residents can work, co-create, study and live. People expect innovation happens on a daily basis, in both formal ways and informal ways. Residents start sharing ideas and communicating with each other efficiently under this willing. Taking advantages of the strength brand, TU Delft, the Science Park aims to create an open innovative hotpot.

Roles of university, municipality and industry in the brand building and community building

TU Delft owns the lands of TU Delft Campus and takes responsibility for managing the Campus. Therefore, the brand building and community building are tasks for the university mainly.

For brand building, the strategy of TU Delft Campus is using the name of TU Delft, which is one of the most famous technology universities in Netherlands. The Campus was divided into two parts, the Campus North was the TU Delft and the Campus South called Technopolis. In order to increase awareness of the Science Park, TU Delft decided to combine two parts.

The university has very important resources to choose and to use for the brand TU Delft Campus, and companies are willing to locate here in order to stay close to the young talents from the university and also the living labs and field labs (Interviewee 8, 2020).

I think municipality also plays a role in brand buildings, because they can set signs on the highways, and along roadside to guide people come to the Campus. But our university plays the main role in the brand building (Interviewee 8, 2020).

What is more, Yes! Delft which is one of the most famous incubators locates on the TU Delft Campus. It also impacts the brand of the Science Park. As mentioned in the previous sections, field labs are also an important factor for impacting the Science Park brand. However, the field labs are also experiencing the developing phases. TU Delft Campus accommodates several international head offices, and the Campus can also take advantages of their reputation. Municipality of delft also plays a role in the brand building. They have power to improve the infrastructure surrounding the Science Park and also advertise the Science Park on the official website and road signs. In conclusion, TU Delft takes responsibilities for designing, maintaining and developing the brand of TU Delft Campus and municipality and on-park firms can facilitate brand building process, the roles of university, municipality and industry are described in *table 4.6*.

Table 4. 6 Roles of university, municipality and industry in brand building

Actors	Explanation
University	-Brand designer; -Brand maintainer; -Brand developer
Municipality of Delft	-Brand developer
industry	-Brand developer

For community building, TU Delft is working on fostering a close sense of

community between the users of TU Delft Campus. The Science Park focuses on the "quadruple helices" in order to stimulate innovation on personal level. With the increasing numbers of residents, the community plays an important role in building common identity among these residents. Good community can help knowledge sharing occurring on daily basis, and more innovation cooperation tend to happen. TU Delft organises many events to link various parties together and support them facilities. Several events are organised by the Science Park in order to ensure residents come in contact with each other and promote the possibilities of their cooperation, such as Highlight Festival, TU Delft Research Exhibition, Community Drinks & Insights, muliple Cafés by Fieldlabs, and the Dies Natalis. The Science Park also provides bookshops, food courts and coffee shops for residents to meet with each other. What is more, many on-park companies are also willing to support places for holing events because this can also show their companies to other actors and promote their cooperation chances.

We want to create an environment where people can exchange their knowledge on a daily basis and make them feel like home on the Campus (Interviewee 8, 2020).

We have contacts with the Science Park community manager and support our places for meetings (Interviewee 4, 2020).

We support our places and we are willing to do so. I think this is in win-win situation (Interviewee 5, 2020).

As mentioned in the previous sections, TU Delft Campus has many sub-ecosystems, such as Yes! Delft and RoboVally. These sub-ecosystems also work on building their own communities. The ambition of TU Delft Campus is to transform all parties into a single large community. The community manager is working on making all parties feel like they are an integral part of the Science Park.

It is important to make residents recognize the added value of this Science Park and we are working on making them have sense of the Campus (Interviewee 8, 2020)

The municipality of Delft is also working on the community building, but does not focus on the TU Delft Campus. The municipality takes responsibility for making everyone in Delft feel like at home. It means municipality is working on providing a comfortable and convenient living environment and this helps to attract more companies and facilitate the community building of TU Delft Campus.

Community building of this Science Park is the job of university, but we do a lot of works on providing a better living environment for all the citizens. We do not involve in the community building of the Science Park, but we try to make everyone in Delft feeling like at home (Interviewee 9, 2020).

We sometimes go on the street and ask the companies what they want and try to improve the current situation (Interviewee 9, 2020).

In conclusion, the university is the driver of community building and also manages

the whole Campus. The community manager of the Campus keeps in touch with all parties and tries to bind them together. Employees of on-park firms and staff/ students of university are major users of the Campus, and in TU Delft Campus case, the firms always support their places and equipment for meetings or some events and they also organize their own events for sub-ecosystems. Municipality plays its role as a facilitator and helps the Campus to build a better living environment. The roles of university, municipality and industry in community building are described in *table 4.7*.

Table 4. 7 Roles of university, municipality and industry in community building

Actors	Explanation
University	-Driver; -Manager; -Facilities supporter
Municipality of Delft	-Living environment co-builder
Industry	-User; -Manager of sub-ecosystem; -Places supporter

Add values of Brand & Community building dimension
TU Delft Campus is building a next-level innovation campus. In that case, innovation is not only expected to occur in the university or R&D departments of companies, but also occur on daily basis. Residents can share their knowledge and information in their daily life. Therefore, the community building is essential because only everyone has a sense of entirety, the common identity will be built and all parties will be bind more tightly. The social proximity between on-park actors can be promoted and their mutual trust as well.

One of prerequisites of building community is developing the brand. A powerful brand can attract more actors with their resources and make them more willing to involve in the social events. What is more, a strong brand can bring on-park actors a better reputation, which benefits their business and promotes their capability of attracting R&D partners and funds.

Challenges
Due to the early development phase, the sub-ecosystems focus on developing themselves. What is more, the Campus North and the Campus South are not integrated tightly enough. The challenge for community building now is to make the separate parties bind more tightly and make them have a sense of entirety.

The challenge for brand building now is to identity the Science Park from the TU Delft. TU Delft Campus seems like the same as Technical University, so the brand manager of the Science Park is going to make sure people know there are university and also the Science Park.

4.3.3. R & D dimension

TU delft is one of the best technology universities in Netherlands, and the university has several R&D networks with industry to stimulate innovation. TU Delft has many innovative resources to attract companies to locate on campus. There are 8 faculties with 5200 staff, 25000 students and many innovative facilities and also 21 field labs. This section mainly talks about how the university,

municipality and industry play their roles in R&D facilitating and governance R&D networks.

Roles of university, municipality and industry in the R&D development

University is the knowledge producer centre, and also provides talents and good facilities for industry. The strongest innovative resources of TU Delft now are the talents and field labs. At current stage, these two are the most attractive factors for industry. Although there are many R&D networks between university and industry, many partners are not willing to locate on Campus due to the early development stage and costs. Therefore, the university together with municipality is working on R&D networks buildings and attracting more partners to the Campus.

TU Delft together with municipality and other partners has established several interfaces for the interaction between triple helices. For example, TU Delft, municipality of Delft and TNO established incubator Yes! Delft in 2005.

The Dutch government stated in 2004 that universities had a third major task in addition to research and education. They want universities to build more relationships with companies and solve more social problems. What is more, TU Delft also wanted more students to start their own companies. Then we built Yes! Delft.（*Interviewee 3, 2020*）

Nowadays, TU Delft Campus holds variety platforms for students and start-ups to develop. TU Delft provides several programs for student to develop their skills and their ideas. What is more, the university also provides some financial supports for students. The most important way to gather university, municipality and industry together is to build interfaces between them. For students, there are DREAM team, Delft Centre for Entrepreneurship and TU Delft Impact Contest 2020. For star-ups, there are YES! Delft, RoboValley, Aerospace Innovation Hub and Delft Enterprises. For large companies, they are invited to become a partner of X! Delft. These interfaces aim to match resources of each partner, and gather all parties together to attract more useful resources. These interfaces provide the chances for scientist, government, entrepreneurs and students to interact with each other and support each other. What is more, these interfaces also aim to mitigate the gaps between scientific and practise, such as the field labs, which can help to stimulate innovation from concept to product.

There are not many companies interested in investing fundamental science. The higher TRL (technology readiness level), the more attractive the companies are willing to work with you. Therefore, we set up several field labs in order to promote the TRL and attract more partners (Interviewee 2, 2020).

Companies and professors outside are always want to go to places where happens (Interviewee 3, 2020).

We have many small innovation ecosystems, such as Yes! Delft, RoboVally and so on. They organise their own events and develop their innovation ecosystem. All the triple helices involve in their development (Interviewee 8, 2020).

These interfaces are always funded by public fund and established by public sectors.

University as the knowledge centre plays key roles in establishing these interfaces, because these interfaces should focus on the study fields of university. What is more, university becomes the driver and cooperate with municipality to get more funds from EU and national or regional government. Industry is also willing to become the partner of these interfaces, and some companies or research institutes are also in the board of foundation of these interfaces. These PPP platforms always have their own foundation in order to develop the ecosystems rapidly and efficiently.

The main shareholders of Yes! Delft and TU Delft, TNO and municipality of Delft. There are also more than 30 industry partners who pay for the annual fee. The shareholders hold regular meetings to decide the development of Yes! Delft. (Interviewee 7, 2020)

Although the filed labs belong to the university, but we have our own foundation and work on our business. And we also have close connections with Technical University and municipality to discuss about what are needed (Interviewee 3, 2020).

Besides these field labs and incubator, anther strength of TU Delft Campus is talents. Companies also work with students directly. Some of companies are willing to support PhD students and together with university to train students. There are also some companies provide workshops for students to exchange knowledge and information with industry. What is more, most of start-ups on the Campus are established by the graduates from TU Delft.

What is more, both the university and municipality of Delft play roles in attracting new companies to move to the Science Park. For example, there are several professors of TU Delft help new companies moving to the TU Delft Campus. These staffs have a lot of experience in creation of the Technology Campus or have many connections with industry. The municipality of Delft also has a list of companies and try to invite them moving to the Campus.

In conclusion, the current innovation network structure of TU Delft Campus is that firstly, several start-up ecosystems supported by university, government and some companies. University involves in setting up these ecosystems and the talents of university flow into these ecosystems which help these start-up ecosystems develop better and better. What is more, municipality also play roles in contributing to these ecosystems, such as providing facilities, financial or policy supports. These vibrant start-up ecosystems also attract many outside companies to become partners and provide their resources and also seek commercial opportunities. Secondly, there are several large companies locating on the Campus, such as 3M, Exact, and Microsoft etc. Some of these companies have connections with university in terms of R&D. They invest in fundamental science and become partners of start-up ecosystems to support start-ups. However, the strengths of the large companies have not been fully utilized. Therefore, in the case of TU Delft Campus, TU Delft plays its roles as the PPP platforms driver, talents transporter, knowledge producer, capital attractor and decision maker. Municipality of Delft play its roles as co-driver of PPP innovation platform, coordinator between university and companies and capital attractor. Companies on TU Delft Campus always play their roles as innovation tester and developer and major capital supporter. ***Table 4.8*** illustrates the overview of

university, municipality and industry play their roles in the TU Delft Campus R&D development. An overview R&D structure of TU Delft Campus is shown as *figure 4.5*.

Table 4. 8 Roles of university, municipality and industry in R&D dimension

	Start-ups ecosystem	**Scale-ups innovation network**
Roles of university	-Pre-incubator founder; -Incubator founder; -Talents transporter; -Knowledge producer; -Technology supporter; -Funds attractor	-Technical supporter; -Attractor; -Talents transporter; -Field labs founder
Roles of municipality	-Co-founder of PPP innovative platforms; -Policy supporter; -Funds attractor; -Investor	-Coordinator between university and companies; -Co-founder of field labs; -Attractor
Roles of industry	-Large firms work as investor and partner; -Start-ups play their roles as technology user and developer	-Investor for fundamental research; -Field labs user; -Driver of innovation networks according to companies' demands;
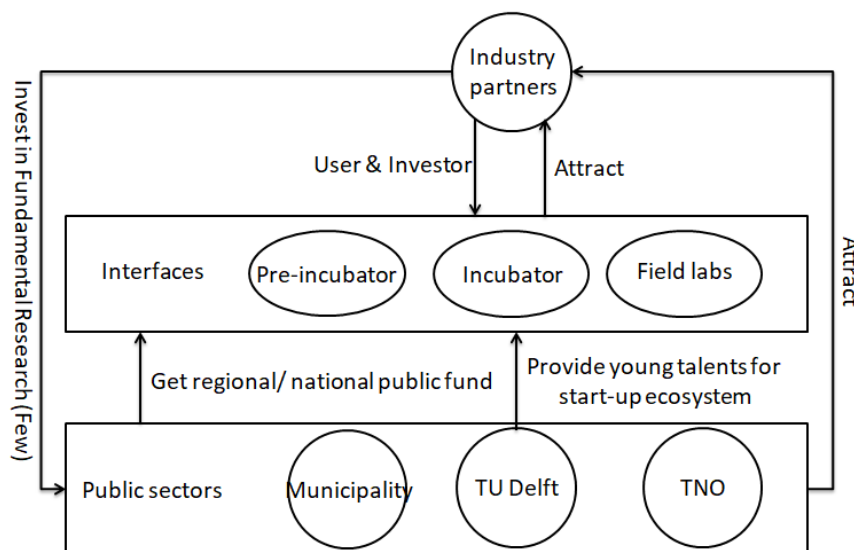
Figure 4. 5 An overview of R&D structure of TU Delft Campus

Add values of R&D dimension

R&D is the practical way of innovation and determines the innovation outcomes of the Science Park. However, it is hard to do all jobs from the concept (technology readiness 1 to 3) to product (technology 7 to 9) for only one actor, except worldwide large companies like GE. Therefore, the university, municipality and industry should play their roles to create an environment or places for each other to interact. The strong start-up ecosystem of the TU Delft Campus helps to attract many large firms to invest in the innovations and also attract young talents and researchers to start their own business. The field labs mitigate the technology gap

between the fundamental research and practise, which stimulates the interaction between university and industry and external researchers. Pre-incubators, incubators and field labs on the TU Delft Campus provide more chances for the triple helices to interact with each other. The more interactions between innovative actors, the higher chance R&D networks can be built and innovation can be created and stimulated. The R&D network building promotes the cognitive proximity between actors and makes them easier to cooperate with each other on R&D practice.

Challenges

Although there are many large firms and innovative public private partnerships on TU Delft Campus, they do not interact with each other as much as expected. There are several reasons: firstly, TU Delft Campus accommodates firms working in wide ranges topics. Actually, TU Delft decided to develop variety of topics because the university expect inter-disciplines to spark innovation (Interviewee 8, 2020). Secondly, there are not enough nodes (companies or organizations) in this Science Park due to the early development stage.

> *There are not many companies working on the same field of us. You can see that, there are not many companies on this Science Park. Therefore, we do not have so many R&D networks with on-park actors (Interviewee 5, 2020).*

Thirdly, the innovation network governance of TU Delft Campus is not strong enough. There are not many R&D matching works are done in this Science Park.

> *University is knowledge producer and we can test the new knowledge and ideas. I think it is better if there are more innovation matching works are done (Interviewee 5, 2020).*
>
> *We expect the Science Park could be more vibrant, and it needs time. 3M is working on a wide range of research fields, therefore we are welcome all high-tech firms to locate here (Interviewee 4, 2020).*

What is more, Delft is a city without too much industry culture. Therefore, it is a challenge for TU Delft Campus to attract new residents because the costs of movement are always expensive and weak industry culture.

In conclusion, the next steps of TU Delft Campus are attracting more high-tech companies and taking advantages the current resources, such as the high-tier incubator, large firms and so on, and doing more matching works. Matching works mean that the board of director should work with university and on-park firms to learn more about what research topics on-park actor are interested in and the worldwide trend of these topics. More chances can be provided for university, municipality and industry to interact with each other in R&D network building and work together on innovation outputs.

4.3.4. Board of Director Level

Board of director is the decision making level of the Science Park. They take the responsibility of the Park development. The board of TU Delft Campus mainly consists of three parts, real estate development part, community and branding part

and collaboration part. This section discusses about the roles of university, municipality and industry played in the decision making of park development.

TU Delft takes in charge of Park management and makes decisions on the Park development. At current development stage, the manage team of Science Park mainly focuses on the park management (facility and built environment), new residents attraction and brand & community development. Therefore, the management team is divided into three main parts. Real estate part takes in charge of the construction and built environment of the Science Park. Collaboration part works on collaboration with companies. Brand and community part focuses on promoting brand impact and building a vibrant innovation and living ecosystem. A brief description of Campus operation structure is shown as *figure 4.6*.
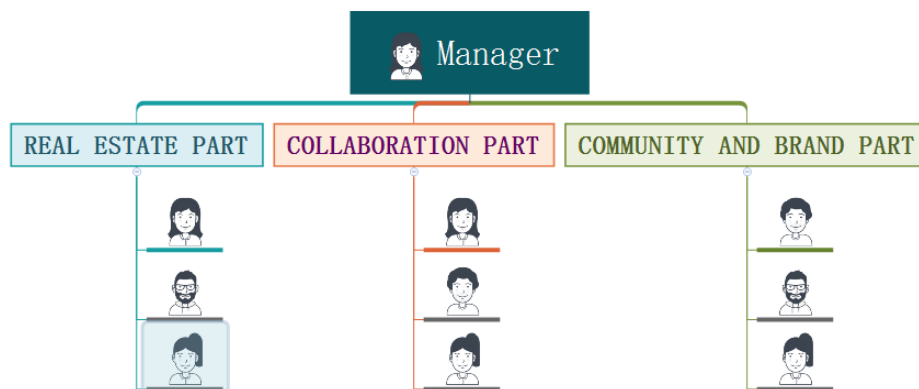
Figure 4. 6 Operation structure of TU Delft Campus

Besides Technical University, the municipality of Delft also involves in the decision making process. However, the municipality mainly plays its role as decision making influencer rather than decision maker. The Space & Economy, Advice Department of municipality has regular meeting with Science Park management team once a month to discuss the demands and development directions of Campus.

> *We have regular meeting with university and discuss what are needed in terms of the facilities, infrastructure and field labs etc. It is quite broad, not only the building, but also the Science Park development directions (Interviewee 9, 2020)*

The companies on the Campus play insignificant roles in the decision making process. Basically, due to the early development stage of the Science Park, there are few things needed companies to co-decide. Then, most of properties belong to the TU Delft, so the university takes in charge of Park logically. What is more, most of firms are running small business and they normally focus on their own business, so they do not want to involve in most of park decision making. Finally, the resources of large companies have not been used sufficiently yet, especially their innovation and business networks. The mutual benefit relationships between those large firms and the Campus have not been established completely.

In conclusion, TU Delft Campus obeys a top-down operate structure and mainly steered by the Campus management team of university. Municipality of Delft has tight connections with the university on the Science Park development. On-park firms mainly focus on the small ecosystems and their own business. On-park firms mainly join in the decisions of improving facilities and built environment due to

they are users at current stage.

Challenges

On-park firms are not really involved in the Park development because they seldom participate in the decision making processes during the park development. Although it makes little impact on the construction of built environment and real estate development, it can influence the innovation creation and stimulation process. On-park firms should involve in the decision making of entrance criteria and R&D development. The more new companies are welcomed by existing companies, the greater the opportunity for cooperation with each other. But it is worth noticing that the Campus should keep open and avoid lock-in effects. What is more, industry has a better understanding on the market. It is therefore wise to involve them in deciding the directions of R&D development and provide more chances for university, municipality and industry to interact with each other. If all parties participate in the decision making, they would also like to take more responsibilities.

4.4. SWOT analysis

This section discusses about the strength, weakness, opportunities and threats of TU Delft Campus in innovation networks building and governance. The SWOT analysis aims to provide an overview of the innovation network building and governance conditions of the case. Based on the SWOT analysis, some advice will be offered. It can also give some lessons to other university anchored science park.

4.4.1. Innovation network building

TU Delft Campus is focusing on developing innovation networks now. Start-up innovation ecosystems, filed labs have been developed on the Campus and become the strength of the Science Park in developing new innovation networks. However, there are also some weakness and threats duo to the early development phase. A SWOT analysis is conducted as following.

Strength

Strength is positive internal factors of innovation network building of the TU Delft Campus. Based on the results of field works, some strong points of innovation network building and governance are found. TU Delft Campus has the qualified talents, field labs working in higher TRL and a strong start-up ecosystem. These factors attract more partners to cooperate with on-park actors, thus promoting the proximity among them. Innovation network building process can be stimulated. The positive factors are described as following:

✓ TU Delft Campus has qualified talents. High-tech companies are always willing to locate close to these talents;
✓ The Science Park sets up several PPP field labs. Due to the higher TRL, more companies are willing to involve in the cooperation to develop their products. What is more, professors are also willing to come to where things happen;
✓ There are strong start-up ecosystems on the Park. For example, Yes! Delft becomes one of the most famous incubators in Europe. These star-up ecosystems can attract both young talents to practise new ideas and large firms to participate based on their interests.

- ✓ There are three fouths of lands have not been developed. Therefore, the Science Park has multiple possibilities for developing real estate;
- ✓ There are several large compnies locating on Campus, such as 3M, Exact. These large firms with high reputaion and R&D networks can also help to build innovation network of the Science Park.

Weakness

Weakness is negative internal factors which have negative impact on the innovation network building. TU Delft Campus is facing some challenges on the innovation network building. These factors hinder the innovation network building due to the low breadth, density and proximity and they can be eliminated by the university, municipality and firms. These negative internal factors are shown as following:

- ✓ The Campus still lacks central meeting place for users from all around the campus due to the distance between Campus North and Campus South. This is not helpful for the knowledge and information exchange;
- ✓ Few education activities are held on the Campus South, so there are not many chances for students and on-parks firms to interact with each other except certain programs;
- ✓ Campus South is not easy to access and the public transport to the south of campus is still needed;
- ✓ More work places are needed for new residents. The density of Campus South is still a bit low now.
- ✓ Brand building is also on the early stage. Only a strong brand can attract more companies and financial capital.

Opportunity

Opportunity is external positive factors for the innovation network building. These factors can help facilitate the network building by promoting the breadth, density of the park and proximity among different actors. They are elaborated as following:

- ✓ Some investors, such as ASR Science Park Fund, begins to invest for the real estate development of the science park;
- ✓ The Science Park is attached to TU Delft. The high reputation of TU Delft helps to attract new tanents
- ✓ More demands on technoligical solution of industry;
- ✓ There is a wide range of topics foucesed on Campus. Therefore, various companies foucus on different topics are welcome. And the interdisciplinary interaction may bring unexpected innovation outcomes.

Threat

Threat is negative external factors. These external factors influence the breadth, density and proximity of the science park. The factors are shown as following:

- ✓ There is no industry culture in Delft;
- ✓ Lack investors in investing real estate in the Science Park due to the costs.

4.4.2. Innovation network governance

The governance of TU Delft Campus is still at park management phase. Park management mainly consists of facilities development, real estate development,

living environment development and community building. However, there is lack of R&D networks governance now. Actually, R&D network governance is not the first priority due to the shortage of firms.

Strength

TU Delft has tight connections with municipality which facilitates the resources sharing and stakeholder involvement process. Decisions are also made under the balance of their different interests. Several successful PPP platforms involve university, municipality and industry partners. Their interaction facilitates the resources flow, stakeholder involvement and makes the decisions are made more reasonable. The factors are shown as following:

✓ The university and municipality have regular meetings. Strong connections are built between them because of the common goals. Therefore, they work together to attract more actors and provide an active innovation environment for these actors
✓ Triple helices interact with in the PPP platforms, and goals are always related to the organizational, local and regional development.

Weakness

On-park firms do not have power in the innovation development on park level. It may hinder the resources flow and has negative impact on the stakeholder involvement and decision making of the innovation development. Interventions, such as R&D events, are not enough for stimulate the interaction of different actors. It will hinder the resources flow and information exchange. The internal negative factors are described as following:

✓ Weak involvement of on-park firms in the development of Science Park;
✓ Innovation ecosystem of the Campus is a somehow independent. Parties are not bind together strong enough.
✓ There are not many R&D events are organized on Campus.

Opportunities

TU Delft Campus is in line with the development of city development. Therefore, the governance beyond park level brings more resources and facilitation interventions to the innovation development of the park and linkages building of on-park actors. The opportunities are illustrated as following:

✓ Large firms and successful star-up ecosystems can play important roles in the governance of innovation networks because of their rich resources.
✓ TU Delft Campus is part of TIC Network proposed by municipality of Delft and an important actor of "Smart City". Therefore, the local and regional government also take care of the development of the science park

Threat

Threat is negative external factor. Due to Delft has no industry culture, it will hinder the stakeholder involvement processes.

✓ There is no industry culture in Delft and not many off-park companies are interested in locating here.

4.4.3. Conclusion

In conclusion, TU Delft Campus is working on the innovation network building and tries to build a more vibrant innovation ecosystem now. The governance of innovation networks is still needed to be improved. *Table 4.9* shows an overview of S, W, O, T of TU Delft Campus in innovation network building and governance.

Table 4. 9 Overview of S, W, O, T of the TU Delft Campus

	Innovation network building	Innovation network governance
Strength	**R&D dimension:** -Qualified talents; -Qualified field labs; -Strong start-up ecosystem **Real estate dimension:** -Available lands for new tenants **Community and brand building:** -Several large companies enhance brand awareness.	**Decision making process:** -Strong connection between university and municipality **Stakeholder involvement:** -University, municipality and industry partners are involved in the PPP platforms
Weakness	**Real estate dimension:** -Lack work place for new tenants -Lack public transport to the south of campus -Lack central meeting place for users from all around the campus **Community and brand building:** - There are not many R&D events are organized on Campus; -Few education activities are held on the Campus South; - Brand building is also on the early stage	**Decision making process:** -Weak involvement of on-park firms in the development of Science Park; -Parties are not bind together strong enough. **Stakeholder involvement:** -There are not many R&D meetings are organized on Campus.
Opportunity	**Community and brand building:** -High reputation of university is helpful for attracting new tenants; **R&D dimension:** -Innovation network of field labs; -More demands on technological solution; -Various R&D topics are developed on Campus. **Real estate dimension:** -Investors, such as ASR	**Resources management:** -Large firms and successful star-up ecosystems can play important roles in the governance of innovation networks because of their rich resources

	Science Park Fund, begins to invest.	
Threat	**Real estate dimension:** -Lack investors in investing real estate; **R&D dimension:** -There is no industry culture in Delft	**Stakeholder involvement:** -There is no industry culture in Delft and not many off-park companies are interested in locating here

Based on the strength, weakness, opportunity and threat, the advice will be offered to promote the capability of innovation network building and governance through building on strengths, eliminating weaknesses, exploiting opportunities and mitigating treats.

Table 4. 10 SWOT analysis of TU Delft Campus

	Strength	**Weakness**
Opportunity	-On-park companies and start-up ecosystems are expected to take advantages of their R&D networks to contribute to the Park -The university should promote more stakeholder involvement strategies to develop field labs in order to attract more firms	-With the increase of the breadth and density of Campus, more R&D events and meetings can be organised;
Threat	-TU Delft and municipality should work more tightly on brand building to attract more investor on real estate development and more actors with useful resources to build R&D networks; -More central facilities should be established to mitigate the distance gap between Campus South and Campus North;	-Public transport, especially the Campus South, is still needed to be improved by municipality

PART 4

EMPIRICAL RESEARCH

Chapter 5 Leiden Bio Science Park

5. Leiden Bio Science Park

Following the TU Delft Campus case, this chapter discusses about the Leiden Bio Science Park. Leiden Bio Science Park was established in 1984 and is more mature than TU Delft Campus due to the higher numbers and variation of firms, higher accessibility and mobility and higher reputation. This case is also conducted in in the form of semi-structured interview, including science park managers, on-park company managers and key persons at the universities and municipalities.

The structure of this chapter is as following, an overview description of Leiden Bio Science Park is introduced at first. Then, the performances of innovation network building and network governance are illustrated based on the interview of representatives of the three helices and the theoretical framework. After that, a SWOT analysis is conducted based on the feedbacks of the interviewees and the advices to the Science Park are offered following the SWOT analysis.

5.1. Case description

Leiden has been a university city since 1575 and is known as "City of Discovery". Leiden University, the oldest university in Netherlands, locates in Leiden city. Leiden University was founded in 1575 and becomes a top-tier reputation university in Europe. In 1980s, a biotechnology professor from Leiden University, Rob Schilperoort, convinced Leiden University and Leiden City Council to develop biotechnology. Therefore, Leiden Bio Science Park was founded in 1984 by Leiden City Council and Leiden University. Now the Science Park becomes the largest life science cluster in the Netherlands and the top five successful Science Park in Europe.

Leiden Bio Science Park covers more than 110 hectares of land. Majority lands of park are on the west of the city centre of Leiden, and a small part of the Park locates on city of Oegstgeest. The Park mainly focuses on the medical life sciences and has strict entrance criteria. It means that only bio-technology related companies can develop their business on this Park. *Figure 5.1* shows the situation of LBSP, the yellow part is the Science Park and the red part is city centre of Leiden (Visscher, 2011). *Figure 5.2* shows the map of Leiden Bio Science Park.
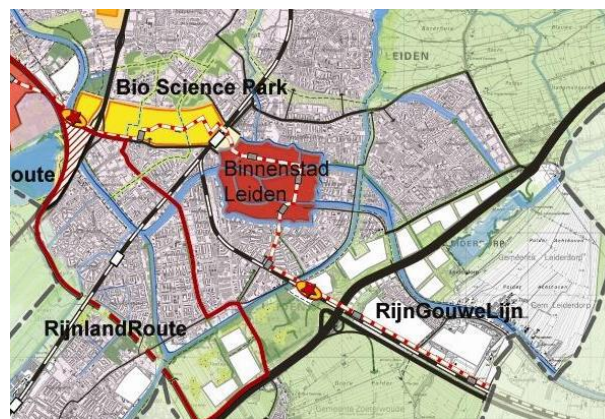
Figure 5. 1 Situation of LBSP (Visscher, 2011)

Figure 5. 2 Map of LBSP (Retreived from https://leidenbiosciencepark.nl/media/downloads/JUST_LBSP_Plattegrond2019_Digitaal.pdf)

Leiden Bio Science Park is becoming a vibrant biotechnology cluster with a wide range of high-tech organizations. The Science Park accommodates 214 organizations now, including 150 companies, 14 health care organizations, 11 research institutes, 11 educational institutes and 28 other organizations. The companies from start-ups to multinationals focus on drug developing and medtech companies, service providers and dedicated business services. More than 19,000 people from 14 countries or regions are working on the Park. As a high-reputation Science Park, the numbers of companies and employees are still increasing.

Within the lively cluster, scientists, entrepreneurs and students can be bind tightly and interact to stimulate innovation. Lots of regular meetings and social events are organised by the Science Park, and these events promote the chances of interaction and cooperation between on-park actors. What is more, the Park is a typical PPP science park, which is managed by the foundation of the Science Park. The foundation was changed in 2019, and the current stakeholders are Leiden University, Leiden University Medical Centre, City of Leiden, City of Oegstgeest, Entreprise Association and Janssen. Therefore, the decisions are made under the balance of all parties of the Science Park, and all resources of involved actors can be used more smoothly.

Development vision
The Province of Zuid Holland outlines Leiden Bio Science Park as a knowledge intensive cluster or so-called knowledge axis in this region. City of Leiden also has an ambition to create a knowledge city and wants to develop the area as a top of knowledge area in Europe in the domain of life sciences and health. From the perspectives of government, the Science Park is working on solving the health problems in society, especially the gaps between high-income people and low-income people. There is a vision that people in Netherlands can live 5 years longer and get better health. Leiden Bio Science Park plays a key role in human health and produces many important discoveries, such as World first fluid vaccine Quivaxem produced by Crucell, the first medicine against Duchene muscular dystrophy produced by Prosensa and the LUMC and so on.

The Science Park aims to create a green area where scientists, entrepreneurs and students can work, live and develop together. Many important discoveries have been made in LBSP, giving rise to the Park's Motto "Key to Discovery". In order to develop this Science Park future into a more complete cluster, the companies in different development stages, from research companies to production and suppliers will be accommodated. Nowadays, there are many companies from more than 14 countries and regions on this Science Park. Therefore, the visions of the Park are becoming a top science park in worldwide and creating more add value for human society.

Development stage

For over 35 years now, Leiden Bio Science Park has become the number 1 Life Sciences & Health hotspot in The Netherlands and also the top five successful science parks in the Europe. In the early of 1980s, a new building was built in order to support the small innovative companies to develop with the help of Leiden University. This building, the Academic Business Centre, became the seed for Leiden Bio Science Park. This was an experiment of the municipality and the university, and the province and central government also provided their supports. At the same time, a professor named Rob Schilperoort played key roles in driving the Science Park. He went to America under the support of Dutch government and became enthusiastic about the first American science parks. Therefore, he convinced the university and government to develop a bio-technical science park. The trip to America also brought two biotech companies who wanted to come to the Netherlands, and to Leiden: Centocor, which developed medicines, and Molecular Genetics, which worked on agricultural crops. Leiden Bio Science Park was established in 1984. Rob Schilperoort played his role as trailblazer was almost finished in 1990. In the beginning, the municipality of Leiden decided to sell some lands to some companies in order to stimulate the activity of this area. Then, there are several companies invest in the real estate development of LBSP. After that, there are several large companies move in or invest to purchase the equity of some start-ups or scale-ups, such as the Johnson & Johnson. The Leiden Bio Science Park foundation was set up in 2006, which represents a public-private partnership. The foundation was set up for the purpose of growth the park in size and quality. In 2019, the foundation was changed. The new stakeholders are City of Leiden, City of Oegstgeest; Leiden University, Leiden University Medical Center (LUMC), Entrepreneurial association and Janssen. Now in the late 10s the triple helices play essential roles in the park development. It is a real joined effort of municipalities, the province, Innovation Quarter and the NFIA on the government side, on the research institute side predominantly the LUMC and the university (and a bit TNO, the university of applied science and the LIS) and finally the companies. ***Table 5.1*** shows the overview of the key moments of Leiden Bio Science Park.

Table 5. 1 An overview of key events of Leiden Bio Science Park

Year	Event
1983	Professor Rob Schilperoort went to America and brought back the idea of Science Park.
1984	Incubator BioPartner Centre (Academic Business Centre) was established by the

	Ministry of Economic Affairs, the Municipality of Leiden, Leiden University and the LUMC.
1984	American companies Centocor and Molecular Genetics decided to open an overseas plant in Leiden.
1984	Leiden Bio Science Park was established by Leiden University and Municipality of Leiden.
1987	Centre for Human Drug Research was founded on the Science Park by public fund.
1987	Leiden Academic Centre for Drug Research was established by public fund.
1999	Centocor (Janssen) became a wholly owned subsidiary of American company Johnson & Johnson.
2006	Leiden Bio Science Park foundation was set up.
2009	American company Johnson & Johnson bought 18% stake in Crucell.
2016	Pre-incubator PLNT was established.
2019	Leiden Bio Science Park foundation was re-organised.

Most companies grew up on the Science Park from the beginning. At the current stage, Leiden Bio Science Park has built a vibrant innovation ecosystem where offers the full biopharmaceutical value chain of drug development, from target definition to a registered and ready-to-market product, and relevant business services. The park is famous enough for attracting impact partners and there are many companies from start-ups to large firms with strong power in innovation. Many regular meetings, social events and R&D events are organised by the Science Park. However, there are not many formal R&D events are organised and more innovation governance is needed in the next development step of Leiden Bio Science Park.

5.2. Innovation network building and governance

For over 35 years' development, Leiden Bio Science Park has developed from 3 organizations to 214 organizations now and is working on optimising innovation network governance. Based on the theoretical framework proposed previously, the performance and strategies of Leiden Bio Science Park in terms of innovation network building and network governance are discussed.

5.2.1. Innovation network building

Based on the theoretical framework, there are two main factors influencing the innovation network building of the Science Park. The first one is breath and density which refer to the numbers and sorts of company and entrance criteria of Science Park. The second one is proximity, which includes cognitive proximity, social proximity, organizational proximity and geographical proximity.

Density and Breadth
Leiden Bio Science Park counts 214 organizations now. From the establishment of

the Science Park, the numbers of companies and organizations increase continuously. *Figure 5.3* shows the increase trends of companies and organizations from 1984 to 2020 with an interval of five years (Jousma et al., 2009; Leiden Bio Science Park Official Website). The numbers are counted at the beginning of each year. Most of the growth came from the establishment of start-ups and spin-offs, and most of the spin-offs have Leiden University or Leiden University Medical Centre involved (Jousma et al., 2009). Many of those start-ups and spin-offs have developed to scale-ups. There are also some companies choose to move into the Park or start a division on the Park.
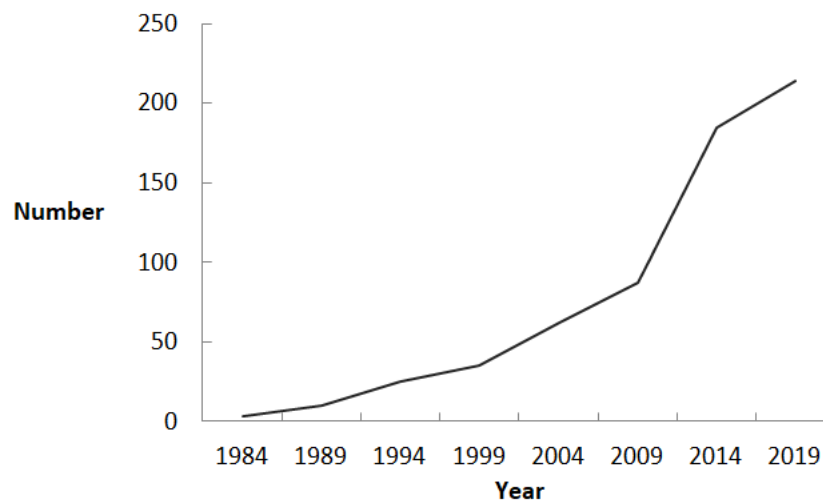
Figure 5. 3 Increase trends of companies and organizations

With the development of the Science Park, a full biopharmaceutical value chain of drug development has been built. The Park accommodates companies in all size, from start-ups to multinationals and companies in all sorts, from drug developing and medtech companies to service providers and dedicated business services companies. The types of 150 companies are shown as *figure 5.4* (Leiden Bio Science Park Official Website). There are also several companies and organizations offer services support, which is shown as *figure 5.5* (Leiden Bio Science Park Official Website).

January 2019
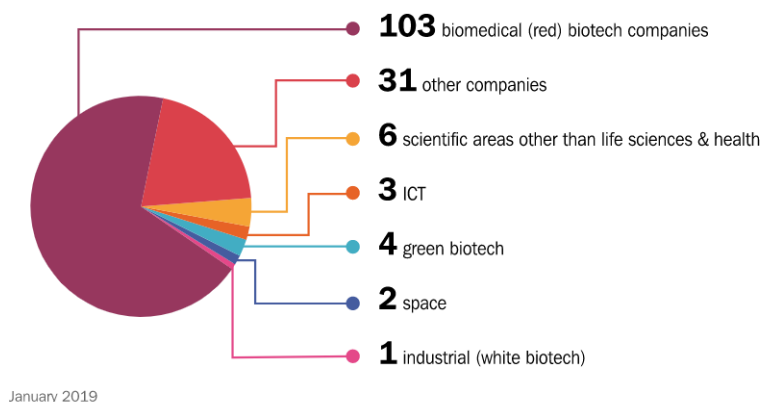
Figure 5. 4 Main types of on-park companies (Leiden Bio Science Park Official Website, retrieved from https://leidenbiosciencepark.nl/the-park/facts-and-figures)
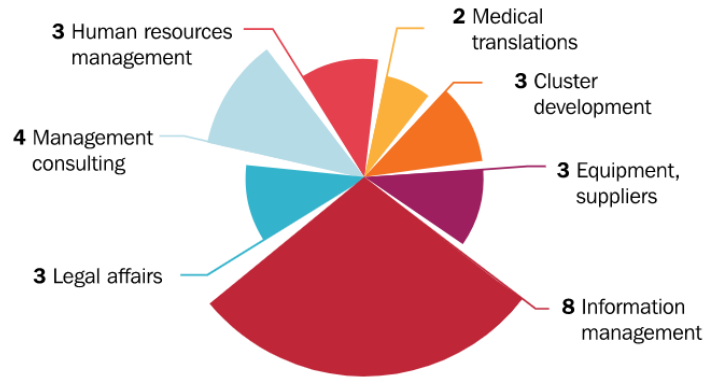
Figure 5. 5 Service supporters (Leiden Bio Science Park Official Website, retrieved from

https://leidenbiosciencepark.nl/rd/drug-development-services-and-business-services
)

Lots of jobs are also created due to the development of on-park companies and organizations. Between 1984 and 2019, the number of on-park people has almost quadrupled to a total number of 19,026 at the beginning of 2019. *Figure 5.6* shows the increase trend of employees working on the Science Park (Jousma et al., 2009; Leiden Bio Science Park Official Website).
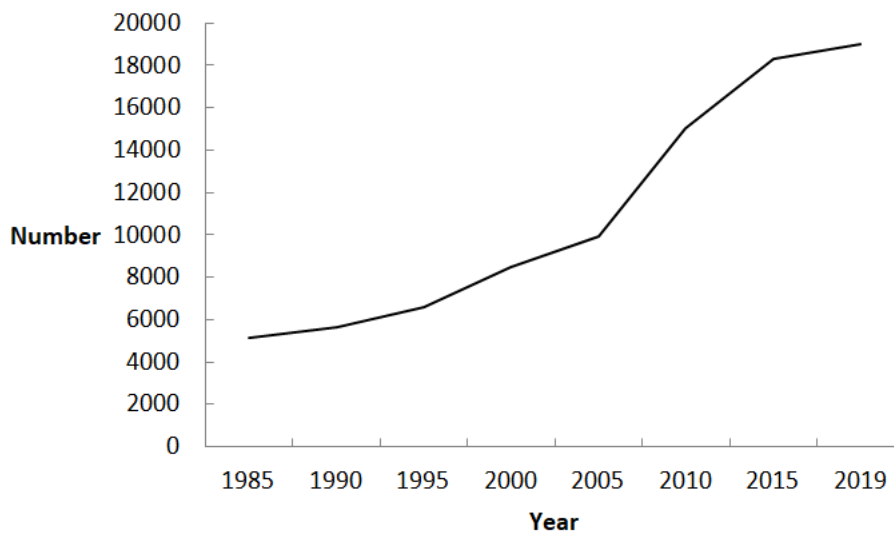
Figure 5. 6 The increase trend of employees working on the Science Park

However, with more and more companies and people coming in, the challenge for Leiden Bioscience Park is land shortage. The Park can continue to increase its density or build more high-rise buildings. But the living environment comfort always needs to be considered.

Proximity
It is not easy to describe proximity with mathematical data. Therefore, the descriptions of proximity are based on the interview results and are divided into four aspects.

Cognitive proximity
The strict entrance criteria ensure the cognitive proximity between on-park actors.

All on-park parties are working on biotechnology related business. Therefore, a similar knowledge base is established on the Science Park. The Park also support several share research facilities and provides some training programs which also benefit for the cognitive proximity between on-park actors.

> *We have strict entrance criteria. It means that only bio-technology related companies or organizations can locate on the park. Therefore, on-park actors have more chances to contact and cooperate with each other due to the similar research topics (Interviewee 10, 2020).*

> *We provide several training programs, for example the Biotech Training Facility and Paul Janssen Futurelab Leiden. These professional training programs aim to help train staff for all aspects of the job (Interviewee 11, 2020).*

Except training programs, there are also many joint-education programs. These programs are from dedicated vocational training to specialized PhD programs. Many education programs are provided by the joint-effort of university, research institutes and some companies.

> *We cooperate with Leiden University to develop several PhD programs. We invest in those fundamental researches and also hope these talents can contribute to our development (Interviewee 14, 2020).*

What is more, there are many R&D events, such as TechTalks which is organised by the Science Park and Luris (Technology Transfer Office of Leiden University), are organised on the Science Park. These R&D events provide more opportunities for on-park actors to interact with each other.

> *We will learn about the research trend in worldwide and select several interesting topics and invite actors related to participate in the events. We provide many opportunities for on-park actors to contact with each other and promote their cooperation chances (Interviewee 11, 2020).*

> *As technology transfer office, we learn about the researches of university and also the on-park actors. We together with the Science Park Office organise TechTalks as a regular R&D event (Interviewee 12, 2020).*

Social proximity
There is a multitude of regular meeting organised at the park (e.g. the Pharma Science Symposia, CEO breakfast etc.). What is more, there are also several social events and formal and informal gatherings. These social events make the community more vibrant and promote the mutual trust between on-park actors.

> *I think these social events are useful for developing personal relationships between on-park actors. Most of them are willing to participate in these events. And this can also promote the knowledge and information exchange between the actors, thus stimulating innovation (Interviewee 12, 2020).*

> *We can talk with each other at CEO breakfast and it helps to exchange our information and promote our cooperation chances to a certain extent (Interviewee*

14, 2020).

> *People are always willing to participate in these social events and sports days, and I think it is good for developing their social relationships (Interviewee 10, 2020).*

Not only these social events make contributions to the social proximity between on-park actors, there are also many public facilities, such as Grand Café "De Stal" and the Life Sciences café, for actors to develop their social relationships. People can have a communication or party at these public meeting places.

Organizational proximity
Leiden Bio Science Park is managed by the foundation of the Science Park. The foundation consists of representatives of all on-park parties. Therefore, on-park actors have more opportunities to interact with each other due to under the same set of governance system. What is more, most of companies grew up on the Science Park from the beginning and most of these start-ups and spin-offs have connections with Leiden University or Leiden University Medical Centre. With the development of small businesses on the Park, several successful ones are bought by the world famous companies. For example, Centocor, which is known as Janssen now, and Crucell are acquired by American company Johnson & Johnson in whole or partly. The American company brings in the capital and also brings in their work styles.

> *Actually, all on-park parties are involving in the Park development. The foundation was changed at last year, and the new foundation consists of all the triple helices. (Interviewee 11, 2020).*

> *The foundation was changed because stakeholders concluded the park needed a face to the outside and the association of entrepreneurs was not sufficiently able to be that face on behalf of all companies, knowledge institutions and the authorities. The change was driven by all stakeholders at that moment; the two municipalities, the knowledge institutes (LUMC and University Leiden) and the entrepreneurial association. (Interviewee 16, 2020)*

However, there are also some challenges due to the organizational proximity between certain companies. For example, Crucell is an important bio-technology company on the Bio Science Park. But the company even has no connection with the Centre for Human Drug Research in vaccine development.

> *We have never talked with each other although we are close. They may work on their vaccine works in America. It is interesting. It is not because we have a fight and don't like each other. This is quite worth to think (Interviewee 14, 2020).*

Geographical proximity
For over 35 tears' development, the infrastructure and facilities are quite mature now. It is not difficult to reach the Park and to find any company. The Science Park is committed to easy accessibility of the infrastructure in and around Leiden Bio Science Park. The accessibility of the businesses should be excellent due to the nearby A44 motorway. In addition, although it is hard to get to everywhere within the Park by public transport, it is near to the central railway station of Leiden City

and easy to get to the Park on foot. The office of Bio Science Park will also take some actions if there are some problems.

Municipality of Leiden as one of the stakeholders of Leiden Bio Science Park foundation mainly takes responsibilities for the infrastructure development and special planning.

We have a foundation and we get feedbacks through our meetings. The municipality plays key roles in the infrastructure development and special planning. We will make sure the Science Park can be easily access and also the infrastructure and special plan within the park is convenient (Interviewee 16, 2020).

What is more, the Science Park has many public places and shared facilities, which can mitigate the geographical gap between each actor. The urban amenities, such as path and bicycle road, are mature now and the map of the Science Park can be downloaded on the official website. It is convenient and clear for anyone who wants to visit any organization on the park and easy to get there by walk or by bicycle. Now, a new road RijnlandRoute is under construction and it will provide better access to the Leiden area and improve traffic flow between Amsterdam, The Hague and Rotterdam.

Conclusion

This section mainly talks about the breath and density of Leiden Bio Science Park and also the proximity within the Science Park. Leiden Bio Science Park accommodates 214 companies and organizations now which are in all size, from start-ups to multinationals and in all sorts, from drug developing and medtech companies to service providers and dedicated business services companies. There are still 300000 m^2 of green fields are waiting for developing. However, the density of the Park will become quite high in few years due to the strong brand of the science park. The Science Park organises a lot of social and R&D events and provides many training and education programs in order to promote the chances for on-park actor interact with each other and develop their knowledge database. ***Table 5.2*** provides an overview of the factors of network building in Leiden Bio Science Park.

Table 5. 2   Overview of network building factors in TU Delft Campus

	Current strategies	Challenges
Breadth	-Attract bio-technical firms and organizations from all size; -Attract all sorts of firms under the bio-technology value chain; -Establish other facilitating organizations, such as PPP platforms and training centers.	-With the development of the Science Park, the shortage of lands becomes the main challenge.
Density	-Due to the shortage of lands now, the first strategy is building in high density and	

	the other strategy is building in high rise.	
Cognitive proximity	-Provide training programs; -Establish pre-incubator, incubator and accelerator; -Strict entrance criteria; -Education programs between student and on-park firms; -Support several public places for actor to exchange knowledge and information.	-The knowledge resources of companies, research institutes and university should be matched better.
Social proximity	-Organize Several social events; -Support several public places for actors to develop social relationships.	-The social proximity is maintained well in Leiden Bio Science Park now.
Organizational proximity	-Many start-ups and spin-offs are connected with Leiden University or LUMC; -Several companies are bought by the same headquarters in worldwide; -All on-park actors are managed by the Science Park Foundation/ Office.	-More formal R&D events can be organised to promote interaction between different organizations;
Geographical proximity	-Develop infrastructure within and around the park; -Improve urban amenities of the Science Park; -Provide the map of Science Park for visitors.	-No obvious challenge now.

5.2.2. Innovation network governance

This section describes the performance of innovation network governance in the Leiden Bio Science Park. Innovation network governance aims to involve all innovation related parties with in the Science Park in decision making process and steer actors' behaviour for achieving collective goals. Actually, from the perspective of innovation, it is hard to steer the development directions and results due to the high uncertainty. However, good governance can provide more opportunities for them to interact with each other, thus stimulating innovation creation and development, rather than they build innovation network organically. According to the theoretical framework, the assessment is based on *1) whether the stakeholder involvement processes are facilitated; 2) whether there are resources matching and allocation work done; 3) whether related stakeholders are involved in the decision making processes and influenced by the decisions*.

Stakeholder involvement
Leiden Bio Science Park has experienced a development of over 35 years. There are also several phases of stakeholder involvement of the innovation networks. At the beginning, there was no network governance. University, especially the professor Schilperoord played main roles in engaging powerful stakeholders. In the 1990s, the science park was included in the development vision of city of Leiden. Therefore, municipality of Leiden also involved in the stakeholder involvement

processes. Nowadays, with the development of the science park, there are more diverse actors with different stakes participating in this innovation ecosystem development. Therefore, the decisions of who are welcome to the park are co-decided by the representatives of on-park actors. What is more, the triple helices not only interact on the science park level. Leiden Bio Science Park is the most successful knowledge hub in local area and an important actor of Medical Delta, so its development always influenced by the local, regional and national interventions. It is a real joined effort of municipalities, the province, InnovationQuarter and the NFIA on the government side, on the research institute side predominantly the LUMC and the university and a bit TNO, the university of applied science and the LIS and companies now.

Resources matching and allocation
Leiden Bio Science Park has built a vibrant innovation ecosystem now and proposed many strategies to facilitate the resources transfer. The park now is managed by the foundation and this ensures that all on-park parties are involving in the park development. The current stakeholders are municipality of Leiden, municipality of Oegstgeest, Leiden University, LUMC, Janssen (the biggest company on the park) and Entrepreneurial association, representing all the on-park companies. Therefore, the important decisions are made with the agreement of all the university, municipality and industry and the interests of every party can be considered. Therefore, the resources of each actor can be transferred more smoothly under the negotiation and coordination of representatives of them.

> *The Science Park is owned by the foundation now. Triple helices are involved in the park management and participate in the decision making process. You can say that every important decision is made by all on-park parties (Interviewee 11, 2020).*

> *We will talk about the development direction and demands of the Science Park within the foundation. The foundation represents all the triple helices (Interviewee 11, 2020).*

Similar with the TU Delft Campus, LBSP also set up several PPP platforms, such incubator BioPartner, pre-incubator PLNT and so forth. These interfaces involve triple helices from local, regional and national level to interact with each other and share their resources to achieve collective goals. What is more, the science park has become an important node of national bio technology network. Therefore, government on regional and national level also takes care of innovation development of the science park and propose funds and policies to stimulate its development.

On park level, there are also several facilitating strategies for stimulating the interaction and resources sharing. The staffs of Science Park Office always learn about the trend of the bio-technology in worldwide and organise several R&D events for related on-park actors. Luris, the technology transfer office of Leiden University, also involves in the R&D events organization. It makes university and industry bind together through these events. What is more, CEO breakfast is also held once a month, and this provides more opportunities for CEO level to communicate with each other, thus promoting their innovation cooperation

opportunities.

We learn about the research trend and find the interesting topics for the on-park actors. We organise TechTalk with Luris for companies and research institutes in order to help them develop their R&D capabilities and promote their communication and cooperation chances. We also organise other formal or informal R&D events (Interviewee 11, 2020).

I can contact with other CEOs during the CEO breakfast, but it is just a one hour breakfast and happens once a month. It helps to promote the cooperation opportunities between on-park actors, but not as much as it is expected (Interviewee 14, 2020).

It is obviously that there are several governance measures in terms of innovation networks building and development. However, the challenge now is that most of the R&D events are informal and more formal events need to be organised. More innovation resources matching works should also be done.

We need more formal events to make actors do real things rather than only informal R&D events (Interviewee 11, 2020).

They should learn about what on-park actors are doing and match the resources between them (Interviewee 14, 2020).

Decision making
As mentioned, the park is controlled by the foundation, which consists of six stakeholders representing all the university, municipality and industry. All decisions are made under the balance of these stakeholders. Therefore, the boundary of each party is broken and the resources can be transferred sufficiently. The development of the science park represents the mutual interests of all on-park parties. Each party is also influenced by the decisions made by the foundation.

Actually, the decision making processes are not only occurred on the park level due to the position of the science park on regional and national biotechnology development. In order to achieve higher level goals, the regional and national interventions also influence the decision making process. For example, regional and national government provide some funds or policies to stimulate the development of certain research topics. The development of the science park should also in line with the city and higher level goals.

In conclusion, Leiden Bio Science Park involves all the university, municipality and industry in the innovation development of the science park and also fulfils its roles in the city and regional development. Triple helices interact with each other at several levels. Several facilitating strategies are used in stimulating the resources transfer. However, the resources matching works are not enough for the innovation development of on-park actors and more formal R&D activities are needed. ***Table 5.3*** shows the overview performance of LBSP on innovation network governance.

Table 5. 3 Overview performance of LBSP on innovation network governance

Factors	Performance

Stakeholder involvement	-University, municipality and industry work together on stakeholder involvement process; -The involvement process is under the balance of all on-park parties and in line with the city and region ambitions.
Resources matching and allocation	-Triple helices interact with in the PPP platforms, and also the science park and local and regional level. Resources are transferred under their negotiation and coordination. -Resources matching works within the science park are not enough now.
Decision making	-All the triple helices of science park have power in decision making and they influence each other; -Triple helices also interact beyond the park level to achieve the local, regional and national goals.

5.3. Roles of university, municipality and industry in innovation network building and governance

Based on the theoretical framework, there are four dimensions, lands and real estate dimension, community dimension, R & D dimension and board level, that the triple helices should involve in to provide a better environment for innovation networks building and governance innovation networks. This section mainly discusses about the roles of university, municipality and industry played in the four dimensions to create innovation networks building environment and governance innovation networks.

5.3.1. Lands and Real Estate dimension

Lands ownership determines the structure of real estate development, and further determines the breadth and density of the Science Park. Leiden University owns most of the lands of Leiden Bio Science Park, and makes contracts for ground lease with parties that want to build. An overview of the landownership of Leiden Bio Science Park is shown as *figure 5.7*. The blue area is owned by Leiden University, the yellow area is owned by LUMC and the green area is owned by municipality of Leiden
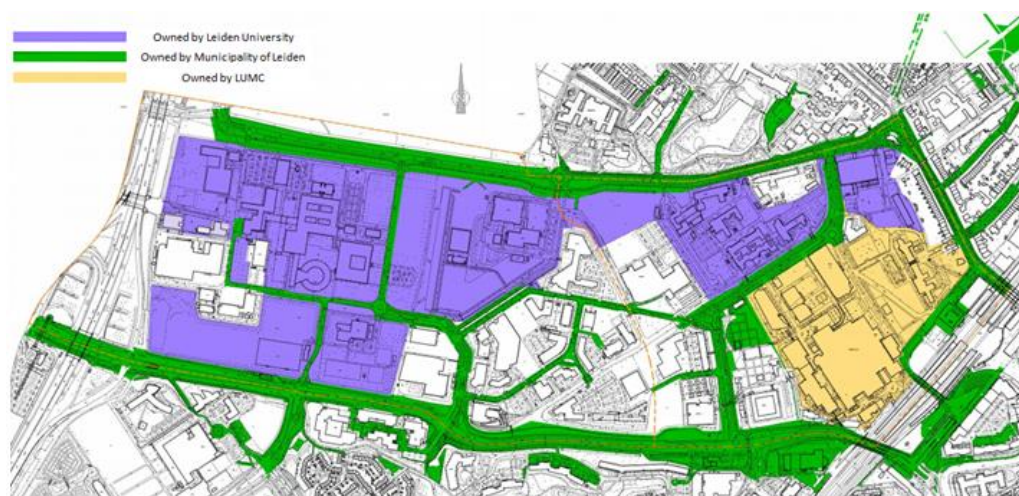
Figure 5. 7 Overview of landownership on Campus

As shown in the picture, the white area with in the Science Park was owned by the municipality. These lands were sold to the developers in order to attract more developers at the early development stage.

Companies are always interested in getting lands. At the beginning of the Science Park development, municipality decided to sell some lands to simulate the park development. Those lands were sold immediately (Interviewee 16, 2020).

At current stage, most of lands are owned by the university and will not sell the lands forever. University will lease the land for construction companies and these companies should pay for fees.

Leiden University chose to have a long term vision on the LBSP. Beside that the branching is regulated in the rural planning and in a branching committee and both the municipality and University keep a strict branching at the park. In order to achieve this all, university made the decision never to well their lands so that are always in control of the branching and ownership (Interviewee 16, 2020).

Roles of university, municipality and industry in the real estate development
Leiden University owns the most of lands and therefore has power to decide the lands use of the campus and has strong power in making final decisions on who are welcome to the Science Park. Municipality of Leiden also takes responsibilities for the rural planning and give permits for the new buildings. Due to the policy that university will never sell its lands and government also has limited capital for investing in real estate development, the major investment comes from the construction companies and other big investors. Therefore, the university, municipality and industry should cooperate with each other to contribute to the real estate development of Leiden Bio Science Park.

Leiden University owns the most of lands and co-decide the lands use on the park. Although there is a regular meeting with the foundation to decide the land use, university has the strongest power due to the ownership.

The university is the owner of a large part of the land so has to co-decide what to do with the land. But there is a regular meeting with the foundation and the municipalities about the area development so actually we decide together (Interviewee 13, 2020).

University has the strongest power in deciding who are welcome to the park due to the ownership of the lands (Interviewee 11, 2020).

Another important stakeholder in the real estate development is municipality of Leiden. Municipality has the legislative power on the spatial planning and giving the permits for new buildings. As one of the members of foundation, municipality of Leiden also involves in the discussions on the land use and whether a new company is welcome to locate on Park. What is more, municipality also provides some financial supports for the real estate developing.

We interview the university and the companies to find they need and translate their demands in the rural planning. What we do is to learn about their demands

and try to help them to be successful (Interviewee 16, 2020).

During the 35 years' development of Leiden Bio Science Park, real estate developed step by step. At the beginning, municipality of Leiden sold some lands to the companies in order to stimulate the area development. The strategy made sense because the lands was sold our immediately. With the development of the Park, more and more investors are willing to rent the lands from Leiden University and construct their own buildings. Now a complicated business system is established between the land owner, construction companies and tenants. There are also three companies locating in the city of Oegstgeest, and a fourth one is under construction. Therefore, the municipality of Oegstgeest also plays a role in the real estate development of the Science Park. The current real estate development scheme is that university offers the lands and also invests in their own new buildings, municipality gives permits, drafts the urban spatial planning and maybe some money and industry, mostly the construction companies, provides major investment.

We work together with the municipality and companies, but of course the main drivers are the companies who want to expand their business in the Bio Science Park. We as a university are not only the land owner but also one of the organizations who invest a lot in new buildings. And also BioPartner, the incubator, invests at the moment in a new building (Interviewee 13, 2020).

Most companies are not willing to construct their own buildings for developing business. Therefore, there are several construction companies who construct the buildings and rent the working spaces to tenants. A complicated business model has been established on the Park (Interviewee 11, 2020).

Municipality has limited resources in the knowledge producing and capital support. The strongest strategy of municipality is the rural planning, which can stimulate the development of Science Park (Interviewee 16, 2020).

Figure 5.8 shows the roles of university, municipality and industry in real estate development briefly.
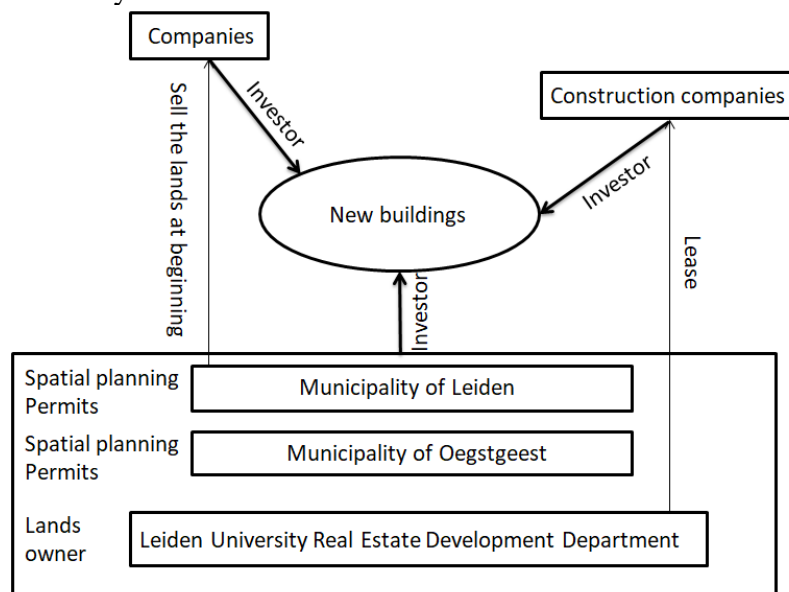
Figure 5. 8 Real estate development on Leiden Bio Science Park

In conclusion, according to the development phases, there are two main real estate development strategies. Firstly, at the early development stage, municipality of Leiden sold parts of lands to the developers and stimulated the area development. With the development of the Science Park, there are more and more investors come to invest in the real estate of this area. Currently, the university lease the lands and several construction companies invest to build new buildings and then become part of community. Most of the external investors invest on new buildings for earning rent fees. Therefore, the main roles of university are land owner and the strongest decision influencer. The main roles of municipality are legal supporting, decision influencer, coordinator, and investment attractor. The main role of industry is investor and developer. ***Table 5.3*** illustrates the overview of university, municipality and industry play their roles in the Leiden Bio Science Park real estate development.

Table 5. 4 Roles of university, municipality and industry in lands & real estate dimension

	Early stage	**Current scheme**
Configuration	-Municipality of Leiden sold the lands; -Investors & developers develop real estate; -Lands ownership is transferred	-Leiden University leases the lands; -Investors & developers develop real estate and pay for land using;
Roles of university	-Decision influencer.	-Lands owner; -Strongest decision making influencer;
Roles of municipality	-Lands owner; -Legal supporting; -Decision maker; -Investment attractor;	-Legal supporting; -Decision influencer.
Roles of industry	-Investor and developer.	-Driver of a real estate development; - Investor and developer.

Add values of Lands & Real Estate dimension
Looking back on the real estate development of Leiden Bio Science Park, it can be found that real estate development of a science park is a long term process. Different strategies should be used in different development phases. At the beginning, municipality sold the lands to attract investors. This strategy flourished the area development and attracted several investors. Although university does not sell lands for commercial parties, the brand effect at current stage attracts many investors to construct buildings here.

Real estate development helps to increase the density of the Science Park and make the Park look more vibrant. With more and more companies locating on the Park, the Park becomes more attractive. With the real estate development, geographical proximity can be promoted, because more density more accessible for actors. However, the comfort of living environment should always be taken account of. What is more, social proximity may also be promoted because actors have more chances to communicate with each other. As a result, there are high chances to

promote cognitive proximity between actors due to the geographical proximity and social proximity and strict entrance criteria of the Science Park.

The functions of real estate should also be considered. It does not mean more buildings is better, but means more useful buildings and facilities should be built. The demands of the real estate development are always discussed on the foundation meetings.

Challenges

The biggest challenge on lands & real estate dimension is the land shortage for the future development. More and more companies choose to move in the Science Park because of the brand. Therefore, solutions of the challenge should be promoted ahead.

5.3.2. Community and brand building dimension

After decades of development, Leiden Bio Science Park has been a vibrant knowledge cluster with various companies, research institutes, education activities, professional training, supporting facilities and network and partnering events.

Roles of university, municipality and industry in the brand building and community building

There is a Science Park Office under the foundation who fulfils the task of park operation. Therefore, the brand building and community building are managed by the Science Park Office now.

For brand building, Leiden Bio Science Park has developed for 35 years, and there are mainly three phases during the Science Park development. At the beginning, Prof. Schilperoord played the key roles in the brand building. The reputation of Prof. Schilperoord promoted the attractiveness of the Science Park. After that, the municipality of Leiden realized the importance of the Science Park for knowledge economy development. Therefore, the municipality and university worked together to develop brand of Science Park. With the development of the Science Park, some companies developed to larger ones and had an impact on the brand building. All parties are making contributions to the brand building now.

I think in the beginning Prof. Schilperoord was most crucial during the late `80s. After that, in the 90`s I think it was mostly a joined effort of the municipality and the university. After that in the 00`s it was predominantly the larger companies (Centocor and Crucell that "made the name"). And now from the `10s onwards it really is the park organization, in which all partners are represented (though in the beginning the municipality of Leiden was most important). So now in the late `10s it is a real joined effort of municipalities, the province, InnovationQuarter and the NFIA on the government side, on the research institute side predominantly the LUMC and the university (and a bit TNO, the university of applied science and the LIS) and finally the companies (Interviewee 11, 2020).

The municipality finally realized the importance of Leiden Bio Science Park for the economy and area development. But I think it would be better if they realized that earlier (Interviewee 14, 2020).

Actually, at current stage, the brand of Science Park is quite famous in the Europe. However, looking back to the development of science park brand building, it can be found that all the university, municipality and industry play roles in the brand building. The roles of university, municipality and industry in brand building of Leiden Bio Science Park are described in *table 5.4*.

Table 5. 5 Roles of university, municipality and industry in brand building

Actors	Explanation
University	-Co-brand designer; -Brand developer.
Municipality of Leiden	-Co-brand designer; -Brand developer.
industry	-Brand developer.
Leiden Bio Science Park Foundation	-Brand maintainer; -Brand developer

For community building, Leiden Bio Science Park has built a vibrant cluster for all on-park actors to study, do research and live. The park office organizes many social events and formal or informal gatherings. For example, there are monthly Life Sciences Café at De Stal, regular R&D meetings, HR network, the network of Leiden female beta scientists and so forth. What is more, the park also organizes several sports activities, such as Leiden Bio Science Park Sports Day, Leiden Bio Science Park Football Competition and so on. These social or R&D events provide the opportunities for on-park actors to interact and make them familiar with each other.

We organize a lot of events for the park users and these events can promote their cooperation chances. They are willing to participate in these social or R&D events (Interviewee 11, 2020).

I think these social events indeed promote the mutual trust of on-park actors and help them to develop personal relationships. It will benefit their cooperation and stimulate innovation (Interviewee 12, 2020).

The community building is mainly the task of Bio Science Park Office, who is hired by the foundation. On-park actors pay the fees for the park development and the money will be used for the park operation (Interviewee 11, 2020).

In conclusion, the Science Park Office takes the responsibility for community building. Employees of on-park firms and staff/ students of university are major users of the Leiden Bio Science Park, and in this case, the companies and organizations pay the fees for the park operation. Therefore, all the parties also involve in monitoring the performance of the Science Park Office. Municipality plays an important role as a facilitator and coordinator in helping the park to build a better living environment. The demands of the park users will be translated to the rural plan, and it will benefit for the community building due to the more facilities and better infrastructure. The roles of university, municipality and industry in community building are described in *table 5.5*.

Table 5. 6 The roles of university, municipality and industry in community building

of LBSP

Actors	Explanation
Leiden Bio Science Park Office	-Driver; -Manager.
University	-User; -Facilities supporter.
Industry	-User; -Facilities supporter.
Municipality of Leiden	-Living environment facilitator

Add values of Brand & Community building dimension

One of prerequisites of building community is developing the brand. A powerful brand can attract more actors with their resources and make them more willing to involve in the social events. What is more, a strong brand can bring on-park actors a better reputation, which benefits their business and promotes their capability of attracting R&D partners and funds. When there are many actors locating on the park, the community building becomes essential because only everyone has a sense of entirety, the common identity will be built and all parties will be bind more tightly. The social proximity between on-park actors can be promoted and their mutual trust as well.

Companies always pay more if they want to locate on the Park. They can only use the resources and participate in the park events when they become a part of community. They should pay for these resources. (Interviewee 11, 2020)

Challenges

As Leiden Bio Science Park has developed for 35 years, it becomes an international science park now. People on the park come from more than 14 countries and regions. For example, Astellas, Aeon Astron from Japan, TLC Biopharmaceuticals from Taiwan and the German Milteny Biotec and companies and people from other countries choose to locate on the Science Park. Therefore, cultural difference is a challenge for the community building now.

We provide Dutch courses for free, but I think it is not enough. Although people are open and willing to communicate with each other, there still are some cultural barriers. We should learn about their preference and also provide some courses on Dutch culture. (Interviewee 11, 2020)

American companies have different safe standard and culture from us. For example, the building of Janssen is surrounded by the guardrails. However, we prefer to build an open area, but in the end we compromised. (Interviewee 16, 2020)

5.3.3. R & D dimension

Leiden Bio Science Park becomes the top five successful science parks in Europe and number 1 life science cluster in the Netherlands. There are more than 100 biomedical life science companies working together with the university and research institutes. They are dedicated to the development of vaccines, innovative drugs, and platform technologies.

Roles of university, municipality and industry in the R&D development

University is a large knowledge factory where the knowledge and qualified talents are produced. Leiden University and Leiden University Medical Centre set up a technology transfer office, Luris, which aims to connect with the industry. Luris not only registers the patent of the university and LUMC, but also provides many strategic and legal supports. Although Luris does not only focus on the innovation of bio-technology, most of cooperation between Luris and industry in terms of bio-technology are happened on the Science Park. Luris also encourages graduates and professors of university and LUMC to start a start-up or spin-off to develop their own business and provide funds for helping them. There are main two funds are provided, the first one is UNIIQ, which is set up by consortium of Erasmus MC, TU Delft, Leiden University and the regional development agency InnovationQuarter, partly made possible by the European Union through EFRO programme, and the second one is ELF Pre-seed, which is set up by Leiden University, LUMC and Rabobank. What is more, Luris helps the park office to organise regular R&D meetings, which provides more opportunities for on-park actors to interact and communicate with each other.

We are the technology transfer office of Leiden University and LUMC, an we do not only focus on the bio-technology and life science. But I think most of bio-technology related cooperation is happened on the park. (Interviewee 12, 2020)

We help to organise the regular R&D events. You know, people are always working in their buildings and they have no reasons to cross the street and communicate with each other. That's why we organise these events to stimulate their connections. (Interviewee 12, 2020)

Luris is located in PLNT, Leiden Centre for Innovation and Entrepreneurship, where companies, innovative students, entrepreneurs, investors, professors meet and inspire each other, exchange knowledge and work on innovation together. PLNT is an interface for the partners to connect with each other, which benefits for stimulating their interaction and cooperation. Such interfaces are important for innovation because these interfaces provide the chances for scientist, government, entrepreneurs and students to interact with each other and support each other.

PLNT is a pre-incubator where help students to take the first steps towards the future. We provide coaching, laboratory, financial supports and other helps to them. (Interviewee 15, 2020)

PLNT is a foundation with the major founders of Leiden University, Municipality of Leiden and Hogeschool. We are a non-profit organization and set up by the public funds. (Interviewee 15, 2020)

I think the interfaces between the triple helices are important, such as PLNT and BioPartner. When all the actors can connect with each other conveniently, there would be a better result. (Interviewee 15, 2020)

In addition to PLNT, there are also several interfaces, such as the incubator BioPartner and the triple helix organization Economie071 which aims to strengthen the economic structure in the Leiden region. BioPartner was established at the

beginning of the Science Park in 1984 by the support of the Ministry of Economic Affairs, the Municipality of Leiden, Leiden University and the Leiden University Medical Center. In 2002, another foundation, the Life Science Incubator Leiden Foundation was initiated by the Ministry of Economic Affairs and supported by Leiden University, LUMC and the municipality of Leiden. In mid-2007 both foundations merged. BioPartner plays a key role in supporting start-ups to scale-ups during the last decades.

Most of the companies grew up on the Science Park and go to success, for example Centocor, Crucell, Galapagos, Mentor, Pharming, ProQR and Prosensa. During their developments, a lot of supports are needed. Therefore, the pre-incubator, incubators and accelerators are important for the ecosystem. (Interviewee 15, 2020)

Although the university is the knowledge centre, many companies do not rely on the university too much. Life science and bio-technology research need long-term development and most R&D activities happen in the companies. However, the talents of the university are important for the companies, especially the start-ups and spin-offs. Start-ups always begin with a few people and the qualified workers are important for them when they grow up. What is more, some larger companies and research institutes are willing to invest in the fundamental research and set up joint-education programs with the university.

Our Science Park is a little different from other science parks. R&D always happens in the companies. Therefore, the companies do not rely on the university too much. (Interviewee 10, 2020)

At the beginning, there were many companies willing to develop their business on the Science Park due to their relationships with the professors of the university. (Interviewee 11, 2020)

There are not many large companies locating on the park and most of them growing up on the park. Those start-ups are always established with a few people, and with their development, qualified talents are important for their further development. (Interviewee 15, 2020)

We cooperate with Leiden University to develop several PhD programs. We invest in those fundamental researches and also hope these talents can contribute to our development (Interviewee 14, 2020).

In conclusion, Leiden Bio Science Park has established a vibrant innovation ecosystem with university, research institutes, and companies from all size and from R&D companies to services supporters. Leiden University mainly plays its roles as knowledge producer and talents supporter. In Leiden Bio Science Park, the university does not stand on the significant position. The renowned research groups, including Leiden University, LUMC and CHDR etc., make the Park strong in bio-technology research. These public sectors together with the municipality attract regional and national public funds to support SMEs on the park. What is more, the academia and non-profit organizations share the facilities with on-park actors and also provide several training programs. Larger companies, such as Janssen, also

cooperate with university of other research institutes to provide education programs and make large investment in the R&D development. What is more, the Science Park Office also fulfils its roles to organise several R&D events and try to stimulate R&D processes rather than it happens organically. An overview of the roles of university, municipality and industry in R&D dimension is shown as *table 5.6*.

Table 5. 7 Roles of university, municipality and industry in R&D dimension

	Explanation
Roles of university	-Triple helices interfaces (such as pre-incubator, incubator and so forth) co-founder; -Talents supporter; -Knowledge producer; -Technical facilities supporter; -Training programs provider; -Funds attractor
Roles of other research institutes	-Knowledge producer; -Co-initiator of PPP platforms, such as incubators; -Technical facilities supporter; -Training programs provider; -Funds attractor.
Roles of municipality	-Co-founder of PPP innovative platforms; -Policy supporter; -Funds attractor; -Investor
Roles of SMEs	-Innovation tester and developer.
Roles of larger firms	-Fundamental research investor; -Training or education programs supporter; - Innovation tester and developer.
Roles of Science Park Office	-Coordinator between each innovative actors; -Innovation process stimulator.
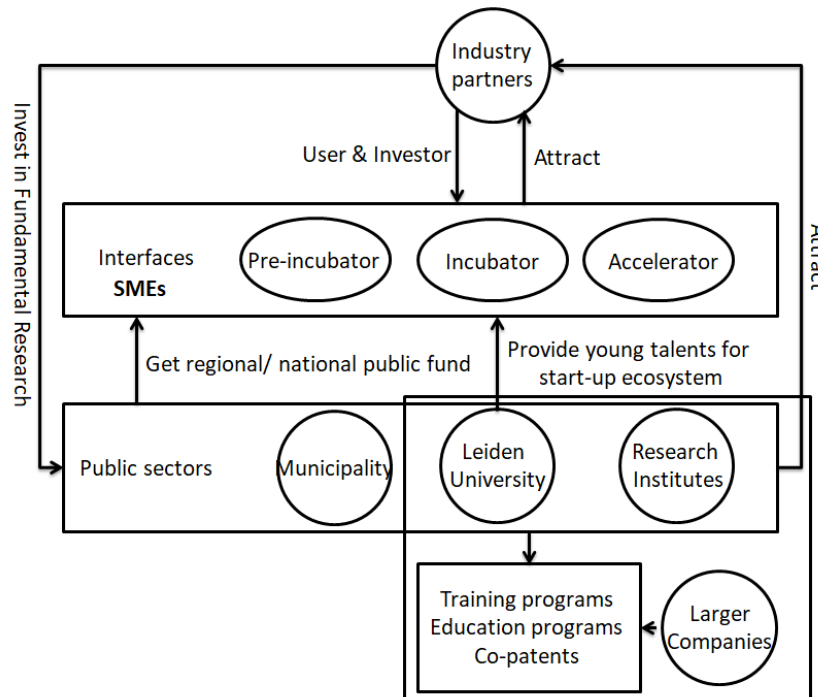
Figure 5. 9 An overview of R&D structure of Leiden Bio Science Park

Add values of R&D dimension

For over 35 years' development, Leiden Bio Science Park has accommodated various innovative actors. A vibrant environment has also been built for on-park actors to communicate and cooperate with each other conveniently. In addition to the vibrant environment, the park office also pays attention to the R&D events organization. These events promote the cognitive proximity and social proximity between the actors and promote their cooperation chances. Although innovation is hard to steer, but the governance of the innovation networks can stimulate the interaction and cooperation between each party, thus stimulating innovation performance.

Challenges

Although there are several R&D events organised by the Science Park, most of these events are informal and not very strict. It is more like social events rather than the R&D event. It can stimulate the interaction between actors, but only have limited impacts. Therefore, more R&D network governance are needed to make more real innovation results.

TechTalk is an informal event and open for everyone who is interested in the topics. It is not very strict. (Interviewee 12, 2020)

The park managers should learn about what people are doing here and make a database to match their resources. (Interviewee 14, 2020)

The challenge now is that few formal R&D events are organised. Only informal gathering cannot make much impact in innovation stimulation. We need more formal events to make people do real things. (Interviewee 11, 2020)

5.3.4. Board of Director Level

Board of director is the decision making level of the Science Park. They take the responsibility of the Park development. Leiden Bio Science Park is managed by the Leiden Bio Science Park Foundation. The foundation consists of six stakeholders representing the university, municipality and on-park firms. All on-park parties are involving in the decision making process directly or indirectly.

The foundation of Leiden Bio Science Park was re-organised in 2019. The current stakeholders are municipality of Leiden, municipality of Oegstgeest, Leiden University, LUMC, Janssen (the biggest company on the park) and Entrepreneurial association, representing all the on-park companies. Therefore, every important decision will be made under the balance of triple helices. Under the foundation, there is a Science Park Office taking responsibilities for the park management. A brief description of the Science Park operation structure is shown as *figure 5.10*.
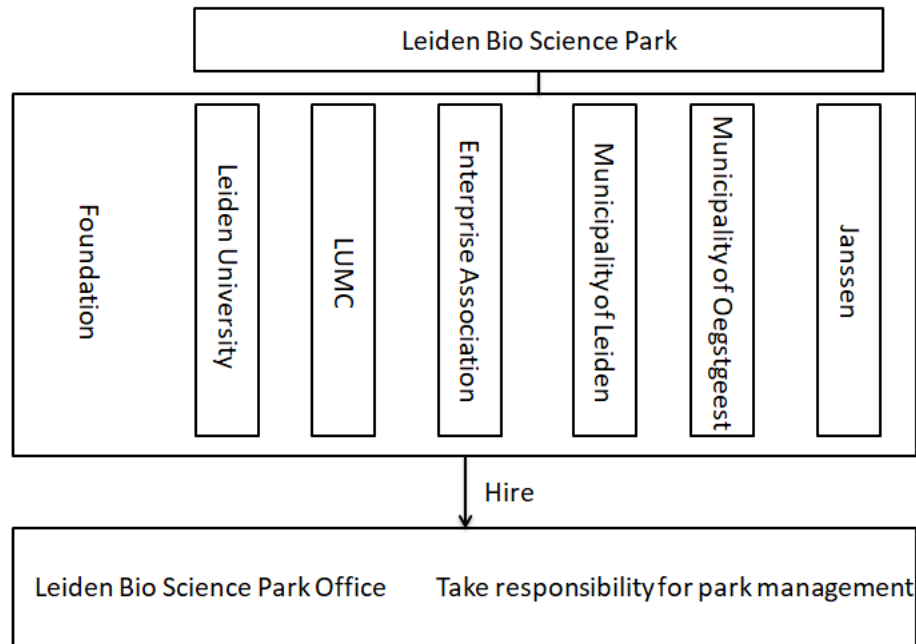
Figure 5. 10 Operation structure of LBSP

The stakeholders of foundation are selected according to the power and interests of the actors. Leiden University and LUMC represent for the research institutes, Entrepreneurial association represents all the on-park companies and also the two municipalities. It is noticeable that Janssen become one of the stakeholders due to its power and resources, although it is also one of the Entrepreneurial Association.

I think we have an advanced operation system, and it is different from most of the science park in Europe. The foundation of the Science Park represents for the all triple helices and all the decisions are made under their balance. (Interviewee 11, 2020)

We have a foundation and we will discuss about what are needed and what are the problems or bottlenecks. All parties are participating in the decision making process. It is helpful for the park development. (Interviewee 16, 2020)

Janssen as the largest companies on the park has many resources and high reputation. Therefore, this company is also selected as a member of the foundation. (Interviewee 16, 2020)

Under the Science Park Office, there are also several operating levels. Each level also consists of all the university, municipality and industry. Their resources can be used smoothly and their core values can also be protected under this operating scheme.

Actually, there are several operating levels under the foundation. It is quite complicated, but all the operating levels consist of the triple helices. Therefore, Leiden Bio Science Park is really a triple helices thing. (Interviewee 11, 2020)

In conclusion, the decision making process involves in all on-park parties. A separate management team fulfil the tasks of park management and their

performances are assessed by the foundation. Therefore, Leiden Bio Science Park can be called as a true triple helices science park.

Add value of the operating scheme of LBSP
Under this operating scheme, all on-park parties participate in the decision making process. It helps to make on-park actors to realise the collective goals rather than only goals of themselves. The representatives of each party sit around the table can promote speed and quality of the problems solving process. What is more, the park management team is supervised under the foundation. It is also good for the park development because if the office does not fulfil its tasks well, on-park parties would not want to pay for the office.

5.4. SWOT analysis

This section discusses about the strength, weakness, opportunities and threats of Leiden Bio Science Park in innovation networks building and governance. The SWOT analysis aims to provide an overview of the innovation network building and governance conditions of the case. Based on the SWOT analysis, some advice will be offered.

5.4.1. Innovation network building

Leiden Bio Science has established a vibrant innovation environment for on-park actors to build innovation networks.

Strength
Strength is positive internal factors of innovation network building of the Leiden Bio Science Park. Based on the results of field works, some strong points of innovation network building and governance are found. These factors contribute to the breadth, density and proximity of the science park. The positive factors are described as following:

✓ Leiden Bio Science Park has high reputation, and this attracts lots of new tenants;
✓ There are several famous research institutes locating on the park, such as Leiden University, LUMC, CHDR and so on;
✓ Leiden Bio Science Park stakeholders have strong networks in R&D development;
✓ The Park boasts highly trained staff, both academically trained and vocational;
✓ Leiden Bio Science Park, Leiden University and the LUMC are part of the regional life science and health consortium Medical Delta;
✓ Leiden Bioscience Park has state-of-the-art open life science research facilities and most of the facilities are shared with on-park actors;
✓ There are companies in all sorts: drug developing and medtech companies, service providers and dedicated business services;
✓ The Park has lively networks and many support facilities for the park users.

Weakness
Weakness is negative internal factor. For Leiden Bio Science Park, there are not many large firms who have strong power in supporting small businesses and

attracting industry partners. Start-up ecosystems need more supports to build linkages with others in order to get more resources. The factors are shown as following:

✓ There are not many large firms locating on the park;
✓ Start-ups and young companies need more coaching, inspiration programs, knowledge exchange and support in the field of finance, HRM and ICT;

Opportunity
Opportunity is positive external factor. These factors can help facilitate the network building by promoting the breadth, density of the park and proximity among different actors. They are elaborated as following:

✓ Leiden Bio Science Park has a strong medical and pharmaceutical image;
✓ Life science has broad development prospects;
✓ Dutch government attaches importance to the role of health and life sciences in economic and social development;
✓ The R & D of large pharmaceutical companies has been integrated globally, and the opportunities in the Leiden Bio Science Park lie in the research and development of many small and medium-sized biotechnology companies.

Threat
Threat is negative external factors. These external factors influence the breadth, density and proximity of the science park. The factors are shown as following:

✓ The competitions within the Science Park and the competitions between Bio Sicence Park and other life science clusters;
✓ Lands shortage in the future due to the rapid development of Leiden Bio Science Park.

5.4.2. Innovation network governance

Leiden Bio Science Park has an advances management system. The park has gone through the facilities and communities management phases and starts to pay more attention on the innovation network governance.

Strength
The representatives of university, municipality and on-park firms make the decisions are made under the balance of different interests and can also stimulate the resources flow.

✓ Leiden Bio Science Park Foundation consists of representatives of university, municipality and on-park firms. All on-park parties are involving in the decision making process directly or indirectly.

Weakness
Interventions to stimulate formal cooperation and resources matching works need to be improved in order to stimulate the linkages building of on-park parties.

✓ Although there are some measures for the innovation network governance, more formal R&D events should be organised.

✓ The R&D resources matching works between on-park actors are still not enough.

Opportunities

More external resources can support on-park actors to develop their innovation and build more linkages with both internal and external actors.

✓ International capital is injected into the science park. For example, the American capital has played an essential role in the park development. Janssen becomes one of the stakeholders of the park foundation.

Threat

Some external factors have negative effect on the resources flow and hinder the decision making processes.

✓ As the park becomes more international, some cultural differences may hinder the decision making process.
✓ More long tern subsidies or financial support are needed due to life sciences are characterized by long-term, expensive, and high-risk product development;

5.4.3. Conclusion

In conclusion, Leiden Bio Science Park has gone through the park management phases and tries to improve the governance on innovation activities. ***Table 5.7*** shows an overview of S, W, O, T of Leiden Bio Science Park in innovation network building and governance.

Table 5. 8 Overview of S, W, O, T of the Leiden Bio Science Park

	Innovation network building	**Innovation network governance**
Strength	**R&D dimension:** -Qualified talents; -Qualified research facilities; -Top-level life science research groups; -Part of Medical Delta program; **Community and brand building:** -High reputation in Europe; -Companies from all sizes and all sorts; -Lively networks and public facilities.	**Decision making process:** -All on-park parties are involving in the decision making process directly or indirectly.
Weakness	**Community and brand building:** -There are not many large firms locating on the park; **R&D dimension:** -Start-ups and young companies need more coaching, inspiration programs, knowledge exchange and support in the field of finance, HRM and ICT.	**Resources management:** -The R&D resources matching works between on-park actors are still not enough; -More formal R&D networks should be organized by the Science Park.
Opportunity	**Community and brand building:** -Leiden Bio Science Park has a	**Stakeholder involvement:** -International partners may inject

	strong medical and pharmaceutical image; **R&D dimension:** -Life science has broad development prospects globally; -Dutch government attaches importance to the role of health and life sciences in economic and social development; -The R & D of large pharmaceutical companies has been integrated globally, and the opportunities in the Leiden Bio Science Park lie in the research and development of many small and medium-sized biotechnology companies.	more activities in the park.
Threat	**Real estate dimension:** -Lands shortage in the future due to the rapid development of Leiden Bio Science Park; **Community and brand building:** -Competitions within the on-park actors and competition between park and other life science clusters.	**Decision making process:** -As the park becomes more international, some cultural differences may hinder the decision making process. **Resources management:** -More long tern subsidies or financial support are needed due to life sciences are characterized by long-term, expensive, and high-risk product development;

Based on the strength, weakness, opportunity and threat, the advice will be offered to promote the capability of innovation network building and governance through building on strengths, eliminating weaknesses, exploiting opportunities and mitigating treats.

Table 5. 9 SWOT analysis of LBSP

	Strength	Weakness
Opportunity	-University, municipality and industry should work together on attracting more public funds to develop research	-Leiden Bio Science Park Office should pay more attention on the R&D governance and more formal events need to be organised;
Threat	-As the park becomes more international, cultural differences should be noticed, and some measures should be proposed to mitigate the effects of cultural differences; -Strategies should be proposed to deal with the land shortage in the future real estate development	-Strategies should be proposed to mitigate the competition relationships between on-park actors and provide more chances for the cooperation

PART 5

Synthesis

Chapter 6 Comparison of Literature and Practice

6. Comparison of Literature and Practice

This chapter compares the findings of the empirical research with the information of theoretical research. The comparison is divided into three sections step by step. Section 6.1 mainly discusses whether both cases are facing the challenges of innovation network building and innovation network governance and verifies the add value of innovation network building and governance for the innovation creation and stimulation. Section 6.2 illustrates the main factors of the innovation network building and governance. Finally, section 6.3 describes the roles of university, municipality and industry played in the innovation network building and governance.

6.1. Verification

It is hard to compare the development model of TU Delft Campus and Leiden Bio Science Park due to the different focused topics, different duration, different location and many other factors. Not only for these two situations, each science park has its own special conditions and is unique. However, the in innovation network building and governance processes have some similarities and are essential for the innovation creation and stimulation of all the high-tech parks. The theoretical study has shown that many science parks are not as successful as they are expected due to the weak innovation network building and governance. This section mainly discusses about the performance of the two cases.

TU Delft Campus
For the performance of linkage building of on-park actors, the facilitation effect of the science park is limited. For different type and size of actors, they are benefited by the science park differently. The larger firms, such as Exact and 3M, do not depend much on the science park. They build their innovative linkages mainly depend on their own resources and they have few connections with other on-park firms. However, for small businesses, there are more opportunities for them to interact with others with the support of incubators and field labs. Based on the results of interview, the most innovative connections are built between on-park and off-park actors, and the connections building within the park are limited. There are several small innovation ecosystems have been established, such as Yes! Delft. However, there are not many connections between these sub-ecosystems within the science park.

TU Delft Campus is a relatively young science park which was started in 2005. During 15 years of development, the park has established several PPP innovative organizations and attracted various firms from start-ups to large companies. However, according to the results of the interviews, TU Delft Campus is still facing several challenges of innovation development. Although there are more than 200 companies locating on the campus, the variation of these companies are limited. Most the companies are start-ups and only few scale-ups locate on the campus. There are also few services companies, which focus on the certain fields, locating on the campus. What is more, the south of campus, where most companies located in, is still quite empty now. The infrastructure surrounding south area also needs to

be improved. The accessibility to the south of campus by public transport is low. The brand building of the Science Park is at the early stage and more strategies needs to be proposed to develop the social relationships between on-park actors. The biggest challenge for TU Delft Campus now is the real estate development. More working spaces are required for the new tenants. Few companies are willing to construct their own buildings on the campus, so no working spaces means no companies will come here.

The science park is also an important knowledge hub for the city development. Therefore, the park development is in line with the city development. Therefore, the university connects with municipality tightly on the park development and city development. University takes responsibility for engaging stakeholders based on the vision of science park development. Municipality of Delft also influences the stakeholder involvement processes due to the city development goals. Engaging more stakeholders in the innovation networks aims to use resources effectively and sufficiently. Resources management is a key issue of network governance. In order to stimulate resources transfer, the Campus set up several PPP platforms to involve all the university, municipality and industry in different levels. University, government and on-park and off-park firms interact and cooperate with each other in these organizations to achieve their collective goals. However, the interventions on park level and city level are not strong enough now. However, there is little facilitation on resources matching works and resources allocations beyond the organizational level. More strategies, such as R&D activities, should be proposed to facilitate the interaction between different on-park actors and also actors outside the park in order to stimulate resources transfer between different actors. There is no powerful industry partners involved in the decision making processes of science park development, although there are some interactions of triple helices beyond the park level.

The weak real estate development, brand and community lead to the low breadth, density and proximity of the science park. What is more, the interventions of stimulating interaction and resources flow are not enough as well. It can be concluded that the performance of on-park actors on the innovative linkages building is influenced by the innovation network building and governance. University, municipality and companies can work interactively on the four dimensions to promote the capability of innovation network building and governance.

Leiden Bio Science Park
Actors located on Leiden Bio Science Park build their innovative networks not only by their own resources, but also take advantages of the science park. On-park actors can get additional information and resources from each other due to the similar research topics and interaction opportunities created by the park management office. For larger firms, they do research not only by themselves, but also together with the university and other on-park research institutes. Small businesses are also supported by the universities, on-park research institutes and firms and other off-park partners. Due to the physical condition and interventions, such as R&D events, financial and policy supports, LBSP indeed facilitate the linkage building of on-park actors.

Leiden Bio Science Park is much more mature than TU Delft Campus. LBSP was

established in 1984, and a vibrant bio-technology cluster has been built with in the science park over decades of development. There are companies from all sizes and this cluster provides services throughout full of the (bio) pharmaceutical value chain. In order to gather on-park parties together and stimulate the interaction between them, there are many formal and informal events organised. There are also many shared facilities offered for on-park actors. Due to the high reputation and strong innovative resources, lots of companies are willing to locate on the LBSP and seek the cooperation with the university, research institutes and on-park firms. Therefore, it can be concluded that LBSP has a vibrant environment where scientists, entrepreneurs and students can easily get in touch with each other and drive an innovation network with in the Science Park. In another word, there is a good environment for the innovation network building on Leiden Bio Science Park.

Currently, LBSP is still facing some challenges. Although the management system of LBSP is advanced, the governance in terms of innovation networks still needs to be improved. In the past years, the governance works was mainly focused on the level of facilities and community on park level. There were not many works on R&D management. People always sit around table and discussed about how to improve the quality of living environment or other facilities. Although there are several regular R&D events organised on the Park, most of these events are informal and these events are mainly initiated for stimulating the contacts of on-park actors. Actually, innovative resources of each on-park actor should be learnt by the science park manager of management teams and match their interests and resources to steer and stimulate their R&D cooperation. In conclusion, although Leiden Bio Science Park offers a vibrant environment for building innovation networks, more governance on the resources transfer is still demanded.

Conclusion

Literature shows a contrast performance of on-park actors on the innovative linkages building. Many researches show that science parks can facilitate the innovative linkages building of on-park actors. However, there are still certain numbers of researches argued that science parks do not contribute to the innovative linkages building of on-park actors. Science parks as an intervention can facilitate the interaction and cooperation of on-park actors by creating a collaborative environment and stimulating resources flow. More interaction and resources flow can stimulate the innovation performance of the science park. Based on the study of two cases, some evidence can be found to verify innovation network building and governance can contribute to the linkages building of on-park firms. Theoretical part elaborates that innovation network building (breadth, density and proximity) and network governance (stakeholder involvement, resources management and decision making) can facilitate the interaction of different parties and stimulate the resources flow. As the results of TU Delft Campus, the park is not bread enough and has low density on the south of Campus where most of companies are located. The proximity between on-park actors is somehow low. More public transports should be built to increase the mobility of Campus South and more R&D and social activities should be organised to promote the cognitive and social proximity. Urban amenities on the south of campus should also be improved to connect people from different organizations. In order to improve the innovation network building of TU Delft Campus, more stakeholders with important innovative resources should be involved in and the resources should be matched and allocated properly. Therefore,

the network governance becomes essential to involve stakeholder from different level and ensure resources can be used effectively and efficiently. According to the results of Leiden Bio Science Park, on-park firms have more opportunities to connect with other actors due to the better performance on the breadth, density and proximity. What is more, the governance of LBSP involves all the representatives of university, government and companies in several levels, from organizational level to park level and also the local and regional level. Resources can be used more smoothly due to the involvement of all parties. However, the resources matching works are not enough for the innovation development of LBSP. More facilitative strategies should be proposed to matching each actor's resources, thus stimulating innovation.

It is also should be noticed that, LBSP has a longer development period than TU Delft Campus. Therefore, it has more breadth, density and proximity. These factors stimulate the innovation network building of the science park. However, the network governance of LBSP involves in all representatives of university, government and firms in several levels, which makes voices of all parties can be heard and resources can be transferred more smoothly. Although the triple helices interact with each other from organizational level to local and regional level during the innovation development of TU Delft Campus, on-park firms have weak power on park development.

6.2. Main factors of innovation network building and governance

There are several factors that influence the innovation network building and governance processes. University, municipality and industry can work together to provide an environment that affects these factors, thus promoting the capabilities of innovation network building and governance. *Table 6.1* provides an overview of the factors of innovation network building and governance both from theory and practice.

Table 6. 1 An overview of factors of innovation network building and governance

Factors	Literature	TU Delft Campus	LBSP
Innovation network building	-Breadth; -Density; -Cognitive proximity; -Social proximity; -Organizational proximity; -Geographical proximity	-Numbers of powerful firms; -Mobility; -Accessibility; -Enough working spaces; -Shared technical facilities; -Higher TRL labs; -Vibrant community; -Public leisure facilities; -Brand influence; -Sense of entirety (the science park).	-Sizes of firms; -Sorts of firms; -Social relationships; -Trust; -Mobility; -Accessibility; -Similar research topics; -Joint-training or education programs; -Shared technical facilities; -Public leisure facilities; -Triple helices connection platforms;

			-Brand influence.
Innovation network governance	-Stakeholder involvement; -Resources matching and allocation; -Decision making	-Stakeholder engagement; -Innovative resources matching and allocation	-Innovative resources matching and allocation; -Involving all on-park parties.

Actually, the findings of practise just explain the information from the theoretical research. The integration of theoretical research and empirical research is shown as *table 6.2*.

Table 6. 2 Integration of factors of innovation network building and governance

Factors	Main factors	Impact factors
Innovation network building	-Breadth & Density;	-Numbers of powerful firms; -Sizes of firms; -Sorts of firms; -Enough working spaces;
	-Cognitive proximity;	-Shared technical facilities; -Similar research topics; -Joint-training or education programs; -Higher TRL labs;
	-Social proximity;	-Public leisure facilities; -Brand influence; -Social relationships; -Trust;
	-Organizational proximity;	-Sense of entirety (the science park); -Triple helices connection platforms;
	-Geographical proximity	-Mobility; -Accessibility; -Enough working spaces;
Innovation network governance	-Stakeholder involvement; -Resources matching and allocation; -Decision making	-Stakeholder engagement; -Innovative resources matching; -Involving all on-park parties.

After learning about these factors, the performance of TU Delft Campus and Leiden Bio Science Park is discussed.

For TU Delft Campus case, there are firms from start-ups to international head offices. However, most of the firms are start-ups incubated by several incubator or PPP platforms. The large firms on park have limited interaction with other on-park firms and the university. What is more, there are few services firms or organization locating on the Campus, such as business service companies, financial agencies etc. In addition, the Campus South has a low density with large green fields. Shortage of working spaces is a big challenge for the science park. There is also lack of central public facilities and urban amenities on the Campus South. The public transport to the Campus South still needs to be improved. The strongest weapons of TU Delft

Campus are the field labs and strong start-ups ecosystems which help to build innovative connections between university, municipality and industry. TU Delft takes the responsibilities for managing the science park. It should be noticed that different types of organizations are benefited differently.

For Leiden Bio Science Park case, the infrastructure and urban amenities are quite mature now with the 35 years' development. A vibrant innovation ecosystem has been built with firms from in all sizes and variation of function. LBSP is different from TU Delft Campus due to the focused subjects, and development stage. Most R&D works are done in the firms and university is not as important as TU Delft Campus case. The science park now provides several social and R&D events to stimulate the interaction between on-park actors. What is more, several training programs and education programs are provided by the university, research institutes and larger firms. There is also a training centre, Bio Training, which supported by the EU funds. Leiden Bio Science Park is controlled by the foundation which involves all on-park parties in the decision making process.

The comparison between two cases is shown as following:
- ✓ Both cases consist of actors with resources of knowledge, financial capital, human capital, regulation and built environment. However, there are more research institutes, financial resources and powerful R&D firms locating on the Leiden Bio Science Park.
- ✓ TU Delft Campus focuses on a variety of high-tech topics with several start-up ecosystems and sets up several PPP field labs. But there are few service companies, such as business services, financial agencies etc. Leiden Bio Science Park focuses on the topic of bio-technology and accommodates firms from all size and covering full range of Biopharmaceutical supply chain.
- ✓ TU Delft Campus still has large green fields on the Campus South which is waiting for developing. On the contrast, the challenge for LBSP is the lands shortage in the future due to the increasing of tenants.
- ✓ LBSP has a better environment to promote the cognitive proximity, social proximity, geographical proximity and organizational proximity than TU Delft Campus. It is because that LBSP organises more social and R&D events and the infrastructure, urban amenities are also better than TU Delft Campus. The science park office of LBSP takes more care about the R&D development than manager of TU Delft Campus at current stage.
- ✓ The triple helices interact with each other in several levels, from organizational level within the park to the local and regional levels in both cases. However, the power of industry in Leiden Bio Science Park is much stronger than that in TU Delft Campus. There are also more strategies of facilitating resources allocation in LBSP.

6.3. Roles of university, municipality and industry played in innovation network building and governance

In order to create a vibrant innovative environment, university, municipality and industry should involve in the innovation creation and stimulation processes. According to the impact factors of innovation network building and network governance, there are four dimensions that require university, municipality and

industry to work together in. These dimensions are Lands & Real Estate dimension, Brand & Community Building dimension, R&D Development dimension and Board Level.

Lands & Real Estate dimension

As discussed in the theoretical part, lands & real estate dimension can help to contribute to the breadth and density of the science park and also the geographical proximity and social proximity between on-park actors. Real estate development can support the park users as working or living places. In addition, real estate development provide diverse urban amenities, such as central public facilities, restaurants etc., which facilitate the interaction between the actors. What is more, it can help to attract more human capital or companies to locate on the park because of the vitality and high quality of life.

In the case of TU Delft Campus, the lands mainly controlled by the Real Estate Development and for a long term development, the Board of TU Delft and Real Estate Department decide not to sell the lands for commercial using. Therefore, there are more actors should be involved in the real estate development of the science park. The economy and education departments of municipality of Delft connect with the university tightly to attract investors and also help to invest a small part of money for the real estate development. Industry becomes the major investors. ASR Science Park Fund invests in commercially exploitable real estate located in Dutch science parks. There are several buildings, such as a new building Next Delft, are invested by the ASR Science Park Fund. What is more, some large firms choose to invest in their own buildings, such as Exact. Exact together with construction companies to build its own building. However, TU Delft Campus is facing some real estate challenges. Lots of green fields need to be developed in order to provide more working space and attract more powerful actors. What is more, some urban amenities should be built in order to provide more places for the interaction of actors. These challenges have a negative impact on the innovation network building of the science park.

In the case of Leiden Bio Science Park, the lands are owned by the university and also municipality although most of lands owned by university. Urban development department of municipality of Leiden and Real estate department take responsibility for the land use and plan. However, it is not university or municipality's job to invest commercial buildings. Therefore, investors need to be attracted. At beginning, municipality of Leiden chose to sell some lands to stimulate this process. With several decades' development, a complex commercial system has been built for the building construction and rent. Due to the policy proposed by the university and municipality, the lands of university will not be sold for commercial using. Therefore, some lands are leased by university and construction companies pay for annual fees. Leiden Bio Science Park is different from many other science parks. The lands use and plan are also influenced by the stakeholders of science park foundation. It is a co-decision making process. With the development of 35 years, LBSP has built a vibrant ecosystem which is supported by the buildings and amenities. These buildings ensure the park can accommodate different actors and amenities provide convenience and accessibility for on-park actors. This also facilitates the interaction and cooperation of different parties.

University is always the lands owner of a university anchored science park.

Therefore, universities have right to lease or sell the lands, although they always propose the policy restricting land sales. Municipality does not have too many resources except the legislative power in special planning and giving permits. However, municipality of Leiden chose to sell some lands to stimulate the development of LBSP at the early stage. Industry, mainly the construction companies, mainly plays its role as the major investor to develop the real estate of these areas. ***Table 6.3*** describes the roles of university, municipality and industry played in Lands & Real Estate dimension from both literature review and empirical research.

Table 6. 3 Roles of university, municipality and industry played in Lands & Real Estate dimension

	Literature	**TU Delft Campus**	**LBSP**
Roles of university	-Lands owner; -Investor	-Lands owner; -Decision maker; -Investment attractor.	-Lands owner; -Strongest decision making influencer;
Roles of municipality	-Land owner -Policy supporter; -Investor	-Policy supporter; -Decision influencer; -Investment attractor; -Coordinator.	-Policy supporter; -Decision influencer; -Investor.
Roles of industry	-Investor; -Developer	-Investor and developer	-Driver of the real estate development; -Investor and developer.

The common scheme of real estate development now is that university offers the lands, municipality gives permits, drafts the urban spatial planning and maybe some money and industry provides major investment. However, the difference is TU Delft and municipality of Delft should work together on attracting more investors, while the main driver of LBSP is the companies who want to locate on the science park.

Brand & Community Building dimension
According to the discussion of theoretical part, brand & community building can contribute to the breadth of the science park and social proximity and cognitive proximity between on-park actors. The resources flow can also be stimulated within the community.

TU Delft Campus has brand manager and community manager who take responsibilities for building brand and community of ecosystem. What is more, staff from Valorisation centre also works on building business relationships of on-park actors and potential on-park actors. Employees from different sectors cooperate with each other to manage the brand and community of the science park. Larger on-park firms share their places or facilities with others when some events are organised. SMEs depend more on the resources of incubators, university and other larger firms due to their limited resources. Due to the early stage of brand and

community building, the social proximity between different parties is still low now and the brand is not strong enough to attract many powerful actors. One effect of low social proximity, the cognitive proximity can be also low due to lack of social communication. These are also the challenges of TU Delft Campus now.

Leiden Bio Science Park is controlled by the foundation. Daily affairs are managed by the science park office which is hired by the foundation. Therefore, the community is mainly maintained by the science park office. On-park firms are not only the community user, but also share their facilities, such working space and other technical facilities. Start-ups and other small business depend more on the community to seek more support from the science park or on-park larger firms. Large firms are more dependent, but they also want to seek more cooperation opportunities. Currently, except the university and municipality of Leiden, the brand of Leiden Bio Science Park is promoted by the famous firms and organizations and some governmental agencies, such as InnovationQuarter and the NFIA on province level. A strong brand helps LBSP attract more partners and residents, and they also bring their resources. Community building of LBSP stimulates the social relationships among on-park actors, and increase the social proximity between each other. With the increase of social proximity, cognitive proximity can be increased by the interaction between different parties.

Brand and community building are always managed by the Science Park Owner. University and municipality always take responsibilities for these tasks due to the ownership and common interests. Industry also has many resources in the brand and community buildings. ***Table 6.4*** describes the roles of university, municipality and industry played in Brand & Community Building dimension from both literature review and empirical research.

Table 6. 4 Roles of university, municipality and industry played in Brand & Community Building dimension

	Literature	**TU Delft Campus**	**LBSP**
Roles of university	-Brand designer; -Brand developer -Community builder; -Facilities supporter	-Brand designer; -Brand maintainer; -Brand developer； -Community builder; -Manager; -Facilities supporter	-Co-brand designer; -Brand developer; -Community user; -Facilities supporter
Roles of municipality	-Brand co-designer; -Brand developer; -Living environment co-builder	-Brand developer； -Living environment co-builder	-Brand co-designer; -Brand developer; -Living environment co-builder; -
Roles of industry	-Facilities supporter; -Brand developer; -Community user.	-Brand developer； -Facilities supporter; -Community user	-Brand developer; -Facilities supporter; -Community

Based on the literature, university plays a leading role on the brand and community building of the science park. Municipality also plays an important role as the facilitator and support for the brand and community building. It is because most university anchored science parks were controlled by the university and municipality in the Netherlands. However, Leiden Bio Science Park is an exception. The brand and community management works are done by the science park office, which is under the control of science park foundation.

R&D Development dimension

Based on the theoretical research, the main tasks for university, government and industry in R&D development dimension are to create knowledge flow among on-park actors and contribute to the cognitive proximity between on-park actors. R&D development dimension requires the science park provide more opportunities for on-park actors to cooperate with each other in the knowledge creation and knowledge utilization. What is more, some innovative resources matching works also need to be done by the science park management team.

The Valorisation centre of TU Delft aims to bring innovation to the market. It plays important roles in the innovation development of the science park. The Valorisation centre takes responsibility of innovative collaboration works in the science park. What is more, the field labs are also managed by the Valorisation centre. Except the efforts of university, municipality of Delft and industry also contribute to the R&D development. The education and economy sectors of municipality of Delft connect with university tightly to find what are needed to improve the field labs and what resources they can provide. Municipality always provides some financial supports and helps to attract more firms and public fund. Beyond the city level, the regional agencies, such as InnovationQuarter, also invest in the R&D development of on-park actors, especially the start-ups and spin-offs. University, municipality and TNO initiate the incubator Yes! Delft. The incubator has developed a strong network, including the financial supporters, academia organizations and industry partners. A clear structure can be illustrated from bottom to top. University together with other public sectors to initiates several PPP platforms, which supports the small business and attract larger industry partners. The Valorisation centre of TU Delft is the main sector takes responsibilities for managing the innovation collaboration of the science park and the education and economy sectors of municipality also facilitate the R&D development. Regional agencies also participate in the innovation development of the science park and provide financial supports. On-park firms, such as Exact, also invest in the fundamental research and support master and PhD students from TU Delft. There are several channels, such as TTO, incubators etc., for on-park actors to seek cooperation with others. However, more interventions, such as R&D meetings, workshops, need to be organised in order to facilitate the knowledge creation and transfer processes. As described in the theoretical part, university, municipality and companies should work interactively on creating R&D connections and facilitate knowledge flow in both formal (such as joint-research) and informal (such as informal R&D gathering) ways.

Leiden Bio Science Park focuses on the bio-technology development. Many

researches are done with in the firms and research institutes. Therefore they do not depend on university so much. However, the university supports many start-ups and spin-offs and these small businesses and these small businesses always have more innovative connections with others. Luris is the technology transfer office of Leiden University and Leiden University Medical Centre. Luris helps students and researchers to bring their knowledge to the market and help them to attract financial support. For example, the UNIIQ Fund, which set up by consortium of Erasmus MC, TU Delft, Leiden University and the regional development agency InnovationQuarter, partly made possible by the European Union through EFRO program and ELF, the Pre-seed fund set up by Leiden University, LUMC and Rabobank. What is more, there are also several PPP platforms, such as pre-incubator PLNT and incubator BioPartner, which are initiated by the university, municipality and other public sectors. These platforms also support star-ups and spin-offs and attract larger industry partners locating both on and off park. There are also some larger on-park firms and organizations, such as Janssen and CHDR. These larger firms not only do their own research, but also cooperate with university to cultivate talents. The park office organises several R&D events and these events stimulate the interaction between on-park actors. Except the training centre BioTech, which is funded by EU, there are also several training programs provided by the university, research institutes. LBSP performs well in the network building (breadth, density and proximity), and triple helices interact from organizational level to local and regional level. However, based on the theoretical part, network governance requires three aspects of stakeholder involvement, resources management and decision making. The challenge that LBSP is facing is the shortage of resources management. More R&D resources matching works should be proposed by managers and also on-park actors in order to facilitate resources flow among all parties.

In R&D development dimension, all the university, municipality and industry play important roles. Except the directly connections between university, research institutes and companies, an essential tool for the R&D development is PPP platforms, such as field labs and incubators. University, municipality and other public sectors are always the initiators of those platforms and industry becomes the partner and pays for fees. *Table 6.5* describes the roles of university, municipality and industry played in R&D Building dimension from both literature review and empirical research.

Table 6. 5 Roles of university, municipality and industry played in R&D Development dimension

	Literature	TU Delft Campus	LBSP
Roles of university	-Knowledge producer; -Talents supporter; -Initiator of innovative public-private partnerships; -Technical facilities supporter; -Funds attractor	-Pre-incubator founder; -Incubator founder; -Talents transporter; -Knowledge producer; -Technology supporter; -Funds attractor	-Triple helices interfaces (such as pre-incubator, incubator and so forth) co-founder; -Talents supporter; -Knowledge producer; -Technical facilities supporter; -Training programs

			provider; -Funds attractor
Roles of municipality	-Investor; -Initiator of innovative;	-Co-founder of PPP innovative platforms; -Policy supporter; -Funds attractor; -Investor; -Attractor for new firms	-Co-founder of PPP innovative platforms; -Policy supporter; -Funds attractor; -Investor
Roles of large firms	-Facilities supporter; -Investor; -Driver of innovation networks according to companies' demands.	-Investor for fundamental research; -Field labs user; -Driver of innovation networks according to companies' demands; -Partner of PPP innovative platforms.	-Fundamental research investor; -Training or education programs supporter; - Innovation tester and developer.
Roles of SMEs	-Innovation tester and developer.	-Innovation tester and developer.	-Innovation tester and developer.

The most important thing in R&D development is to create opportunities for the interaction of triple helices in order to take advantages of all their resources. Organizations like incubator, field labs and other platforms should be established and also the formal and informal meetings or events should be organised.

Board Level

Each science park always has a management office taking responsibilities of the daily management of Science Park. Some of the offices belong to the university and some belong to the foundations. According to the literature, most of the university anchored science parks are managed by the university directly in the Netherlands. However, Leiden Bio Science Park is managed foundation which consists of six stakeholders. *Table 6.6* describes the configuration of Board Level of the science park from both literature review and empirical research.

Table 6. 6 The configuration of Board Level of the Dutch science park

	Literature	**TU Delft Campus**	**LBSP**
Controller	-Eindhoven University of Technology Real Estate Management (**TUE Science Park**); -University Twente (**Drienerlo Campus University of Twente & Kennispark Twente**);	-TU Delft Real Estate Development	-Leiden Bio Science Park Foundation

	- The Amsterdam Development Corporation, which is on behalf of the university of Amsterdam and the City (**Science Park Amsterdam**) ;	

Board level refers to the actors who steer the management of the science park. TU Delft is the manager of TU Delft Campus, although municipality of Delft is a strong influencer. LBSP is totally different from TU Delft Campus. LBSP foundation involves all the representatives of university, municipality and industry. All the decisions are made under the balance of these stakeholders. Therefore, the development of LBSP is in line with the interests and goals of most on-park actors.

PART 6

Conclusion & Discussion

Chapter 7 Conclusion & Discussion

7. Conclusion & Discussion

In this chapter, the conclusion will be developed by addressing the answers to each sub-research questions and the main research question. After that, the recommendations on the innovation network building and governance and on the future research will be given. In addition, the reflections on the research scope, theoretical framework and empirical results are discussed.

7.1.   Conclusion

The objective of this research is to investigate the roles of university, municipality and industry played in the innovation network building and governance processes. It can help to promote the innovation network building capability of the science park and also promote the efficiency of innovative problems solving processes. In order to realize this goal, 3 progressive sub-goals are developed: 1. Understanding the concept of innovation network building and governance; 2. Understanding the impact factors of innovation network building and governance; 3. Gaining insight of how university, municipality and industry play their roles in building the innovation networks and governance.

The theoretical framework was developed (Chapter 2) at first to achieve these goals. Then, the empirical research was conducted on the TU Delft Campus (Chapter 4) and Leiden Bio Science Park (Chapter 5) in order to verify the theoretical framework and gain insight of the roles of university, municipality and industry played in the innovation network building and governance. A synthesis (Chapter 6) was proposed to compare the theoretical research and practise.

The main research question of this study is *“What roles can the university, government and industry play in the innovation network building and networked governance during the development of university anchored Science Park in order to create and stimulate innovation? And how do the TU Delft campus and LBSP perform?”* The research question is divided onto three sub-questions in order to answer this question step by step.

What are the innovation network building and innovation network governance?
Both innovation network building and network governance are measures to develop the interaction between innovative on-park actors and make the on-park actors and the science park develop simultaneously.

Innovation network building means the science park should build an environment where innovative on-park actors build their connections with each other in innovation development organically. It aims to develop an environment where actors can interact and cooperate with each other smoothly within the science park. Innovation network building requires 1) actors can be connected by social relationships or R&D connections; 2) actors recognise that they affect and are affected by other actors’ behaviour; 3) there are various innovation related

institutions and firms; 4) resources of on-park actors can be transferred organically. Innovation network governance means involving all parties in the collective goals achieving process and doing the resources matching work between actors. It needs 1) negotiation and coordination in the innovation development; 2) steering actors' behavior to achieve collective goals; 3) involving all related actors in decision making process 4) facilitating innovative resources matching and allocating processes. Innovation network governance helps to provide more opportunities for on-park actors to interact and cooperate with each other and facilitate the resources flow among actors due to the interventions between the actors.

Table 7.1 shows the features of innovation network building and network governance, which also provides the comparative standards for other science parks.

Figure 7. 1 Features of innovation network building and network governance

Innovation network building
Actors can be connected by social relationships or R&D connections;
Actors recognise that they affect and are affected by other actors' behaviour;
There are various innovation related institutions and firms;
Resources of on-park actors can be transferred organically.
Innovation network governance
Negotiation and coordination;
Actors' behaviour are steered to achieve collective goals;
Involving all related actors in decision making process;
Facilitating innovative resources matching and allocating processes.

What are the impact factors of innovation network building and innovation network governance?
Based on the features of innovation network building and governance, related literature was reviewed. According to the literature review, the conceptual model was proposed. The model consists of mainly seven factors: breadth, density, cognitive proximity, social proximity, organizational proximity and geographical proximity. The previous six factors influence the innovation network building process.

Breadth
Breadth mainly refers to 1) on-park actors have variety of resources, including knowledge, financial capital, human capital, regulation and built environment; 2) there are all size of firms with start-ups to international head offices; 3) there are various functional firms and organizations from R&D related firms to services provided firms and PPP platforms for connecting the triple helices. In conclusion, breadth mainly cares about the resources and connections existing on the science park.

Density
Density refers to the real estate development condition of the science park. Density influences the number of working space and geographical distance between on-park actors. What is more, density also has impacts on the vibrant of community and living comfort. However, it does not mean the higher density is better. The density of a science park should be controlled under certain level based on the science park condition and preference of science park users.

Proximity
There are four main types of proximity affect the innovation network building in the science park. They are cognitive proximity, social proximity, organizational proximity and geographical proximity. *Cognitive proximity* influences the knowledge accessibility between the innovative actors. Promote cognitive proximity aims to create the similar knowledge base between actors. *Social proximity* influences the social relationships between actors. It helps to promote mutual trust and familiarity between on-park actors, thus stimulating their interaction and cooperation. *Organization proximity* also influences the knowledge transfer and cooperation between actors under the same firms or organizations. If companies work under the same operate structure or work with the same organizations, they will have more opportunities to interact and cooperate with each other. Finally, *geographical proximity* influences the accessibility of each actor. Physical closeness can promote communication and cooperation chances because of the convenience.

However, it is noticeable that the construction process of proximity is dynamic and the proximity should be controlled at certain level. Too much proximity also has a negative impact on the innovation development due to the lock-in effect, competition and other risks. Therefore, the innovation network governance is required to manage these risks.

In addition to the impact factors of innovation network building, there are three main aspects of innovation network governance should be considered.

Stakeholder involvement
Networks require stakeholders with various resources to participate in the processes of achieving their collective goals. Based on the interests of existed actors and demands of science park development, powerful stakeholders should be involved under the negotiation and coordination of different parties. This is a dynamic process due to the innovation is developing all the time. Triple helices always interact with each other on several levels. On-park organizations have their goals and these goals should also in line with the science park innovation development. Similarly, the park development is also influenced by the local and regional development vision.

Innovative resources matching and allocating works
Resources matching and allocation works aims to facilitate the resources flow among the actors and stimulate the innovation development. Resources flow not only within the science park, but also between park and external actors. Therefore, the strategies should be proposed to optimize resources utilized both in and outside the park. Triple helices work together on managing resources of on-park actors and also take care of the resources of external actors.

Decision making
Efficient governance need to involve all relevant parties in development decision making process, and this can make their voices be heard by all partners. In order to achieve collective goals, there are many negotiation and coordination between different stakeholders. Therefore, every part affect and is affected by the decision

making process. The negotiation, coordination and changed behaviour always help to make better decisions and stimulate the innovation development. The decision making processes are also influenced on several levels. It is because that the goals of science parks are in line with the local and regional development and affect the on-park actors. Triple helices need to interact from the top to bottom.

What roles do the university, municipality and industry play in the innovation network building and governance?
In the practical ways, university, municipality and industry work together on four main dimensions to contribute to the innovation network building and network governance. The four dimensions are Lands & Real Estate dimension, Brand & Community building dimension, R&D Development dimension and Board Level.

Lands & Real Estate dimension
In the Netherlands, university becomes the main land owner of a university anchored science park. For the long-term vision, universities always propose the policy never sell the lands for commercial using and make the area are always kept in control. Sometimes, municipality sells some lands surrounding the lands of university in order to facilitate the area development. But the most lands of the science park are owned by the university. Therefore, investors from industry play important roles in the real estate development. Municipality always plays its roles as the coordinator between university and investors and transfers demands of park users into the special planning. Combine the theoretical research and empirical research, the main roles of university, municipality and industry played in Lands & Real Estate dimension are shown as following:

University is the *main land owner*, and *the strongest decision maker* in the real estate development of a university anchored science park. What is more, university also plays its role as the *investor attractor* at the **early development stage**.

Municipality is the *decision influencer*, who has legislative power in the *spatial planning* and *giving permits*. What is more, municipality always play its role as the *coordinator* between land owner and investor in order to facilitate the real estate development. Finally, municipality also provides a small part of investment for the real estate development.

Industry, mainly the construction companies or investment companies, is the *major investor* in the real estate development. There are also some companies invest for building their own buildings, but only few large companies are willing to do this.

Brand & Community Building dimension
At the early stage of science park development, university and municipality should make a co-effort for the brand building. With the development of the science park, on-park firms or organizations with high reputation also have an impact on the brand building of the science park. For community building, university, on-park firms and organizations are not only the users of the science park, but also the developer of the community. The roles of university, municipality and industry played in the Brand & Community Building dimension is described as following:

University is the *initiator of the science park*, so it always takes the responsibilities

for designing and developing the brand of the science park. Municipality is always the *co-initiator of the science park*. Therefore, municipality plays the similar roles with the university in the brand building. Those firms and organizations with high reputation play their roles as *facilitators* in the brand building.

For community building, the *controller* of the science park always takes the responsibilities for developing the communities and organise several formal and informal gatherings. Those park users play their roles as the *developer* and *facilitator* by sharing their facilities and even the investment.

R&D Building dimension

University, government and industry work in isolation or jointly to establish the research organizations, such as big research institutes, different faculties or labs in the university and R&D departments in the firms. The triple helices also establish the supportive platforms, such accelerators, incubators and innovation programs interactively in order to stimulate the innovation utilization process. Knowledge creating and transfer can be illustrated in three phases. Firstly, knowledge is created based on the staff creativity and the interests of government, industry and university, which can be described as government force, market force and technical force to the knowledge creation. Then, the knowledge is transferred to the utilization phases directly or indirectly through supportive platforms. Finally, it could be regarded as a successful innovation process if the outputs meet the demands of the scope of university, government and industry. The roles of university, municipality and industry played in the R&D Development dimension is described as following:

University is the *central knowledge producer*, and the *main provider of qualified talent*. University also provides several *qualified technical facilities* for industry. What is more, university is an important *initiator for those public-private partnerships*, such as incubators, field labs. Those platforms are established by public funds from regional and national government and even EU public funds. Therefore, university plays its roles as the *funds attractor*.

Municipality is another important *initiator of the PPP innovative platforms*. Municipality also plays its role as the *facilitator* to attract public funds and more innovative actors for the science park.

There are also several public sectors, mainly the research institutes, locating on the science park. These research institutes also play their roles as *knowledge producer*, *initiator of PPP platform*s and *support shared facilities*, which are similar to the roles of university. However, university has more power than these institutes due to the scale in a university anchored science park.

The private sectors are divided into two categories, and the first one is SMEs and the other is larger firms. SMEs have limited resources and mainly play their roles as *small R&D developer* and *knowledge tester*. Larger firms play their roles not only as the *R&D developer*, but also the *investor for fundamental research and start-up ecosystems*. What is more, these large firms always set up *co-education programs* and *co-training programs* with the university and research institutes.

Board Level

Based on the results from both theoretical research and empirical research, most of the university anchored science parks are **controlled by the university** in the Netherlands. Therefore, the strongest decision makers of these science parks are the universities, although local government are involved in the decision making process. Municipality plays its role mainly as a **powerful decision making influence**r due to its legislative power and resources.

However, there is an exception. Leiden Bio Science Park is controlled by the foundation which consists of university, municipality and representatives of on-park public sectors and private sectors. All parties in the science park are involved in the decision making process.

7.2. Recommendations

Based on the research results, recommendations of this research can be proposed. The recommendations consist of the recommendations on the innovation network building and governance of Dutch university anchored science parks and the recommendations on the future research.

Recommendations on the innovation network building and governance
After combing the theoretical research results and empirical research results, the recommendations can be made as following:
- ✓ Innovation network building and network governance are dynamic and support each other. During the innovation development of a science park, triple helices can interwove in promoting the capability of innovation network building and governance to stimulate the innovation of on-park actors.
- ✓ University and government can work together and involve more public sectors to set up some public-private partnerships to provide more chances for the interaction of triple helices.
- ✓ Firms in different sizes and types are influenced by the resources of science parks differently. Small businesses depend more on the external resources, but larger firms are more self-sufficient. Therefore, policy makers should notice the different and propose proper policies.

In addition, the recommendations on the future research can be made as following:
- ✓ Investigate the roles of regional and national government played in the innovation development of university anchored science parks.
- ✓ Gain more details in the forming, developing and roles of public-private partnership platforms in the innovation development of university anchored science parks.
- ✓ Study on the connections between different science parks and find the factors impacted the cooperation between different science parks.

7.3. Reflection

The reflection is divided in reflection on theoretical research, field works and personal reflection.

Reflection on theoretical research
This research mainly investigates the roles of university, municipality and on-park firms. However, there are several other actors also play key roles in the innovation

network building and governance of the university anchored science parks. For example, the regional and national government provide many subsidies and policy supports for the development of the innovation development of the science park. External investment by private sectors is also important for the innovation development of the science park. What is more, this research mainly focuses on the Dutch university anchored science park. Therefore, this study may not explain the roles of university, municipality and industry played in innovation development of the science parks which are not anchored by university and the science parks in other countries.

The theoretical research was conducted according to the literature review, and the selection of literature maybe biased. For example, the types of proximity were combined the research of Boschma and Knobe. There are also more frameworks of proximity in the innovation development by some other researchers. Therefore, the types of proximity used in this research may be limited. What is more, the dimensions of innovation network building and network governance are proposed by the writer and there maybe biases due to the writer's own limitation.

Reflection on field work
The empirical research of this study was mainly conducted through the semi-structured interview. The interviewees are selected as the representatives of triple helices in both cases. This selection may be biased and in order to gain more information, more interviewees should be interviewed, especially the case of Leiden Bio Science Park because TU Delft Campus is still at the early stage. However, due to the limited time, the interview cannot be conducted so much. What is more, the questions of semi-structured interview were proposed by writer. Therefore, the questions may be subjective.

Personal reflection
As a student with the bachelor degree of Civil Engineering, I feel excited to catch the opportunity to do my thesis under MBE. I learnt a lot of new knowledge during this process and it gave me a lot of pleasure. I failed in the first interview due to my improper ways of expression. Fortunately, the first interviewee gave me his feedbacks and his advice. What is more, I learnt more about doing research during this process. Some important lessons learnt along the way 1) be logical in the research design and define the goal, problems and research questions as clear as possible; 2) enough literature should be reviewed when you want to start a research; 3) make sure the research objective has both scientific relevance and social relevance; 4) do not hesitate to express your ideas with your supervisor because they can give you more useful and kind advice; 5) take care of the writing work, especially the student like me who is not from English spoken country.

References

Bakouros, Y. L., Mardas, D. C., & Varsakelis, N. C., 2002. Science park, a high tech fantasy?: An analysis of the science parks of Greece. Technovation, 22(2), 123–128.

Balland, P.A., 2012. Proximity and the evolution of collaboration networks: evidence from research and development projects within the global navigation satellite system (GNSS) industry. Regional Studies, 46(6), pp.741-756.

Balland, P.A., Boschma, R. and Frenken, K., 2015. Proximity and innovation: From statics to dynamics. Regional Studies, 49(6), pp.907-920.

Baregheh, A., Rowley, J. and Sambrook, S., 2009. Towards a multidisciplinary definition of innovation. Management decision, 47(8), pp.1323-1339.

Benneworth, P. and Hospers, G.J., 2007. The new economic geography of old industrial regions: Universities as global—local pipelines. Environment and Planning C: Government and Policy, 25(6), pp.779-802.

Bevir, M., 2012. Governance: A very short introduction. OUP Oxford.

Blank, S. (2010, January 25). What's A Startup? First Principles.. Retrieved March 2, 2019, from https://steveblank.com/2010/01/25/whats-a-startup-first-principles/
Boschma, R., 2005. Proximity and innovation: a critical assessment. Regional studies, 39(1), pp.61-74.

Bryman, A. and Becker, S., 2012. Qualitative research.

Cantwell, J. and Santangelo, G.D., 2002. M&As and the global strategies of TNCs. The Developing Economies, 40(4), pp.400-434.

Carayannis, E.G. and Campbell, D.F., 2009. 'Mode 3'and'Quadruple Helix': toward a 21st century fractal innovation ecosystem. International journal of technology management, 46(3-4), pp.201-234.

Carrillo, F.J., 2004. Capital cities: a taxonomy of capital accounts for knowledge cities. Journal of Knowledge Management, 8(5), pp.28-46.

Castells, M., 1985. High technology, space, and society (Vol. 28). SAGE Publications, Incorporated.

Chan, K.-Y. Y. A., Oerlemans, L. A. G., & Pretorius, M. W., 2010. Knowledge exchange behaviours of science park firm: The innovation hub case. Technology Analysis & Strategic Management, 22(2), 207–228.

Chan, K.Y.A., Oerlemans, L.A. and Pretorius, M.W., 2009, August. Knowledge exchange behaviors of science park firms: The innovation hub case. In PICMET'09-2009 Portland International Conference on Management of

Engineering & Technology (pp. 964-1006). IEEE.

Cohen, D. and Crabtree, B., 2006. Qualitative research guidelines project.

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

Culkin, N., 2016. Anchor Institutions and Regional Innovation Systems for supporting micro and small businesses. e-Organisations and People.

Culkin, N., 2016. Entrepreneurial universities in the region: the force awakens?. International Journal of Entrepreneurial Behavior & Research.

Curvelo Magdaniel, F.T., 2016. Technology campuses and cities: A study on the relation between innovation and the built environment at the urban area level (Doctoral dissertation, Delft University of Technology).

Curvelo Magdaniel, F.T., 2016. Technology campuses and cities: A study on the relation between innovation and the built environment at the urban area level (Doctoral dissertation, Delft University of Technology).

De Bruijn, H. and Ten Heuvelhof, E., 2018. Management in networks. Routledge.
Den Heijer, A.C., 2011. Managing the University Campus: Information to support real estate decisions. Eburon Uitgeverij BV.

Díez-Vial, I., & Fernández-Olmos, M., 2015. Knowledge spillovers in science and technology parks: How can firms benefit most? The Journal of Technology Transfer, 40(1), 70–84.

Díez-Vial, I., & Fernández-Olmos, M., 2017. The effect of science and technology parks on firms' performance: How can firms benefit most under economic downturns? Technology Analysis & Strategic Management, 29(10), 1153–1166.

Díez-Vial, I., & Montoro-Sánchez, Á. N., 2016. How knowledge links with universities may foster innovation: The case of a science park. Technovation, 50, 41–52.

Díez-Vial, I., & Montoro-Sánchez, Á. N., 2016. How knowledge links with universities may foster innovation: The case of a science park. Technovation, 50, 41–52.

Ehlenz, M.M., 2018. Defining university anchor institution strategies: Comparing theory to practice. Planning Theory & Practice, 19(1), pp.74-92.

Eisenhardt, K.M. and Graebner, M.E., 2007. Theory building from cases: Opportunities and challenges. Academy of management journal, 50(1), pp.25-32.

Etzkowitz, H. and Leydesdorff, L., 2000. The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university–industry–government relations. Research policy, 29(2), pp.109-123.

Etzkowitz, H. and Zhou, C., 2017. The triple helix: University–industry–government innovation and entrepreneurship. Routledge.

Etzkowitz, H., Ranga, M., Benner, M., Guaranys, L., Maculan, A.M. and Kneller, R., 2008. Pathways to the entrepreneurial university: towards a global convergence. Science and Public Policy, 35(9), pp.681-695.

Ferraris, A. and Grieco, C., 2015. The role of the innovation catalyst in social innovation-an Italian case study. Sinergie, 97(May-Aug).

Florida, R., 2006. The flight of the creative class: The new global competition for talent. Liberal Education, 92(3), pp.22-29.

Fukugawa, N., 2006. Science parks in Japan and their value-added contributions to new technology-based firms. International Journal of Industrial Organization, 24(2), 381–400.

Fulbright-Anderson, K., Auspos, P. and Anderson, A., 2001. Community involvement in partnerships with educational institutions, medical centers, and utility companies. Baltimore, MD: Annie E. Casey Foundation.

Gemeente Delft , 2011. Delft Smart City. Retrieved from: https://ris.delft.nl/internet/vergaderingen_41207/agenda/commissie-middelen-en-ec onomie_9542/college-van-bw-masterplan-10-van-de-technologische-innovatie-cam pus-ticpdf_467345.pdf.

Geuna, A. and Muscio, A., 2009. The governance of university knowledge transfer: A critical review of the literature. Minerva, 47(1), pp.93-114.

Gürel, E. and Tat, M., 2017. SWOT analysis: a theoretical review. Journal of International Social Research, 10(51).

Hajer, M., Hajer, M.A., Wagenaar, H., Goodin, R.E. and Barry, B. eds., 2003. Deliberative policy analysis: understanding governance in the network society. Cambridge University Press.

Hall, P.G. and Castells, M., 1994. Technopoles of the world: the making of twenty-first-century industrial complexes. New York: Routledge.

Hart, C., 2018. Doing a literature review: Releasing the research imagination. Sage. Hobbs, K. G., Link, A. N., & Scott, J. T. (2017). Science and technology parks: An annotated and analytical literature review. The Journal of Technology Transfer, 42(4), 957–976.

Hu, T. S., 2008. Interaction among high-tech talent and its impact on innovation performance: A comparison of Taiwanese science parks at different stages of development. European Planning Studies, 16(2), 163–187.

Huang, W.J., 2013. Spatial Planning and High-tech Development: A comparative study of Eindhoven city-region, the Netherlands and Hsinchu City-region, Taiwan.

TU Delft.

Hung, W. C., 2012. Measuring the use of public research in firm R&D in the Hsinchu Science Park. Scientometrics, 92(1), 63–73.

Interviewee 1 (2020, January 15). Interview the Staff of Campus Real Estate Development/Interviewer: Rui Cui.

Interviewee 10 (2020, February 25). Interview the science park manager of LBSP/Interviewer: Rui Cui.

Interviewee 11 (2020, February 14). Interview the Staff of LBSS/Interviewer: Rui Cui.

Interviewee 12 (2020, February 19). Interview the Staff of Technology Transfer Office of Leiden University and LUMC/Interviewer: Rui Cui.

Interviewee 13 (2020, February 28). Interview the Director of Real Estate Development of Leiden University/Interviewer: Rui Cui.

Interviewee 14 (2020, March 5). Interview the manager of Centre for Human Drug Research/Interviewer: Rui Cui.

Interviewee 15 (2020, February 20). Interview the innovation manager of PLNT/Interviewer: Rui Cui.

Interviewee 16 (2020, February 21). Interview the officer of Municipality of Leiden/Interviewer: Rui Cui.

Interviewee 2 (2020, February 21). Interview the Staff of Valorisation centre of TU Delft/Interviewer: Rui Cui.

Interviewee 3 (2020, March 4). Interview the Manager of a field lab of TU Delft/Interviewer: Rui Cui.

Interviewee 4 (2020, February 17). Interview the staff of 3M on TU Delft Campus/Interviewer: Rui Cui.

Interviewee 5 (2020, March 5). Interview the technology manager of Exact on TU Delft Campus/Interviewer: Rui Cui.

Interviewee 6 (2020, February 6). Interview the researcher who studied on TU Delft/Interviewer: Rui Cui.

Interviewee 7 (2020, February 10). Interview the Staff of Yes! Delft on TU Delft Campus/Interviewer: Rui Cui.

Interviewee 8 (2020, March 11). Interview the Staff of Brand manager of TU Delft Campus/Interviewer: Rui Cui.

Interviewee 9 (2020, February 13). Interview the officer of Municipality of Delft/Interviewer: Rui Cui.

Jackson, D.J., 2011. What is an innovation ecosystem. National Science Foundation, 1.

Jongwanich, J., Kohpaiboon, A. and Yang, C.H., 2014. Science park, triple helix, and regional innovative capacity: province-level evidence from China. Journal of the Asia Pacific Economy, 19(2), pp.333-352.

Joseph, R. A., 1989. Technology parks and their contribution to the development of technology-oriented complexes in Australia. Environment and Planning C: Government and Policy, 7(2), 173–192.

Jousma, H., Scholten, V. and van Rossum, P., 2009, June. Framework for analyzing the growth of University Research parks applied to the bioscience park in Leiden, the Netherlands. In Triple Helix VII International Conference 17-19 June 2009.

Katz, B. and J. Wagner. The Rise of Innovation Districts: A New Geography of Innovation in America. Washington: Brookings Institution, 2014.

Klerkx, L. and Aarts, N., 2013. The interaction of multiple champions in orchestrating innovation networks: Conflicts and complementarities. Technovation, 33(6-7), pp.193-210.

Knoben, J. and Oerlemans, L.A., 2006. Proximity and inter‐organizational collaboration: A literature review. international Journal of management reviews, 8(2), pp.71-89.

Knoben, J., 2011. The geographic distance of relocation search: An extended resource-based perspective. Economic Geography, 87(4), pp.371-392.

Lambooy, J., 2004. The transmission of knowledge, emerging networks, and the role of universities: an evolutionary approach. European Planning Studies, 12(5), pp.643-657.

Lamperti, F., Mavilia, R., & Castellini, S., 2017. The role of science parks: A puzzle of growth, innovation and R&D investments. The Journal of Technology Transfer, 42(1), 1–26.

Lawrence, S., Hogan, M. and Brown, E., 2019. Planning for an Innovation District: Questions for Practitioners to Consider.

Lecluyse, L., Knockaert, M. and Spithoven, A., 2019. The contribution of science parks: A literature review and future research agenda. The Journal of Technology Transfer, 44(2), pp.559-595.

Lever, W.F., 2002. Correlating the knowledge-base of cities with economic growth. Urban studies, 39(5-6), pp.859-870.

Leyden, D. P., Link, A. N., & Siegel, D. S., 2008. A theoretical and empirical analysis of the decision to locate on a university research park. EEE Transactions on Engineering Management, 55(1), 23–28.

Liberati, D., Marinucci, M., & Tanzi, G. M., 2016. Science and technology parks in Italy: Main features and analysis of their effects on the firms hosted. The Journal of Technology Transfer, 41(4), 694–729.

Lindelöf, P., & Löfsten, H., 2002. Growth, management and financing of new technology-based firms— Assessing value-added contributions of firms located on and off Science Parks. Omega, 30(3), 143–154.

Lindelöf, P., & Löfsten, H., 2004. Proximity as a resource base for competitive advantage: Universityindustry links for technology transfer. The Journal of Technology Transfer, 29(3), 311–326.

Link, A.N. and Scott, J.T., 2006. US university research parks. *Journal of Productivity Analysis*, *25*(1-2), pp.43-55.

Lyu, D., 2019. Attraction and retention of startups in Urban Innovation Districts (UIDs).

Maarten, 2016. Delft Smart City. Retrieved from: http://luzarchitecten.nl/sites/default/files/Delft%20Smart%20City%20final%20report.pdf.

Magdaniel, F.C., 2012. The university campus as a real estate object and its development in the context of the knowledge economy. In Proceedings of the Joint conference of the 7th International Forum on Knowledge Asset Dynamics and the 5th Knowledge Cities World Summit (pp. 13-15).

Malairaja, C. and Zawdie, G., 2008. Science parks and university–industry collaboration in Malaysia. Technology Analysis & Strategic Management, 20(6), pp.727-739.

Martínez-Cañas, R., Sáez-Martínez, F. J., & Ruiz-Palomino, P., 2012. Knowledge acquisition's mediation of social capital-firm innovation. Journal of Knowledge Management, 16(1), 61–76.

Maskell, P. and Malmberg, A., 1999. The Competitiveness of Firms and Regions: 'Ubiquitification'and the Importance of Localized Learning. European urban and regional studies, 6(1), pp.9-25.

Massey, D., & Wield, D., 1992. Science parks: A concept in science, society, and "space" (a realist tale). Environment and Planning D: Society and Space, 10(4), 411–422.

Morisson, A., 2014. Innovation districts: an investigation of the replication of the 22@ Barcelona's Model in Boston (Doctoral dissertation).

Morisson, A., 2015. Innovation districts: a toolkit for urban leaders. CreateSpace Independent Publishing Platform.

Murphy, T., 2011. Building on innovation: The significance of anchor institutions in a new era of city building.

Muscio, A., Quaglione, D. and Scarpinato, M., 2012. The effects of universities' proximity to industrial districts on university–industry collaboration. China Economic Review, 23(3), pp.639-650.

Nooteboom, B., 1999. Innovation and inter-firm linkages: new implications for policy. Research policy, 28(8), pp.793-805.

Nooteboom, B., 2000. Learning by interaction: absorptive capacity, cognitive distance and governance. Journal of management and governance, 4(1-2), pp.69-92.

Pacagnella Júnior, A.C., Porto, G.S., Pacfico, O. and Salgado Júnior, A.P., 2015. Project stakeholder management: A case study of a Brazilian science park. Journal of technology management & innovation, 10(2), pp.39-49.

Parker, R., 2007. Networked governance or just networks? Local governance of the knowledge economy in Limerick (Ireland) and Karlskrona (Sweden). Political Studies, 55(1), pp.113-132.

Porter, M.E., 1990. The Competitive Advonioge of Notions. Harvard business review.

Provan, K.G. and Kenis, P., 2008. Modes of network governance: Structure, management, and effectiveness. Journal of public administration research and theory, 18(2), pp.229-252.

Quintas, P., Wield, D., & Massey, D., 1992. Academic-industry links and innovation: Questioning the science park model. Technovation, 12(3), 161–175.

Rabelo, R.J., Bernus, P. and Romero, D., 2015, October. Innovation ecosystems: a collaborative networks perspective. In Working Conference on Virtual Enterprises (pp. 323-336). Springer, Cham.

Radosevic, S., & Myrzakhmet, M., 2009. Between vision and reality: Promoting innovation through technoparks in an emerging economy. Technovation, 29(10), 645–656.

Randolph, J., 2009. A guide to writing the dissertation literature review. Practical Assessment, Research, and Evaluation, 14(1), p.13.

Ranga, M. and Etzkowitz, H., 2015. Triple Helix systems: an analytical framework for innovation policy and practice in the Knowledge Society. In Entrepreneurship and knowledge exchange (pp. 117-158). Routledge.

Sarpong, D., AbdRazak, A., Alexander, E. and Meissner, D., 2017. Organizing

practices of university, industry and government that facilitate (or impede) the transition to a hybrid triple helix model of innovation. Technological Forecasting and Social Change, 123, pp.142-152.

Segbers, K., Raiser, S. and Volkmann, K. eds., 2007. The Making of Global City Regions: Johannesburg, Mumbai/Bombay, Sao Paulo, and Shanghai. JHU Press. Simmie, J. ed., 2001. Innovative cities. Taylor & Francis.

Smith, K.H., 2002. What is the'Knowledge Economy'? Knowledge intensity and distributed knowledge bases.

Tallon, A., 2013. Urban Regeneration in the UK. Routledge.

Tanimoto, K., 2012. The emergent process of social innovation: multi-stakeholders perspective. International Journal of Innovation and Regional Development 5, 4(3-4), pp.267-280.

U.S. Department of Housing and Urban Development. (2005). The power of partnerships: Celebrating 10 year (1994–2004), community outreach partnership centres. Washington, DC: Office of University Partnerships.

Valentín, E.M.M., 2000. University—industry cooperation: A framework of benefits and obstacles. Industry and Higher Education, 14(3), pp.165-172.

Van Bueren, E.M., Klijn, E.H. and Koppenjan, J.F., 2003. Dealing with wicked problems in networks: Analyzing an environmental debate from a network perspective. Journal of public administration research and theory, 13(2), pp.193-212.

Van der Veer, M., 2017. Innovation District Development in Dutch practice: an exploration on the role of the built environment with recommendations on role-taking by local public authorities in innovation district development: the Case of the Merwe-Vierhavens & RDM–as part of the CityPorts project.

Vásquez-Urriago, Á. R., Barge-Gil, A., & Rico, A. M., 2016. Science and technology parks and cooperation for innovation: Empirical evidence from Spain. Research Policy, 45(1), 137–147.

Visscher, P.B., 2011. Microphysical proximity and knowledge flow on Bioscience Park Leiden. Erasmus University, Rotterdam.

Wolters, T., The role of the Leiden University at the Leiden BioScience Park.

Ya, S. and Rui, T., 2006, June. The influence of stakeholders on technology innovation: a case study from China. In 2006 IEEE International Conference on Management of Innovation and Technology (Vol. 1, pp. 295-299). IEEE.

Yigitcanlar, T., Martinez-Fernandez, C., Searle, G., Baker, D.C. and Velibeyoglu, K., 2008. Understanding the conditions for the emergence of airport knowledge precincts: a framework for research (pp. 465-475). REAL CORP.

Yun, J., Zhao, X., Yigitcanlar, T., Lee, D. and Ahn, H., 2018. Architectural Design and Open Innovation Symbiosis: Insights from Research Campuses, Manufacturing Systems, and Innovation Districts. Sustainability, 10(12), p.4495.

Zahra, S.A. and Covin, J.G., 1994. The financial implications of fit between competitive strategy and innovation types and sources. The Journal of High Technology Management Research, 5(2), pp.183-211.

Zou, Y., & Zhao, W., 2014. Anatomy of Tsinghua University Science Park in China: Institutional evolution and assessment. The Journal of Technology Transfer, 39(5), 663–674.

Appendix

Appendix A Protocol interviews science park manager

Science park manager   (Name: Position: Date:)
Last: 0.5~1 hour
Introduction

For my graduation thesis of my master program "Construction management and engineering" at TU Delft, I am researching the interactions within the triple helix of university, government and industry in Science Parks (SP). The final objective of my research is to formulate recommendations for improvement of these interactions with the aim to stimulate innovations in the SP.

This research studies the cases of Science Park Delft and Leiden Bio Science Park. For both cases I will collect data in various ways, one of these is by conducting interviews with representatives of the three helices. These are science park managers, on-park company managers and key persons at the universities and municipalities. All the information obtained from these interviews will only be used for academic research and will be anonymized.

This is a semi-structured interview, which contains several main questions and additional questions may also be raised based on your answers. Please do not hesitate to ask for clarification if a question is unclear, and feel free to express your opinions.

Now, let us start the interview.

Basic information
- ✧ What are the main tasks in your job description?
- ✧ Can you use a few words/sentences to describe the specification of the SP you work in? And strength in this SP?
- ✧ What are the criteria to decide whether a company is welcome to locate in the SP? Do they pay anything?
- ✧ Can you outline briefly the structure to operate and manage the SP?

✧ Has the SP a Board of Directors? What is the composition of the Board? And what is your position either in or vis-à-vis the Board?

✧ What has been (is now) the role of the board of directors in the development of the SP?

✧ Who own the land and are there any changes of land ownership?

Innovation network building & governance

✧ What factors do you think are important for the network building of on-park actors?

✧ What are your strategies to engage stakeholders and manage resources?

✧ Who have power in the decision making process of innovation development of the science park?

✧ What are your strategies to stimulate the interaction among different parties?

Roles of the university, municipality and firms played in the innovation network building & governance

✧ What do you think of the roles of university, municipality and firms played in the real estate development?

✧ What do you think of the roles of university, municipality and firms played in the brand building?

✧ What do you think of the roles of university, municipality and firms played in the community building?

✧ What do you think of the roles of university, municipality and firms played in the R&D development?

Problems or bottlenecks

✧ Do you think there are some weaknesses or threats exist in the development of this science park in terms of the interaction of different parties?

Because of my personal situation communication and language can be an issue. Therefore, would you like me to send you the concept report of the interview to check?

Appendix B Protocol interviews municipality

Municipality officer   (Name: Position: Date:)

Last: 0.5~1 hour

Introduction

For my graduation thesis of my master program "Construction management and engineering" at TU Delft, I am researching the interactions within the triple helix of university, government and industry in Science Parks (SP). The final objective of my research is to formulate recommendations for improvement of these interactions with the aim to stimulate innovations in the SP.

This research studies the cases of Science Park Delft and Leiden Bio Science Park. For both cases I will collect data in various ways, one of these is by conducting interviews with representatives of the three helices. These are science park managers, on-park company managers and key persons at the universities and municipalities. All the information obtained from these interviews will only be used for academic research and will be anonymized.

This is a semi-structured interview, which contains several main questions and additional questions may also be raised based on your answers. Please do not hesitate to ask for clarification if a question is unclear, and feel free to express your opinions.

Now, let us start the interview.

Basic information
- ✧ What is the vision of the municipality on the development of city of Delft / Leiden?
- ✧ What is the position of TU Delft Campus / Leiden Bio Science Park in this vision?
- ✧ What are the main tasks in your job description? Do these include direct interaction or cooperation with either company managers, or the university (or any other knowledge institution)?

✧ Who own the land and are there any changes of land ownership?

Innovation network building & governance

✧ What factors do you think are important for the network building of on-park actors?

✧ What are your strategies to engage stakeholders and manage resources?

✧ Who have power in the decision making process of innovation development of the science park?

✧ What are your strategies to stimulate the interaction among different parties?

Roles of the university, municipality and firms played in the innovation network building & governance

✧ What do you think of the roles of university, municipality and firms played in the real estate development?

✧ What do you think of the roles of university, municipality and firms played in the brand building?

✧ What do you think of the roles of university, municipality and firms played in the community building?

✧ What do you think of the roles of university, municipality and firms played in the R&D development?

Problems or bottlenecks

✧ Do you think there are some weaknesses or threats exist in the development of this science park in terms of the interaction of different parties?

Because of my personal situation communication and language can be an issue. Therefore, would you like me to send you the concept report of the interview to check?

Appendix C Protocol interviews on-park firm manager

On-park firm manager   (Name: Position: Date:)

Last: 0.5~1 hour

Introduction

For my graduation thesis of my master program "Construction management and engineering" at TU Delft, I am researching the interactions within the triple helix of university, government and industry in Science Parks (SP). The final objective of my research is to formulate recommendations for improvement of these interactions with the aim to stimulate innovations in the SP.

This research studies the cases of Science Park Delft and Leiden Bio Science Park. For both cases I will collect data in various ways, one of these is by conducting interviews with representatives of the three helices. These are science park managers, on-park company managers and key persons at the universities and municipalities. All the information obtained from these interviews will only be used for academic research and will be anonymized.

This is a semi-structured interview, which contains several main questions and additional questions may also be raised based on your answers. Please do not hesitate to ask for clarification if a question is unclear, and feel free to express your opinions.

Now, let us start the interview.

Basic information
- ✧ Please introduce your company. (E.g. Years in SP. Numbers of staff. Branch. Main business)
- ✧ What are your main sources of finance?
- ✧ Why do you choose this science park to locate and develop your business?

Innovation network building & governance
- ✧ Do you build any innovative network with on-park actors?
- ✧ Do you think the science park facilitate the innovation network building of

your companies? Why?

✧ How are you benefited from the science park?

✧ What factors do you think are important for the network building of on-park actors?

✧ Do you have power in the decision making process of innovation development of the science park?

✧ Are there any interventions proposed by the science park and government to help you build innovative linkages with others?

Roles of the university, municipality and firms played in the innovation network building & governance

✧ What do you think of the roles of university, municipality and firms played in the real estate development?

✧ What do you think of the roles of university, municipality and firms played in the brand building?

✧ What do you think of the roles of university, municipality and firms played in the community building?

✧ What do you think of the roles of university, municipality and firms played in the R&D development?

Problems or bottlenecks

✧ Do you think there are some weaknesses or threats exist in the development of this science park in terms of the interaction of different parties?

Because of my personal situation communication and language can be an issue. Therefore, would you like me to send you the concept report of the interview to check?

Appendix D Protocol interviews university officer

University officer   (Name: Position: Date:)

Last: 0.5~1 hour

Introduction

For my graduation thesis of my master program "Construction management and engineering" at TU Delft, I am researching the interactions within the triple helix of university, government and industry in Science Parks (SP). The final objective of my research is to formulate recommendations for improvement of these interactions with the aim to stimulate innovations in the SP.

This research studies the cases of Science Park Delft and Leiden Bio Science Park. For both cases I will collect data in various ways, one of these is by conducting interviews with representatives of the three helices. These are science park managers, on-park company managers and key persons at the universities and municipalities. All the information obtained from these interviews will only be used for academic research and will be anonymized.

This is a semi-structured interview, which contains several main questions and additional questions may also be raised based on your answers. Please do not hesitate to ask for clarification if a question is unclear, and feel free to express your opinions.

Now, let us start the interview.

Basic information

✧ What are the main tasks in your job description? Do these include direct interaction or cooperation with either company managers, or the municipality?

✧ What are the main stakes of university do you think in the development of SP?

Innovation network building & governance

✧ How do you connect with the science park, on-parks firms and municipality?

✧ Do you build any innovative networks with on-park firms and research institutes?

✧ Do you think the science park facilitate the innovation network building of your companies? Why?

✧ What factors do you think are important for the network building of on-park actors?

✧ Do you have power in the decision making process of innovation development of the science park?

✧ Are there any interventions proposed by the science park and government to help you build innovative linkages with others?

Roles of the university, municipality and firms played in the innovation network building & governance

✧ What do you think of the roles of university, municipality and firms played in the real estate development?

✧ What do you think of the roles of university, municipality and firms played in the brand building?

✧ What do you think of the roles of university, municipality and firms played in the community building?

✧ What do you think of the roles of university, municipality and firms played in the R&D development?

Problems or bottlenecks

✧ Do you think there are some weaknesses or threats exist in the development of this science park in terms of the interaction of different parties?

Because of my personal situation communication and language can be an issue. Therefore, would you like me to send you the concept report of the interview to check?