Toward an open innovation ecosystem
the Automotive Campus in Helmond

Talsma, G.

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Toward an Open Innovation Ecosystem:

the Automotive Campus in Helmond

Master thesis by G. Talsma

AUTOMOTIVE CAMPUS

Date:	29 October 2018
Student name and number:	G. (Giel) Talsma, 0919197
First supervisor TU/e:	dr. J.C.C.M. (Boukje) Huijben
Second supervisor TU/e:	prof. dr. A.G.L. (Sjoerd) Romme
Third supervisor TU/e :	dr. A.S.A. (Annelies) Bobelyn
Supervisor Automotive Campus:	dhr. P. (Pieter) Rahusen

I. Preface

What a tremendous climb it has been. When I left high school I started with sweeping the garage floor of a local Volkswagen dealer. Then a couple years later I bought my first cars and was able to completely restore and repair them. After four years of internships in overalls in the workshop I was finishing my MBO in an office from a car dealership and received my first diploma 'Chef workshop'. I made a choice to continue studying: HBO Automotive Management. This was three years of working in project teams learning from a higher viewpoint. I also did an international internship on Curacao for five months. After receiving my diploma I chose to once more keep on studying, this time the pre-master Innovation Management at the TU/e. After being formally rejected at first, due to my insufficient prior education, I was able to start and what a world opened for me once again. I then found out about the student life, I joint a student association and for the first time I was limited in my time because I had to study. It was a fantastic experience though: I became a 'top athlete', trained 9 times a week for rowing, did another semester abroad in Valencia, gained an academic viewpoint and finally I started my graduation project which was by far the biggest challenge yet.

For completing this challenge I want to express my appreciation to my supervisors. First I would like to thank Boukje Huijben, my first supervisor who supported me with weekly meetings and who was always able to give me feedback on my work (which was often handed in last minute). Secondly, I want to thank my second supervisor Professor Romme for his support, expertise and feedback. Finally, I would like to thank assistant prof. Annelies Bobelyn for being the third assessor on the thesis.

Similarly, I want to thank Pieter Rahusen from the Automotive Campus for giving me this opportunity and giving me all the trust and autonomy I needed, this really kept me in charge of the project.

Finally, I want to thank my friends and family for supporting me: especially my girlfriend Bibi, who was very patient and supporting.

II. Management Summary

Introduction – The thesis describes a study, conducted at the Automotive Campus in Helmond, on creating an open innovation ecosystem. The Automotive Campus strives to be an automotive hotspot and the campus organization has the goal to facilitate, innovate and propagate the automotive industry on national and international level. This is done by offering its residents an ecosystem that stimulates cooperation, automotive innovation and the in and out flow of knowledge. However, the development of the Automotive Campus has, thus far, been mediocre. The Automotive Campus is still not recognized as a mature campus, no major automotive companies have settled at campus grounds since 2013 and there is hardly any involvement of Eindhoven University of Technology as well as cooperation between resident companies. In 2019, stakeholders will evaluate the campus development and therefore there is a substantial pressure to improve the situation due to financial uncertainty. The ultimate goal is to (further) develop an open innovation system at the Automotive Campus and thereby become more attractive for potential residents to settle at the campus. This report contributes to the accelerated development program by answering the following research question: *How can the Automotive Campus organization facilitate the development of an open innovation ecosystem at its campus in the next five years?*

Methodology – A qualitative research method is used to answer this research question. The science-based design uses the first three stages of the regulative cycle to solve the problem: problem identification, analysis and diagnosis and plan of action. Meanwhile, the empirical cycle of De Groot (1961) of is used to create a value proposition artefact. The research starts with a literature analysis from a broad body of literature. Then, semi-structured interviews were done with experts on the topics of open innovation and campus-based ecosystems. This knowledge is combined into a theoretical framework for the development of the Automotive Campus as open innovation ecosystem. Residents of the Automotive Campus were interviewed using the semi-structured interviewing method. Together with field observations, this knowledge is combined into a depiction of the current situation at the Automotive Campus. To show the (non-) correspondence between the theoretical goal and the current situation, a framework is created which combines literature, expert interviews and resident interviews. Besides, the Value Proposition Canvas is used to create a value proposition artefact for the Automotive Campus while combining scientific and design knowledge. This artefact and a set of recommendations for the Automotive Campus organization, iteratively tested during the study, will conclusively answer the research question.

Results: **Literature** – From the literature study and expert interviews, it is evident that open innovation is a recently developed innovation model that is just starting to gain ground in the automotive industry, which traditionally relies on closed innovation practices. To achieve open innovation in the automotive industry, a shift in mindset is needed. Six important properties, conditional to success, are defined as follows: knowledge networks, startups entrepreneurial activities, Knowledge development and students, community building and social facilities.

Campus-based ecosystems are the optimal location for open innovation, stated by literature study and experts. Linkages between companies as well as synergy is easier achieved when companies reside on the same location. Successful campus organizations facilitate this bonding by providing access to shared resources and facilities and stimulate knowledge sharing by enabling companies to connect. The important properties from open innovation and campus-based ecosystem literature together with expert knowledge are merged in to a framework of 14 essential properties.

Results: What is missing - The properties provided in the previous section are assessed on the overlap between the desired and the actual situation and rated in colors (Table 1). Ten of the in total 14 properties are underdeveloped or missing. This rating confirms the earlier statement that the campus is still in its growing phase, i.e. not a mature campus. It also states the missing and under developed properties of the campus.

Table 1 Rating the properties of the Automotive Campus in green (present), orange (needs development) and red (missing)

Essential properties for a campus-based open innovation ecosystem	
Knowledge networks	Resources mobilization
Startups entrepreneurial activities	Creation of legitimacy
Knowledge development and students	Community building
Social facilities	Minimizing distances on campus
Technical facilities	Manage ecosystem diversity and reputation
Guidance of the search	Attracting and hosting connectors
Market formation	Being highly responsive to questions

Results: Value proposition – To develop the value proposition the Value Proposition Canvas is used, a tool which observes the customer segment and designs the value map. The output of the Value Proposition Canvas tool was used to create the value proposition (Figure 1).

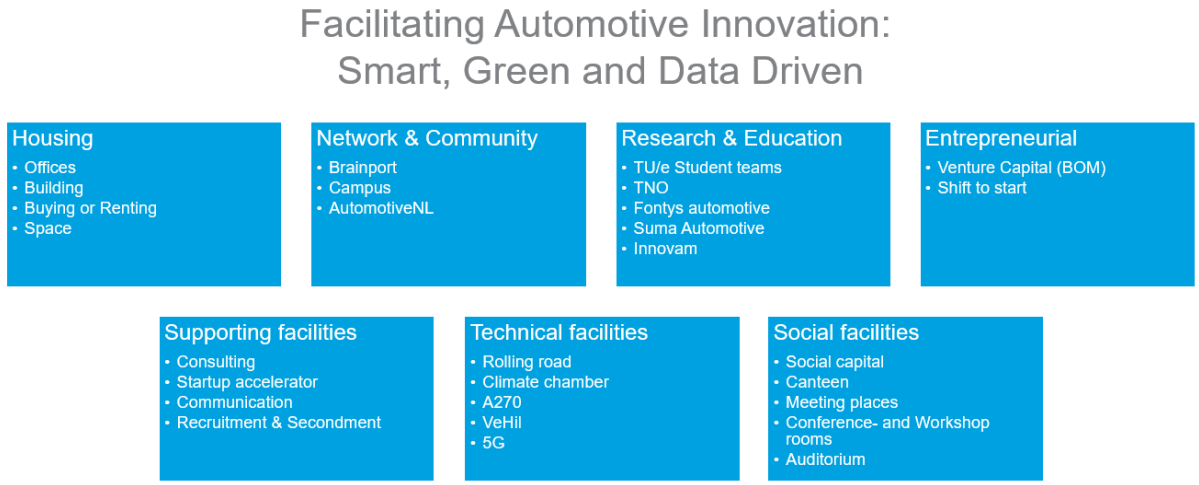

Figure 1 Value proposition Automotive Campus

Conclusion, discussion and recommendations - Ten properties need to be further developed on the Automotive Campus to facilitate open innovation and to be an attractive ecosystem. The most important properties are the ones that currently are missing: knowledge networks, social facilities, technical facilities and market formation. Recommendations are formulated for each property that is missing or underdeveloped. In general, the recommendations can be summarized in terms related to community, social and technological facilities, and knowledge infrastructure.

These recommendations should be used to create a multi-year program plan for the campus development. The plan provides a broad overview of development activities of the campus, the opportunities for creating the open innovation ecosystem and the barriers to this achievement.

The Automotive Campus organization is already working on some of the properties. This thesis gives them more concrete focus points to create a multi-year program for the development of the campus.

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List of Abbreviations

BCI	Buck Consultants International
BMC	Business model canvas
OEM	Original Equipment Manufacturen
R&D	Research and Development
SME	Small and Medium Enterprises
TU/e	Eindhoven University of Technology
VPC	Value Proposition Canvas

III. Introduction

The automotive industry: a branch of technology with products so well integrated in life that users cannot imagine living without them (Rajan, 1996). An industry where success has resulted in one of the largest and most important markets in the world, since industrialized transport and movement have brought mankind extraordinary progress for the last hundred years (Bardou, Chanaron, Fridenson, & Laux, 1982). The automotive industry has paved the way for many other (technological) improvements, from space travel to assembly lines, and without transport facilities, globalization would be a mere dream (Wright & Jaques, 2002). The impact of the automotive industry on our lives has been undisputed. In the past, it shaped the curve of human progress exponentially and this steep rise has not come to an end yet (Utermohlen, 2018).

However, a consequence of human progress is the desire for more. The automotive progression of the last century has opened a lot of doors towards a more industrialized and comfortable life. Yet the opportunities behind those doors are now the ones that push the automotive industry to innovate for, among other things, environment, safety and traffic congestion (Utermohlen, 2018).

As stated earlier, automotive technology has infiltrated our daily lives on a large scale. High tech industry influences customers' perceptions of the world and this results in high expectations. As customers are exposed to constant technological improvement, they are getting used to this and are adjusting their demands towards the available, high tech options. It is exactly this customer demand for innovation that drives the automotive industry towards competition (Ili, Alberts, & Miller, 2010; Hyken, 2016; Disney, 1999).

The automobile markets in the first and second world are nearly saturated, which makes the needs and wishes of customers even more important. Automotive market thus becomes more competitive (Ili, Alberts, & Miller, 2010). Besides that, legislation forces the automotive industry to be innovative as well, mostly on topics of safety and environmental protection. Original Equipment Manufacturers (OEMs) are responsible for the end result in vehicle production for the automotive industry and, since there are many OEMs, the sector is extremely competitive. Manufacturers feel the pressure to invest in research and development (R&D), which is a costly business. OEMs like BMW, Porsche and Volkswagen spent around 80 million euros per innovation in 2006 (Ili, Alberts, & Miller, 2010). This is a high amount, especially when price erosion and the shortened lifespan of vehicles is taken into account. So, we can state that the automotive industry is pushed towards extensive innovation, due to customers' demands, a saturated market and legislation. The obvious next step is determining the way to realize this innovation.

Research shows that the current automotive industry largely operates on the basis of closed innovation (Ili, Alberts, & Miller, 2010). This can be seen as an innovation process solely focused on in house development. Each automotive company has its own R&D department, without knowledge exchange, to ensure a controlled (and private) innovation process. An approach quite surprising for an industry that connects people and contributes to globalization. Naturally, innovating openly, like part of the software industry, creates the chance to benefit from mutual efforts and, moreover, to efficiently improve automotive technology. The term 'synergy' comes to mind, as collaboration results in economic gain due to successful innovation and reduced product development time. So, we can conclude that open innovation in the automotive industry can be the solution to the pressure that nowadays drives the sector as open innovation is based on cooperation and joint effort.

This key to success, called open innovation, is defined by Chesbrough as:

"A distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model" (Chesbrough, Bogers, & West, 2014, p. 17).

Several aspects in this definition stand out. First, we see that an innovation process must be shared deliberately, with parties outside the company's organization. This is the key process of open innovation as it requires companies that share knowledge and creativity with others. From Chesbrough's definition, the management of knowledge-sharing-mechanisms can involve payment or not and it always follows the core business model of the company.

To facilitate collaboration, a good network and easy communication is required. A way to provide such a climate is the creation of a campus-based ecosystem, defined as an ecosystem that '*involves a group of firms that have some linkages and synergies with each other in order to increase their general competitiveness''* (Cloodt, Putra, Romme, & van der Borgh, 2015). So, a campus-based ecosystem allows open innovation by creating linkages and synergies. By using these connections, companies located at the campus are able to increase their innovativeness and therefore their position on the global market.

This master thesis focuses on one campus in specific, namely the Automotive Campus in Helmond, the Netherlands. This campus exists since 2008 and the current campus organization has been active for a year with the goal to improve the campus. The Automotive Campus lies within the 'Brainport' region of the Netherlands, near innovation centers like the High Tech Campus Eindhoven (HTCE) and the Eindhoven University of Technology (TU/e). Therefore the campus is situated perfectly for upcoming automotive innovation. The research is done as a part of the master Innovation Management at the TU/e. The research will cover a six month timespan, starting in March 2018. The collaboration between the organization of the Automotive Campus and its residential companies will be thoroughly analyzed in order to answer the research question:

How can the Automotive Campus organization facilitate the development of an open innovation ecosystem at its campus in the next five years?

This thesis consists of six parts. In the first chapter the history and current status of the Automotive Campus will be described. In the second chapter, the research design is shared including a detailed problem description and subsidiary research questions. In chapter three, the methodology is stated with procedures for literature review, interviews and field observations. Chapter four presents the findings of the research, presenting a value proposition. The thesis will end with a conclusion and discussion with recommendations.

1 Research context

To fully understand the reasoning and impact of this research, the context must be very clear. To achieve a correct perspective, one has to understand the roots of the Automotive Campus and its rich history of entrepreneurship and technology, which started more than fifty years ago. The Automotive Campus as we know it today is the product of a combination of events, both policy-based and location-specific push and pull factors.

1.1 History of the Automotive Campus

The source of information in this chapter is an interview with Daniel de Klein unless stated otherwise. De Klein is a government employee of the municipality of Helmond. He has been fulltime involved with the development of the Automotive Campus since the beginning (Klein de, 2018). A timeline of the history of the automotive campus is provided in Figure 2.

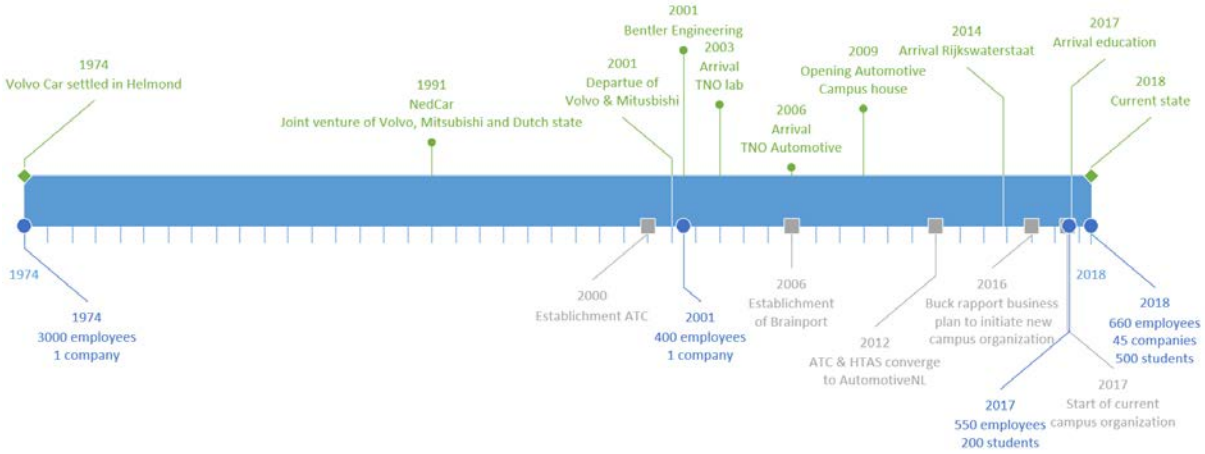

Figure 2 Timeline Automotive Campus and political development

1.1.1 The venue

The roots of the Automotive Campus lay in the late 1960's, when DAF started its passenger car development and production in Geldrop. Interested in developing smaller cars, Volvo Car took over the DAF passenger car division in the early 70's. Volvo settled the development division of Volvo Car in Helmond, on the current campus grounds. By 1974, around 3000 people were employed at this development and production facility in Helmond (Driven by Helmond, 2018). In 1991, NedCar was established as the successor of Volvo Car. NedCar resulted from the joint venture of Mitsubishi Corporation, Volvo Cars and the Dutch state. At NedCar, the development of different passenger cars for both Mitsubishi and Volvo continued in Helmond and the production of these cars took place in Born.

In 2001, the development and engineering department of NedCar in Helmond became independent due to a management buyout and was then quickly taken over by Bentler, a German automotive company. The actual production of NedCar stayed in Born and the developmental activities of Volvo Cars and Mitsubishi where relocated. Bentler's location in Helmond, once a workplace for thousands of people, now houses only 400 employers. Residence of Bentler remained rather short as Altran, a major automotive engineering and testing company, took over the German company. Nowadays, Altran is still located at the Automotive Campus with 140 employees.

Thus, the moving of Nedcar in 2001 caused a drop in employees but at the same time created space and vacant properties at the Steenovenweg. This space attracted TNO, a major independent research organization in the field of applied science, in 2003 as they were searching for a new location. TNO decided to first move their automotive lab to Helmond and after a few years, the complete automotive devision followed. Looking at the development of the Automotive Campus,

TNO has been a key player. The company acted as a pull-factor and their movement towards Helmond was seen as a new impulse for the regional automotive sector. The rehousing of TNO was largely funded by the cities of Helmond and Eindhoven and the province of Noord-Brabant.

Over the years, the venues' opportunities have been noticed by both local government and educational institutes as well as private companies. Their organizational control has influenced the physical development of the location.

1.1.2 The policy background

The Dutch automotive industry has not been in the focus of the Dutch State for long. The trigger to invest in this sector, came from the bankruptcy of DAF in the '90s and the following awareness of needed change to improve the reputation of the automotive industry. Automotive companies, united in the first organization called 'Federatie Holland Automotive', realized they needed to improve their position as the automotive industry was fairly undervalued compared to Dutch maritime and air transport. Different automotive companies expressed the need to exchange knowledge and to stay connected with each other, which resulted in the first cluster organization: 'Automotive Technology Center' (ATC). Stimulating innovation, collaboration and education, the ATC can be seen as the forerunner of Automotive NL, established in 2000. From 2000 onwards on, Automotive NL has been the major party to connect and improve the development of the Dutch automotive industry.

At the time of ATC, the Dutch government decided to support regions with a strong clustering and organization to improve innovation programs, in a so-called 'sleutelgebieden aanpak'. The well-organized automotive sector was the first to hand in a program for support: High Tech Automotive Systems (HTAS). This project was funded equally by government and private companies, allowing for an innovation program of almost 200 million euros. A powerful approach, as the automotive industry already organized itself, ambitious to improve, and the government invested under the condition of collaboration between large and small companies, and knowledge institutes. The Brainport foundation, started in 2006, was an example of such an innovation boost by the government too, and called for public research and development. It was this foundation that specifically influenced the development of the high-tech industry in Noord-Brabant, like the Automotive Campus (Brainport, 2018).

As collaboration in the automotive sector was bound to improve, the arrival of TNO was the trigger to optimize the use of the location in Helmond. TNO brought public research and development into Helmond and, in contrast to the existing private R&D departments of Philips, ASML, ACE etc, this matched with the plans of AutomotiveNL. The city of Helmond initialized the gatherings of companies (TomTom, DAF, VDL), educational and knowledge institutes (Fontys, TU/e) and government (province, Brainport). This collaboration resulted in a very important decision: to create a real campus-based ecosystem in Helmond.

In 2008, the European regional development fund (ERDF) decided to invest 2.27 million euros to improve and develop the campus venue and create the campus as we know it today. The first organization that was in charge of managing the campus grounds was the High Tech Automotive Campus foundation. Besides this organization, the ERDF was used to renovate the current Automotive House and to facilitate organization and acquisition activities.

It has become clear that a lot of different foundations, parties and companies have been involved in the development of the campus area and its organization. Around 2012, the ATC, the HTAS and the campus organisation started clustering their responsibilities. They merged and are currently known as AutomotiveNL. However, to avoid conflict of interest, the campus organization became

independent again in 2017, after Buck Consultants International (BCI) (2016) reported the need for autonomy of the campus organization in order to realize a successful campus ecosystem. This independent organisation is called Automotive Campus organization and is subject of research in this thesis.

1.1.3 The influence of the Brainport region

The realization of the Automotive Campus and its current organization, has been pushed by government, private companies and educational institutes. Especially the Dutch government acted very deliberately when an economic downturn hit Eindhoven in the '90s (bankruptcy of DAF, reorganization of Philips) and the Netherlands as a whole in 2012. By using the 'sleutelgebieden aanpak', the government realized the Triple Helix model of innovation, i.e. to create a collaboration between the knowledge institutes, government and industry. With this collaboration, the region attracted new investments as well as major Dutch knowledge institutes like TNO. Eventually, this unique collaboration led to the Brainport foundation in 2005 and in 2010 the city of Eindhoven received the 'Eurocities Award for creating industries of the future' with this unique collaboration (Brainport, 2018).

As stated earlier, the Brainport foundation led to a growth in economy for the region of Eindhoven. From 2006 to 2016, the regional economy grew by 2.5% per year. Compared to the national economy, which grew by 1.1%, this is more than double. In addition, the productivity of the Brainport region increased over 2004 to 2014 by 46.2%, which is more than twice the increase of the Dutch industrial productivity (+18.6%) as well (Brainport Development NV, 2017). In line with the positive outcome of the Brainport foundation, the Dutch automotive sector currently consists of 300 companies with 45.000 employees active in R&D, education, production and service. The total revenue is €18.6 billion (Buck Consultants International, 2016). This shows that the Dutch automotive industry is a healthy and growing sector. A strong and developing industry is the optimal condition for the Automotive Campus to develop and flourish.

The Automotive Campus lies in the economically stable and promising area of the Brainport region and benefits from its reputation and pull-factor. Over the last ten years, the amount of companies on the Automotive Campus increased from 4 to 45 and around 660 employees currently reside at campus grounds (Boon, 2018).

1.1.4 Current situation at the Automotive Campus and problem introduction

In 2009, the Minister of Economic Affairs officially opened the Automotive House which was rebuild with the European regional development fund (ERDF). This is the main building at the campus. Here, different shared facilities are located and different tenants of the campus reside. The opening marked the official start of the Automotive Campus. Vision: it is to be the place where education, government and automotive industry meet to socialize and network whilst focusing on facilitation of smart and green mobility. This official opening is seen as the start of the Automotive Campus present nowadays.

Currently, the campus has two public and two large private stakeholders. The two public stakeholders are the province of Noord-Brabant and the city of Helmond. The two private stakeholders are building contractors: Bouwbedrijf Van de Ven and Hurk Vastgoed. The stakeholders in the Automotive Campus have invested millions since the official opening (Buck Consultants International, 2016), resulting in a campus with many different shared facilities, from a rolling road to conference rooms. Besides the shared facilities, workshops and seminars are part of daily life at the campus.

However, the Automotive Campus is not yet the innovation hotspot it aspires to be. In 2016, the four stakeholders have ordered BCI to perform a market orientation to gain insight in the development

potential of the Automotive Campus. In their consultancy report, BCI stated that the campus organization is too complex, due to the involvement of many stakeholders and parties. Organizational processes are not transparent to residents and this results in confusion and developmental stagnation (Buck Consultants International, 2016). BCI advised to start an accelerated development program in order to reach the full potential of the campus. This campus potential is embedded in an open innovation ecosystem: an ecosystem that depends on strong relations between campus residents and their intention to share knowledge and ideas. It is noteworthy that such an open innovation ecosystem conflicts with the currently unclear organizational processes at the campus and, at the same time, the traditionally closed innovative automotive sector (Ili, Alberts, & Miller, 2010; Buck Consultants International, 2016).

As a reaction on the consultancy report, the four stakeholders committed to establish a campus organization in 2017. Nowadays, this campus organization has consolidated the interests of the four different stakeholders and has simplified the organizational tasks. This first commitment of the organization will run for a two-year period: from 2017 to 2019. After this, an evaluation will be conducted in order to analyze the growth and development of the Automotive Campus over time (Buck Consultants International, 2016). The vision that underlies the Automotive Campus organization can be described as follows (translated from Dutch):

> *"The Automotive Campus is the most important location in the Netherlands with regard to automotive innovation and related products. Domestic as well as foreign automotive companies see the Automotive Campus as the logical and only choice to settle. They are attracted to the open innovation ecosystem, where companies and knowledge institutes have strong relations, both internally and externally, and are focused on cooperation. Facilities at the campus are leading and (mostly) unique. The companies and people at the campus are stimulated and supported, as they want to become leading automotive players."* (Buck Consultants International, 2016, p. 16)

The establishment of this pilot organization generates time pressure. Development of the campus must be accelerated as success is needed to maintain funding by the four stakeholders. The ultimate goal is to create an innovative and stable campus climate that facilitates its partners and located companies. Surely, the Automotive Campus has made progress in the last decennium. However, more change is needed to overcome the challenges that still stand in the way of a flourishing and booming Automotive Campus.

1.2 Problem statement

The problem related to the Automotive organization, as introduced in previous chapter, can be subdivided into two parts. The first part is directly connected to the success of the automotive industry as a whole and the functioning of the campus in particular. The second part is a simple though pressuring one, related to current time pressure.

Firstly, the Automotive Campus organization wants to contribute to the automotive industry in the Netherlands as a whole. The way to achieve this, is by creating a campus with an ecosystem that stimulates cooperation, automotive innovation and the in and out flow of knowledge. As the report of BCI shows, the campus organization needs to realize this. Since 2017, the organization tries to improve this campus-based ecosystem but the Automotive Campus still does not live up to expectations. The following examples illustrate that mediocre progression:

- Since 2013, up to the moment of writing, no mayor automotive companies have set up an activity on the campus grounds.
- VDL has moved away from the campus leaving only a small department behind
- Lacking involvement of the TU/e, the automotive university of the Netherlands
- Little cooperation on campus between residents
- The Automotive Campus is still not recognized as a mature campus and is still in the growing phase (Buck Consultants International, 2018)

Secondly, in 2019, the growth and development of the Automotive Campus will be evaluated. Stakeholders will then decide whether their investment has yielded the required result. Since financial support of the campus organization depends on those stakeholders, it is of great importance to live up to their expectations. Otherwise, the funding of the organization will experience enormous pressure and the future of the Automotive Campus will be uncertain.

Lex Boon, the current managing director of the Automotive Campus organization, observes the following:

> "Historically, innovation in the automotive industry has always been very closed. But now that it is coming together with two other industries, the high-tech and software industry, which are already much further with 'open innovation', there is an innovation culture change. We want to take on this challenge at the Automotive Campus in order to bring the car industry, in this region, to a higher level" (Lex Boon, Director Automotive Campus organization, 2018).

The statement of Lex Boon above indicates, that the automotive industry can be considered historically ‘closed’ in its innovation process. As such, the automotive industry needs to follow the lead of high-tech and software industries which show that it is possible to innovate more openly. These industries have already a long history in the application of open innovation with for example; open source (Enkel, Gassmann, & Chesbrough, 2009). Collaborating with the high-tech and software industry is already common for the automotive industry, due to the more complicated and advanced cars . A next step would be the active embrace of open innovation by the automotive industry, specifically the Automotive Campus, and thus the realization of the demands of their stakeholders.

1.2.1 Research objective

From this context, the following objective can be formulated.

The objective, formulated in close collaboration with the Automotive Campus organization, is to (further) develop the open innovation system at the Automotive Campus and thereby become more attractive for potential residents to settle at the Automotive Campus. This will be done by creating a value proposition (see for the definition 3.3), focused on developing an open innovation ecosystem for the campus organization with a time frame of five years. This time frame, medium to long term, is chosen with two reasons in mind. First, there is significant time pressure due to the financial uncertainty of the campus organization due to the evaluation of financial resources in 2019. This uncertainty is further supported by the fact that every four years the municipal elections take place. This makes the future funding of the Automotive Campus uncertain as local councilmembers and their visions can change (two of the four stakeholders are government). Second, the development of an ecosystem takes time.

1.2.2 Research questions

Derived from the research context, in open dialogue with the Automotive Campus organization and the TU/e supervisors, the following research question has been formulated.

"How can the Automotive Campus organization facilitate the development of an open innovation ecosystem at its campus in the next five years?"

To answer the research question, three sub-questions have been phrased:

1. *What is open innovation and what are important boundary conditions for successful implementation?*

   The answer to this question will provide insight in the ultimate goal of the Automotive Campus. A literary review serves to identify a preliminary list of potential boundary conditions for open innovation. Additionally, practical expertise will contribute to our perspective on open innovation.

2. *What are campus-based innovation ecosystems and what makes them successful?*

   Again, a literary review and field experience show the requirements that need to be fulfilled.

3. *What is missing to realize open innovation, and what is the unique value proposition of the Automotive Campus?*

   This question asks for research on the Automotive Campus in particular. A detailed analysis of the campus will show the unique properties and the gaps that need to be filled to further develop the campus. For this a value proposition of the Automotive Campus is created to define what kind of value the campus can offer its residents (Harvard Business School, 2018).

The report structure is as follows, in chapter two, the methodology will be explained. In chapter three the three sub-questions formulated above will be answered. A literature study will provide the theoretical background, followed by the assessment of the current situation and the creation of the value proposition. In the last chapter, a conclusion and discussion follow, were recommendations are formulated.

2 Methodology

This thesis follows a qualitative research methodology into a conclusive recommendation and value proposition considering the Automotive Campus, answering the question: *"How can the Automotive Campus organization facilitate the development of an open innovation ecosystem at its campus in the next five years?".* The regulative cycle of Van Strien (1997) for problem solving is used during the entire master thesis project, to assure the desired outcome for all parties involved (Aken, Berends, & Bij, 2007). This regulative cycle has the following stages in which it iterates: problem identification, analysis and diagnosis, plan of action, intervention, and evaluation (Aken, Berends, & Bij, 2007). The last two stages, intervention and evaluation, have not been completed as the duration of the thesis project is insufficient to accommodate this. During the design stage the empirical cycle for research of De Groot (1961) was used to create the value proposition artifact. The empirical cycle can be used to gather specific knowledge for a company and consists of the following steps; observation, induction, deduction, testing of hypothesis, and evaluation (Aken, Berends, & Bij, 2012).

In short, this thesis identifies the problem and analyzes the influencing factors to diagnose the situation. Afterwards it proposes a plan of action to intervene. However, this intervention has to be tested, implemented and evaluated in future work.

The structure is as follows. First, a literature study is done which is followed by qualitative interviews with experts to answer the first and second sub-question. Consecutively, campus residents are interviewed and field observations at the Automotive Campus were made to answer the third sub-question. Afterwards, a framework is created to combine literature, expert analysis and resident experiences. This framework provides an overview of the current situation of the Automotive Campus and its theoretical goal. Lastly, a value proposition for the Automotive Campus is iteratively developed using the insight from literature applied to the specifics of the campus and brainstorm sessions with campus management, followed by recommendations for improvement. Below, a schematic depiction of the research design is shown in Figure 3.

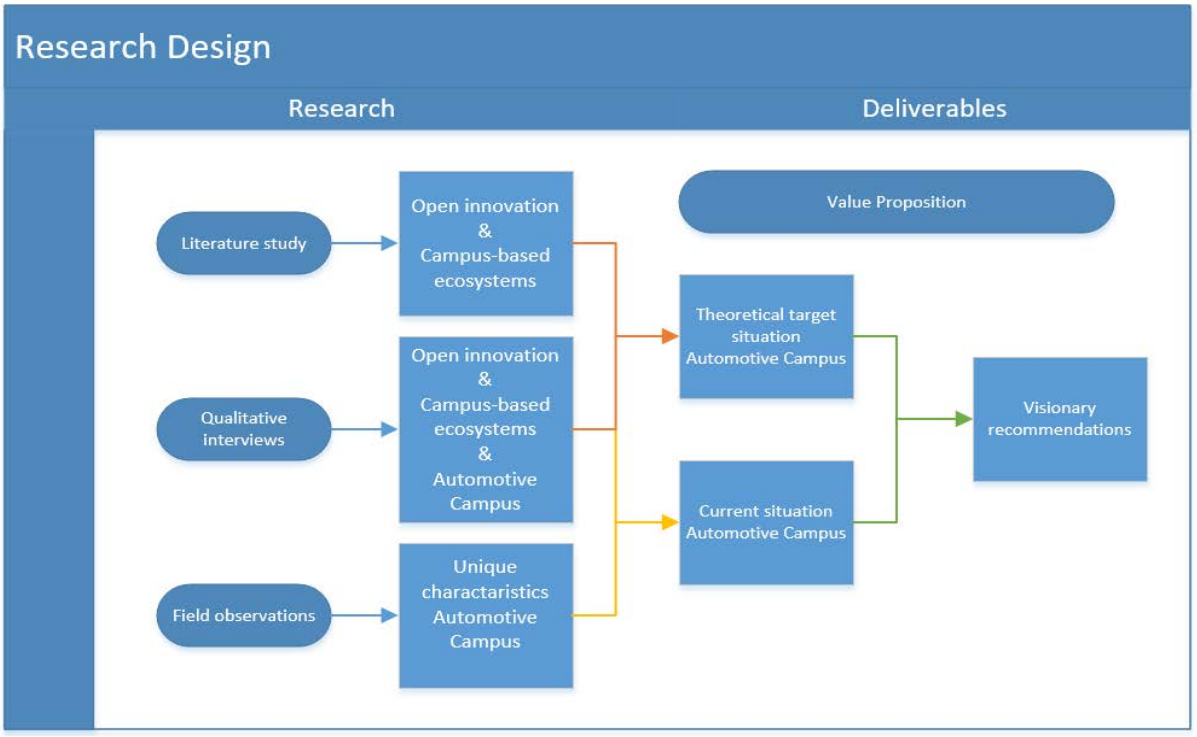

Figure 3 Research Design

To answer the research question, a literature study, qualitative interviews and field observations are done. In this the following sub-chapters, the stages of the design, shown in figure 3, will be explained. The method used will be science-based design, primarily aimed at designing a value proposition and recommendation, thereby applying scientific and design knowledge, as described by Romme and Endenburg (2006). The insights and data gathered in the research will be combined in an ideal target situation via this method. This ideal target situation will be iteratively tested and validated with experts on the topic, the campus organization and residents of the Automotive Campus.

2.1 Procedure: literature study

The first two sub-questions are the following:

1. What is open innovation and what are important boundary conditions for successful implementation?
2. What are campus-based innovation ecosystems and what makes them successful?

To answer these questions, a literature review is done and experts on open innovation, campus-based ecosystems and the automotive industry are interviewed (see 2.2.2.1). The literature review uses the five steps of Denyer and Tranfield (2009): question formulation, locating studies, study selection and evaluation, analysis and synthesis, and reporting results. Relevant literature is found by using expert recommendations and searches in databases like Google Scholar and Web of Science.

Prior to making a selection of literature, prof. dr. A.G.L. Romme and dr. M.M.A.H. Cloodt, experts in the field of open innovation and campus-based ecosystems, recommended relevant articles. These articles were studied, using forward and backward search. When searching for appropriate articles, titles of journal articles were scanned, after which the abstracts were read to come to a final selection of 20 articles on open innovation (related to sub question 1) and 18 on campus-based ecosystems (related to sub question 2). In Table 2 with all keywords used is provided.

Table 2 Keywords for literature search

Campus-based ecosystem	**Open innovation**
campus development	open innovation
campus-based ecosystem	open innovation ecosystem
location-based ecosystem	open innovation AND automotive industry
innovation ecosystem	creating open innovation ecosystem AND SMEs
innovation hotspot	facilitating open innovation
innovation ecosystem	distributed innovation AND network AND model

As this thesis is part of the master program Innovation Management, reviewed literature is mainly gathered from the following journals: Management and Innovation, R&D Management, Harvard Business School, MIT Management Review and Technovation (for a complete list of used literature, see bibliography). Articles focused on the Automotive Campus and the automotive industry provided in-depth knowledge of the campus and its sector. Specific literature on the Automotive Campus has been recommended by experts. An example is the report called “Strategy Automotive Campus 2018-2020” by Buck Consultants International (2016), which is only accessible for the campus organization. As this research uses a qualitative research method, triangulation of data is very important (see chapter 3.5.2), whereby literature review is one of the three major different methods (Yin, 2014).

2.2 Procedure: interviews

Semi-structured interviews were done to answer the three sub-questions. To reduce potential bias, both experts (on topic of automotive industry, open innovation and campus-based ecosystems) and residents of the Automotive Campus were interviewed (Barriball, 1994). In this way, scientific knowledge and practical knowledge was acquired.

The use of semi-structured interviews has several important advantages. First, response rates are higher when using personal interviewing compared to questionnaires or surveys (Harrell & Bradley, 2009; Bailey, 1987)**.** Face to face communication gives the interviewer the possibility to observe the non-verbal response as well. Especially in case of a personal or delicate issue, non-verbal cues can be used to check the validity of the study, see section 2.4 (Gordon. R. L., 1975). Semi-structured interviews also allow the interviewer to respond to the personal thinking, like beliefs and motives, of the interviewee (Richardson, Dohrenwend, & Klein, 1965). The semi-structured approach leaves room for a relatively free discussion, reacting on relevant statements, compared to a fully structured interview. In case of this research, this semi-structured approach is valuable as sub-questions relate to personal experience and preference as well as scientific insights. Interviewing gives the opportunity to obtain all relevant information, without having the risk of interference by another party, e.g. someone else formulating an answer for the respondent (Bailey, 1987). The obtained information is more comparable as all respondents will provide an answer to all questions. This is an advantage of personal interviewing too (Bailey, 1987; Yin, 2014).

To assure dependability and trustworthiness of the research (section 2.4), probing questions are used to acquire in-depth knowledge. Inconsistencies were explored and clarified, and information provided was substantiated and completed (Gordon. R. L., 1975; Bailey, 1987; Barriball, 1994). The interviews were recorded and later summarized. To assure reliability, the summaries were sent to the interviewees for verification. Comments or nuances could be added for verification. The summaries functioned as reliable and valid sources of information and were manually coded. The summaries of the interviews with residents can found in a separate appendix, they have not been included with the main document due to privacy concerns.

This master research combines information from experts, as they can provide a scientific view on the relevant matter, and information from residents, as they add a more practical view. Experts provided context, knowledge and Know-how on topics of open innovation, campus-based ecosystems (sub-question one and two) and the Automotive Campus (sub-question three). Residents provided insights and knowledge applied to the Automotive Campus (sub-question three). As interviews differed per sample, experts or resident, the methodology for both is explained separately.

2.2.1 Expert Interviews

2.2.1.1 Participants

Interviewees were selected based on their proven expertise on the topic of research. All experts have academic experience in their field of expertise and are active in the industry of their expertise. Four experts were contacted and interviewed: see Table 3 for an overview.

Table 3 Experts that were interviewed.

Expert name	Function	Expertise	Code
Sjoerd Romme	Professor of Entrepreneurship & Innovation, TU/e	Campus-based ecosystems; open innovation	E1
Carlo van de Weijer*	Director Smart Mobility, TU/e Global expert ITS, TomTom	Automotive industry; smart mobility	E2
Mercedes Crego Calma	Head Open Innovation Europe, Philips	Open innovation	E3
Daan de Clue**	Managing Director - Automotive & Mobility – TNO	Automotive industry; open innovation	E4

*mr. Van de Weijer functioned both as potential resident and as expert, due to his position at TomTom

**mr. De Clue is a resident on the Automotive Campus and has done his dissertation on open innovation which makes him an expert in the field

2.2.1.2 Protocol

The interview consisted of four topics namely: open innovation, campus-based ecosystems, automotive industry, and the value proposition of the Automotive Campus. Open-ended questions validated the main questions on the topics and probing was used to gain more in-depth information (Barriball, 1994). For E2 and E4 the residents protocol was used see section 2.2.2.2. For E1 and E3 a different protocol was used, see appendix A.

2.2.2 Resident Interviews

2.2.2.1 Participants

A diverse sample was created with the help of the supervisor at the Automotive Campus. An initial list of 40 potential interviewees was made. From the 40, a selection was made of eighteen people to represent a diverse mix of campus residents. To obtain a representative sample, both critics and supporters of the Automotive Campus were interviewed. Moreover, residents, former residents and potential residents were included. To further develop a diverse view, different kinds of residents were selected. The selected residents also differed in terms of the amount of time they resided on the Automotive Campus, for example from 1974 onwards or just 1 month. Company size, from 140 FTE to 1 FTE, mattered and different core businesses were engineering, building, startup, government and startup incubators. The goal of this diverse sample was to gain insight in the many different perspectives and thus obtain a complete and reliable view on the topics of research. The diversity sample represented the full variation without mirroring the distribution of the variation (Seawright & Gerring, 2008).

Seventeen companies were sent an e-mail with a short introduction of the researcher, the research goal and the request for an interview. From these seventeen optional interviewees, a set of ten residents was interviewed. This sample contains eight interviews with residents of the Automotive Campus, one with a former resident, and one with a potential resident.

Two respondents were interviewed twice. One of these interviewees was both a resident and an expert on open innovation and the automotive industry: Daan de Clue. The other interviewee was first interviewed as a potential resident of the Automotive Campus and then as an expert on open innovation: Carlo van de Weijer.

2.2.2.2 Protocol

The goal of the interviews was to find the missing elements between the current Automotive Campus and the open innovation campus-based ecosystem as literature defines it. Insights from the literature study were used to give direction to the interviews. Therefore, the interview protocol is divided in four parts. First the three sub-questions and last the value proposition.

In part one, the interviewees were first asked what their definition of open innovation was and what they knew about this topic. Secondly, a general accepted definition of open innovation from Chesbrough (2017) was given and shortly discussed to make sure the definition was clear. Thirdly, the interviewee was asked if he was familiar with open innovation as defined and what is necessary to accomplish open innovation.

In part two, similar question were asked about campus-based ecosystems. The definition of Cloodt et al. (2015) was used.

In part three, the interviewee was asked to describe the characteristics of the Automotive Campus. This in order to validate the value proposition neutrally for the researcher.

In part four, the interviewee was first asked if he or she was aware of the value proposition of the Automotive Campus. The value proposition was shown, and the interviewee was asked what the most important aspects were and if he or she could suggest missing factors. Thirdly, the automotive campus development for success of a campus-based ecosystem was discussed and the conditions to realize open innovation were topic of conversation.

Before starting the resident interviews, a tryout interview was held after which the interview was improved. The full interview protocol can be found in the appendix B. This protocol has proven to be most successful when leaving room for free discussion (Barriball, 1994; Yin, 2014).

In appendix G a schematic overview of the summaries and coding of the interviews can be found. This has been used as an overview of the information gathered and to see similarities or dissimilarities between the residents. After these trends were found the summaries were again used for more context and information.

2.3 Procedure: field observations

For the duration of the master thesis, the researcher has resided on the Automotive Campus with the campus organization. This resulted in many unique insights related to daily life and the unique characteristics of the Automotive Campus. Besides, experiencing the campus from within laid the basis for the later interviews and provided the appropriate context for in-depth discussion. For the duration of the thesis a diary was kept to keep track of events and interesting moments. This information was used for context and to triangulate data with different sources and thereby validate the data.

2.3.1 Stay at the Automotive Campus

During the master thesis from March to August 2018 the author of this study stayed part-time on the Automotive Campus, where he resided in the main building with the campus organization. During this period, data was collected about residents, processes, the organization and the physical environment as a whole (Courage & Baxter, 2005; Rosenbaum, 2002; Nielsen, 2002).

The office of the campus organization housed four people: the director, who oversees the organization and who is also responsible for the business development on the campus; an acquisition and marketing manager who was also the thesis supervisor; a marketing and community building employee; a project manager from AutomotiveNL and an interim manager of the Automotive House.

The organizations office can be quite chaotic sometimes, due to the continuous stream of people coming by to talk about all kinds of business. This made it the perfect place for getting to know the Automotive Campus, its functioning and the people present. For the literature study and writing part of the thesis a separate room was available.

Throughout his stay, the author met many new people working or conducting business on the Automotive Campus. This opened doors for later performed interviews and improved understanding and function of the campus.

During the Dutch Technology Week, the Automotive Campus had an open day. This day was used to observe all the companies joining in the open day as well as for informal correspondence with residents in order to further deepen the knowledge about the functioning and characteristics of the campus.

2.3.2 Automotive Congress

During the thesis, the Automotive Congress was visited to gain insight in functioning of the automotive industry and their knowledge on and know-how of open innovation

The twelfth edition of the Automotive Congress was held on the 23th of May. The theme was ‘Crossing borders’ which relates to the topic of this thesis. On the event ten different speakers performed. Over 40 exhibitioners, 30 of which were companies working in the automotive industry, were present. About 10 startups and student teams, working in the automotive industry, contributed to the exposition. During the day, the author attended all speeches and interviewed most stand holders. Also people from the automotive industry were informally interviewed to get a better understanding of their knowledge and capabilities on the topic of open innovation.

The information gathered at the event has been summarized in a report. This can be found in appendix E.

2.3.3 High Tech Campus Eindhoven

During the master thesis, three visits to the HTCE were made. The HTCE is universally praised as a highly successful campus-based ecosystem (Romme, 2017). The purpose of the visits to the HTCE was to gain insight in its functioning and atmosphere. It also provided context for the research interviews. This was useful as many interviewees referred to the HTCE, as it and the Automotive Campus lie only 15 kilometers apart.

On the HTCE, two interviews were realized at two different locations. One of the interviewees provided a campus tour as well. Lastly, the open day of the HTCE, during the Dutch Technology Week, was used to see some of the companies at the HTCE from within.

2.4 Value proposition

The value proposition describes the benefits customers can expect from the product or service (Harvard Business School, 2018). The service is in the case of the Automotive Campus a space (rented or bought) on the campus and thereby access to the ecosystem. For and with the ecosystem

the campus organization organizes and houses many events like open days, networking, congresses, drinks, etc. To gain a precise insight in the current value proposition, reports and business plans from the last three years where sourced from the Automotive Campus archive. These were studied and discussed in meetings with the campus organization to apply them to the current situation. At July 2018, the value proposition available at that time was outdated and underdeveloped.

Therefore, the Value Proposition Canvas (VPC), which is a value proposition design tool, has been iteratively used to create a new value proposition for the Automotive Campus (Osterwalder A. , Pigneur, Bernarda, & Smith, 2014). The VPC has just been introduced but is already accepted very well by business designers and strategists (Mulder, 2017; Morle, 2017); Pijl van der, 2017). The VPC tool focusses on how to create value for customers (in this case the campus residents) and is closely related to the Business Model Canvas (BMC) from Osterwalder & Pigneur (2010). It uses the 'customer segment' as input and creates the value proposition as output for the BMC (Osterwalder A. , Pigneur, Bernarda, & Smith, 2014). The BMC itself has been widely used (e.g. (Meertens, et al., 2012; Muhtaroglu, Demir, Obali, & Girgin, 2013; Zolnowski, Weiß, & Bohmann, 2014) and therefor the VPC is chosen to create the value proposition.

The VPC is a simple tool to visualize the fit between the value proposition and the customer segment from the Business Model Canvas. The VPC uses two fields: the value map, which will be designed, and the customer profile map, which can be observed in the market. The two fields are related to the value proposition and customer segment fields in the Business Model Canvas (Osterwalder A. , Pigneur, Bernarda, & Smith, 2014), see Figure 4. The value map (proposition) is the set of benefits that the company designs to attract customers and the customer profile map (segment) is a set of characteristics that are assumed, observed and verified in the market (Appendix G).

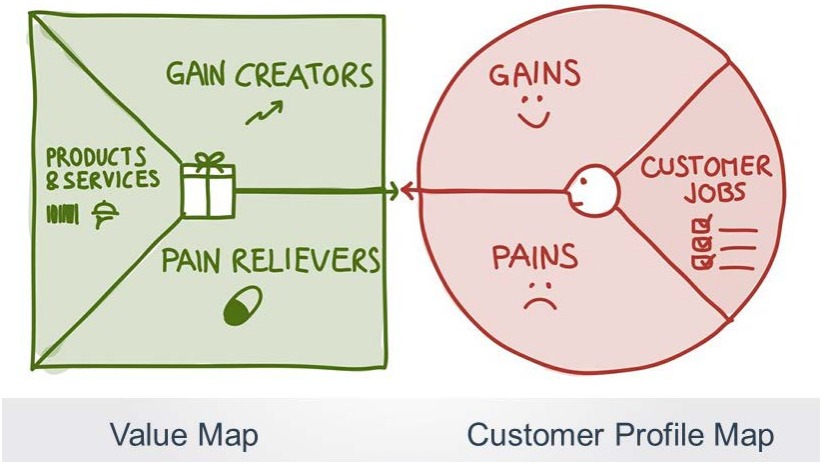

Figure 4 Value Proposition Canvas, source: www.toolshero.com/marketing/value-proposition-canvas

The value proposition is created in the following three steps:

First, the information from the literature analysis and interviews with experts was summarized into a theoretical framework of properties, conditions, and expert knowledge. Together with the information from interviews with residents and field observations, this was used to create an initial VPC.

Second, with the initial VPC, multiple meetings with the Automotive Campus director and acquisition and marketing manager where held to iteratively complete the VPC. Fellow graduates from the master Innovation Management were also consulted to gain new and fresh insight in the development of the value proposition.

Third, a conceptual value proposition was created from the VPC. This value proposition was then iteratively improved, based on feedback received from the residents and experts interviewed after which it was finalized.

2.5 Analysis, reliability and validity

2.5.1 Reliability and validity

Campbell and Fiske (1959, p. 39) define reliability and validity as follows:

"Reliability is the agreement between two efforts to measure the same trait through maximally similar methods. Validity is represented in the agreement between two attempts to measure the same trait through maximally different methods."

A reliable study can be repeated and still measures the same thing. The study must be consistent over time. To conduct a reliable study, data collection and analysis must be transparent. A clear and substantiated method is needed to achieve reliability. In the case of qualitative study, reliability strongly relates to dependability (Lincoln & Guba, 1985). As qualitative research is much more personal and sensitive compared to quantitative research, it is important to consider the term reliability in context of this paradigm. To assure a reliable, and thus dependable, qualitative study, one must strive for credibility, neutrality and applicability (Lincoln & Guba, 1985).

In this research, semi-structured interviewing was used to collect data, which is a qualitative research method. Probing questions assured a dependable outcome as it allows the interviewer to clarify responses and probable inconsistencies (Hutchinson & Skodol-Wilson, 1992; Barriball, 1994). Besides, probing interviews create the opportunity to explore delicate matters and elicit valuable information (Nay-Brock, 1984; Gordon. R. L., 1975; Bailey, 1987).

A valid study refers to measuring what you want to measure: are you hitting the target? What was intended to be measured, must be measured. Methods can be different in nature but still both valid.

Validity in case of qualitative study is affected by the researcher's vision on the study and the degree of trustworthiness of the outcomes. Again, the choice of paradigm assumption influences the interpretation of validity (Creswell & Miller, 2000). To achieve a valid study, moreover a trustworthy study, the findings of the study must be confined and sustained throughout the research (Lincoln & Guba, 1985). In case of this study, validity of the interviews was assured by asking simple questions, directly related to the research question. Background of open innovation, campus-based ecosystems and the Automotive Campus were discussed freely at the beginning of interview, to agree on used definitions. The summary of the interview was verified afterwards by the interviewee which guaranteed the correctness of the report of the interview.

2.5.2 Triangulation to improve reliability and validity

By using multiple sources as support for a proposition, credibility of this proposition increases. Patton (2002) states that 'triangulation strengthens a study by combining methods', which is used in this research by triangulating outcomes of expert interviews, resident interviews, field study and literature study. Triangulation is related to constructivism in the way that it values multiple and diverse sources to achieve trustworthy data.

In any qualitative research, the aim is to "*engage in research that probes for deeper understanding rather than examining surface features*" (Johnson, 1995, p. 4) and constructivism may facilitate

toward that aim. Deeper understanding is valued above surface features, which encourages probing as part of the interview method (Johnson, 1995). Golafshani states *that "engaging multiple methods, such as, observation, interviews and recordings will lead to more valid, reliable and diverse construction of realities"* (Golafshani, 2003, p. 604). This demonstrates the importance of the diverse sources in this research.

2.6 Deliverables and summary

The thesis delivers two documents. Firstly, this master thesis report and secondly, a value proposition and recommendations for (further) developing open innovation at the Automotive Campus Helmond. Both will be explained in a detailed presentation. To further explain the research results, a poster will be used with a research summary.

To summarize, this research will answer the question *"How can the Automotive Campus organization facilitate the development of an open innovation ecosystem at its campus in the next five years?".* To do this, the problem will be identified, analyzed and diagnosed and a plan of action will be formulated by developing a value proposition and visionary recommendations. To design a framework for the theoretical target situation of the Automotive Campus, literature study and semi-structured interviewing of experts is done. Information from literature review and experts will answer the sub-questions "*What is open innovation and what are important boundary conditions for successful implementation?"* and "*What are campus-based innovation ecosystems and what makes them successful?"* To gain more insight in the characteristics of the Automotive Campus, residents are interviewed using semi-structured as well. Combined with field observations, outcomes of resident interviews give the answer to sub-question three, "*What is missing to realize open innovation, and what is the unique value proposition of the Automotive Campus?".* The result will be an assessment of the Automotive Campus on the theoretical requirements for a campus-based open innovation ecosystem. A unique value proposition and recommendations to optimize open innovation on the Automotive Campus result from this.

In the next chapter, results will be reported.

3 Results

In this chapter the sub-questions are answered. First, sub-question one and two will be answered by a literature study and expert interviews in section 4.1.

Second, the current state at the Automotive Campus will be described and assessed on the framework in section 4.2 (framework is provided in 4.1).Third, the value proposition is built in section 4.3. This is iteratively done with the results of a field study and interviews with campus residents and will answer sub-question three.

3.1 Theoretical target situation Automotive Campus

In order to answer sub-questions 1 and 2:

1. *What is open innovation and what are important boundary conditions for its successful implementation?*
2. *What are campus-based innovation ecosystems and what makes them successful?*

First, a literature analysis is done on topics of open innovation and campus-based ecosystems. Second, four experts gave their view on open innovation and campus-based ecosystems, literary was used to structure the interviews.
The literature and the expert knowledge are combined in chapter 3.1.1 for open innovation and in 3.1.2 for campus-based ecosystems. In 3.1.3 the theoretical target situation is given which will be used for the assessment and the creation of the value proposition of the Automotive Campus.

3.1.1 Open Innovation

3.1.1.1 Literature analysis

Innovation is, in general, *"the application of better solutions that meet new requirements, unarticulated needs or existing market needs"* (Maranville, 1992, p. 4). It is known as the discovery of a solution, or kind of remedy, to a problem of which people are either aware or unware. Independent of the awareness of the customer, innovation brings in a new idea that can be tangible or intangible, so either a practical tool or a process improvement. Everybody can benefit from innovation, government, society, companies, and so forth. Based on Frankelius (2009), innovation can be seen as outcome and process in one. Often, innovation follows from scientific research and or or engineering, as those disciplines focus on problem solving. The process of finding the solution to a problem is called innovation, as well as the ultimate outcome of the process, which can be a tangible object or an intangible management tool (Edison, Ali, & Torkar, 2014). As the word implies, innovation is related to invention, but differs from this in a practical sense. Innovation is a more practical kind of invention, focused on improving and making an impact.

The first to define two kinds of innovation was Henry W. Chesbrough, when publishing his book '*Open Innovation: The New Imperative for Creating and Profiting from Technology*' (2003). By introducing the term 'open innovation' he classified the more traditional strategy of innovating as 'closed innovation'. Although Chesbrough was the first to categorize these innovation strategies, open and closed innovation already existed before being recognized as different (Gann, 2005; Christensen, Olesen, & Kjaer, 2005).

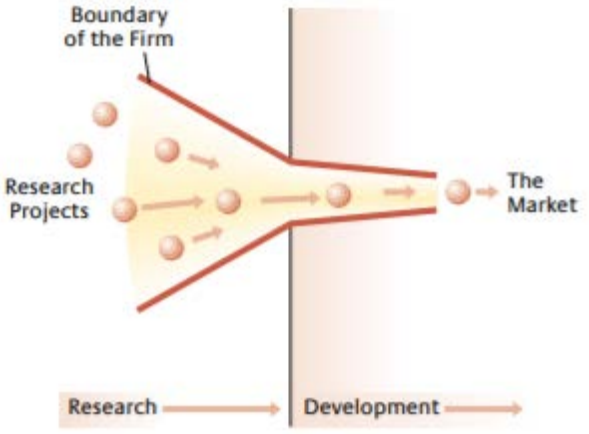

Figure 5 The Closed Innovation Model (Chesbrough H. W., 2003, p. 36)

Chesbrough (2003) defines closed innovation as an in-house process whereby development and commercializing remain within the borders of one company (Figure 5). Companies always search for the most profitable process or goods and, when innovating in a closed way, they develop without consulting outsiders. The word closed is related to the boundaries of the firm.

Originally, Chesbrough referred to open innovation as *"a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology"* (Chesbrough, 2006, p. 1). He states this in his first book, which was a break-through on the topic of innovation management. To give some indication of the impact, before this book Google Scholar resulted in 200 hits after search for 'open innovation', that were not related to open innovation but used terms 'open' and 'innovation' in another context, e.g. 'company X opened a new innovation center on location Y'. Now, 15 years after publication, 'open innovation' resulted in over 4.5 million hits on Google Scholar and 15.000 citations of Chesbrough's book. This shows the popularity of open innovation in the academic world, in the last six years the book has been consistently cited 1600 times per year. In 2014, Chesbrough reformulated open innovation as *"a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model"* (Chesbrough, Bogers, & West, 2014, p. 17). This definition will be used in this master thesis as well.

In contrast to closed innovation, open innovation thus focuses on combining in-house knowledge and strategies with the outside environment (Figure 6). A company that innovates openly, brings its own idea to the market but also the ideas of other companies. Collaboration is something very important and the dashed boundary of the firm shows the connection to the extern (Figure 6). Noteworthy as well is the exploring of new markets along an original innovation path. In the case of closed innovation, all eyes remain fixed on the current market.

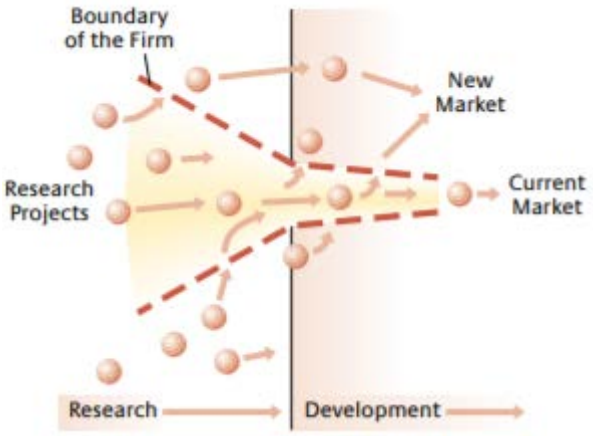

Figure 6 The Open Innovation Model (Chesbrough H. W., 2003, p. 37)

As illustrated by the growing attention on open innovation, it has become a renowned strategy of innovating. Advantages are the reduced costs, partly due to the marshalling of resources and support (Henkel, 2006) and partly the supply of new ideas and knowledge (Laursen & Salter, 2006). Problem solving and discoveries will be easier realized when working together with other companies (Lakhani, Jeppesen, Lohse, & Panetta, 2006). Another advantage is the accelerated time to market with access to resources and knowledge of partners (Powell, Koput, & Smith-Doerr, 1996). These partners are sometimes better prepared to improve inventions, in such a way that they live up to the expectations of both firms (Chesbrough & Rosenbloom, 2002). Products that are delayed in development can be easier commercialized when using new input (Dahlander & Gann, 2010). Providing such input will make the other company gain in legitimacy from its external environment (Nuvolari, 2004). Also, complementary positions of the partners will improve their mutual outcome (Dyer & Singh, 1998). Ultimately, all of the above increases differentiation in the market and the creation of new revenue streams for the company (Chesbrough, 2011).

To develop an open innovation location-based ecosystem, Chesbrough explained the relevance of three factors (Chesbrough, 2010). The first factor, an active university research in a particular industry, is a powerful resource to open up the innovation process. This creates the knowledge diffusion through open networks with stakeholders who have different interests (industry and academia). The second factor is venture capital investments. These are funds for small, early-stage, emerging firms that have a high growth potential or which have demonstrated high growth (PrivCo, 2018). The third factor is the attraction of startup companies, which is important as they introduce new technologies into the ecosystem (Chesbrough, 2003).

Obviously, open innovation knows disadvantages as well as any other strategy. An important boundary for implementation is the difficulty of noting the concrete benefits for both companies. Direct result is not tangible and thus it is hard to note an increase (Dahlander & Gann, 2010). Besides, maintaining relations with a lot of partners can be very difficult and can result in an attention problem (Ahuja, 2000). The greatest struggle companies experience is the fear of losing inventions and resources to competitors (Laursen & Salter, 2006). Managers experience a feeling of discomfort by risking the exposure of their companies' most critical dimensions (Dahlander & Gann, 2010). Another factor that stands in the way of open innovation is over-commitment to a companies' own product, process or engineering. This makes it difficult to open the firms' boundaries (Lichtenthaler & Ernst, 2007). Lastly, the options to choose from are so many that it is hard to make the right decision (Sapienza, Parhankangas, & Autio, 2004).

To profit from the advantages and overcome the disadvantages of open innovation, companies must be aware of these advantages and disadvantages. It must be clear what companies want to achieve with open innovation, so they can manage their innovation process accordingly. It is thus important that companies are well informed on open innovation.

3.1.1.2 Applicability of open innovation to the Automotive industry

Huizingh (2011) argues that the relevance of open innovation is context dependent and that it will not work for all companies. He mentions two characteristics of the context that make the difference, namely internal characteristics, related to demographics and strategies, and external characteristic like industry. The context of the Automotive Campus has impact on the latter characteristic, since its main focus is facilitating companies in the automotive industry. This means that the Automotive Campus organization can improve the facilitation of the industry such that it becomes an optimal environment for open innovation. As a demonstration of the opportunities in the automotive industry, Ili et al. (2010) name the automotive industry's suitabillity for open innovation even though the industry is traditionally very closed (Ili, Alberts, & Miller, 2010; Boon, 2018). Thus, the campus organization can optimize the campus ecosystem to successfully implement open innovation.

Another advantage of the Automotive Campus when it comes to implementation of open innovation, is the fact that a single firm cannot practice open innovation on its own. A firm has to engage with different partners (Chesbrough, 2003; Laursen & Salter, 2006). The setting of the Automotive Campus is extremely appropriate when it comes to connecting companies. The location of several companies on one campus improves their mutual network and so enables collaboration. Those collaboration partners can vary in function as they can be suppliers, customers, competitors, research organizations or institutions (Huizing, 2011).

Important to notice is the need for trust when working together in open innovation. For cooperative relationships to succeed, mutual trust is essential. An intermediary, like the Automotive Campus organization, can provide a basis for this trust but the members must make a continues effort to develop it (Lee, Park, Yoon, & Park, 2010).

3.1.1.3 Important boundary conditions for open innovation

As stated earlier, the definition used for open innovation in this master thesis:

"A distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model" (Chesbrough, Bogers, & West, 2014, p. 17)

As open innovation is a relatively new concept, introduced in 2003, boundary conditions for implementation have not yet been clearly stated in scientific literature. Therefore, in agreement with expert number one, the boundary conditions for open innovation are derived from the definition of Chesbrough. That is, open innovation must:

- be a distributed innovation process;
- be based on pecuniary and non-pecuniary mechanismsand;
- have knowledge flows across organizational boundaries (on a campus).

Firstly, an innovation process is distributed when the company uses sources outside the company, for its knowledge and its technology development (Howells & Malik, 2003). Distributed knowledge is key in a distributed innovation process. The origin of the knowledge flow is relatively inconsiderable as the broader base of knowledge demonstrates the effectiveness of these new methods and organizational structures. These kinds of structures are a definite addition to optimize innovation systems, but not to fully replace the existing in-house processes (Lakhani, 2007).

Secondly, when looking at the definition of open innovation, organizational boundaries are perpetuated by knowledge flows. These knowledge flows are directed by management as they can control the absorptive capacity within a firm (Escribano, Fosfuri, & Tribó, 2009). The idea that new knowledge comes from in-house research, is gradually reducing in popularity (Arora, Fosfuri, & Gambardella, 2001); Gans & Stern, 2003). Cockburn and Henderson (1998) state that firms must recognize the usable, external knowledge and use this recognition as competitive advantage. This ability can be called 'absorptive capacity' and positively relates to the competitive advantage of firms (Arora, Fosfuri, & Gambardella, 2001). Internal innovation becomes less important but stays relevant as it lays the knowledge base for the absorptive capacity (Escribano, Fosfuri, & Tribó, 2009).

Lastly, the mechanisms for the distributed innovation process of inbound and outbound innovation can be pecuniary or non-pecuniary. Once again, management is driving those mechanisms in accordance to the organization's business model. Pecuniary and non-pecuniary relate to two inbound processes and two outbound processes (Table 4) (Dahlander & Gann, 2010). Inbound relates to sourcing and acquiring of innovation. Here, innovation outcomes can be licensed-in or acquired (pecuniary) or externally sourced (non-pecuniary). Outbound innovation relates to the firms selling of ideas and resources in the marketplace. Selling is the pecuniary way of outbound innovation. Revealing is sharing innovation to the outer world (non-pecuniary). For open innovation, all four mechanisms can be used.

Table 4 Four different forms of openness (Dahlander & Gann, 2010, p. 702)

	Inbound innovation	Outbound innovation
Pecuniary	Acquiring	Selling
Non-pecuniary	Sourcing	Revealing

3.1.1.4 Expert interviews

In practice, Chesbrough's definition of open innovation is still rarely used (E1, E2, E3). There is limited awareness of open innovation, and its function in the automotive industry. Definitions by experts show a more practical side of open innovation:

Expert 3: *"Taking advantage of something that is developed elsewhere and use it in your company and to accelerate your own innovation by taking innovation and technologies from the external sources."*

Expert 4: *"Sharing knowledge and Know-how to jointly achieve better products."*

Often, open innovation is used as term to motivate for social capital (E1). Social capital relates to resources, relationships between them and their impact. Experts state that just a few companies embrace the concept of open innovation (E1, E2, E3, E4). In those cases, it is a slow and steady process which can only be realized by a mind shift within the company (E4). Expert four states:

> *"It is a 180 degree turn for firms to go to open innovation from closed. This is mostly a mindset, they are afraid someone else uses their idea. This is slowly improving though."*

When looking at existing open innovation networks, two aspects can be noted: social and technological. Expert one, specialist on the High Tech Campus Eindhoven (HTCE), states that social facilities are needed to offer people room to meet and get to know each other (E1, E3, E4). Shared social facilities, like the hospitality sector, events and sports centers, make (informal) contact easier and thus improve relationships and enhance creativity. Second, expert one states that open innovation can be supported by technology. Shared technological facilities are a major contributor to open innovation (E1, E3). The option to use specialized facilities without having to invest in them, connects people. Employees from different companies will fulfill the social aspect in technology (E1).

For a successful open innovation strategy, the goal of companies must be the same but their interest must differ (E2, E3, E4). That is why a Triple Helix model often succeeds in an open innovation setting as the different partners all have, by definition, a different interest with the same goal (E4). One other relatively easy method for applying open innovation is in a pre-competitive state. In a pre-competitive state, companies develop standards or procedures which they will not use to compete with each other. This is mostly the case in different industry sectors (E2, E4). Expert four states the following, showing the relevance for the automotive industry:

> "*Currently, there are interactions between the vehicle and energy and the vehicle and infrastructure, because electricity is an increasingly dominant source of energy, just like hydrogen. This means that as an OEM you cannot just make a vehicle, but you also have to take into account the restrictions and conditions from the ICT industry, road infrastructure and the energy sector to make them interact and connect"* (E4).

Infrastructure is also important to facilitate open innovation. Companies must be accessible and preferably low-key approachable. Offices that have a closed workspace and an unwelcome environment to externals are obstructing open innovation. All experts emphasize the importance of social networks and communities, because this creates inter-community knowledge. Complementing knowledge and Know-how will accelerate the innovation process (E1, E2, E3, E4).

For open innovation on a more competitive level, it is important to make agreements on executive level within the firm about the shared goals and individual interests (E4). This is difficult when collaborating with more than two or three partners, as it is difficult to objectively secure all interests (E1, E4). Therefore, a neutral partner is a good option to safeguard all the partners interest while

keeping focus on the shared goal (E4). TNO is a good example of a company that often fulfills this function.

Trust is key in open innovation as well. A widely spread anxiety is the chance of intellectual robbery, as collaboration creates interdependence. There is a risk of losing your innovative ideas and plans to another company. However, this chance is small as such an action would exclude a company from collaboration in the future and would result in a bad reputation (E4). Openness and trust are very important to overcome this fear of robbery. Again, the organization of open innovation is relevant when establishing a mutual trust bond. In case of the absence of a mediating, organizing party, agreements between the cooperation companies are crucial. Agreements must demarcate the boundary between the process of open innovation and the ultimate outcome for each company (E2, E3, E4).

Startups are a valuable addition in an open innovation setting (E1, E2, E3, E4). They are by definition open (E3) and make established companies re-think their current business model (E4). Students are also a source of open innovation as they give firms a fresh perspective and a source of external knowledge (E2, E3, E4) and involve themselves in entrepreneurial activities (E2, E3).

3.1.1.5 Conclusion about open innovation

Open innovation is defined as "*a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model*". It has multiple advantages relative to its more traditional predecessor, closed innovation. It is also a relatively new innovation model. Academics started the research in the last 15 years, which makes businesses relatively unfamiliar with the term.

To realize open innovation, there must be a distributed innovation process, partly open firm boundaries and pecuniary and non-pecuniary mechanisms of innovation. Distributed innovation process is a process where the firm uses external knowledge bases for innovation. Boundaries of the firm are partly open for knowledge flows. Open innovation is pushed by the organizational business model and mechanisms for open innovation are acquiring and selling (pecuniary) and sourcing and revealing (non-pecuniary). For open innovation to work, a mind shift is necessary and it has to be supported from within the company. The most important factor for open innovation to work is the availability of networks that can support the present community. Other important factors for open innovation are: social and technological facilities, students (knowledge development), startups (entrepreneurial activities), community building and knowledge infrastructure.

To overcome fear of innovation robbery, trust and reciprocity are needed. Besides, communication and a stable network between (potential) co-operators are required. Companies must share a goal to work for but they must have different interests. To optimize collaboration, a neutral partner can be very helpful.

3.1.2 Campus-based ecosystems

3.1.2.1 Literature analysis

In this thesis, a 'campus-based ecosystem' is '*an ecosystem [that] involves a group of firms that have some linkages and synergies with each other in order to increase their general competitiveness*' (Cloodt, Putra, Romme, & van der Borgh, 2015, p. 1). Those linkages are directly created by the shared location, facilities and industry focus of a campus-based ecosystem. A successful campus-based ecosystem delivers the following for its residents:

1. It facilitates research and development by providing its residents access to shared resources and facilities.

2. It creates an innovation community that improves knowledge sharing between people (Romme, 2017).

Just as open innovation, the creation of high-tech environments is a reaction to rapidly developing technology industries (Organisation for Economic Co-operation and Developent (OECD), 2008). To keep up with modern development, companies must change their way of innovation (Enkel & Gassmann, 2010; Gassmann, Enkel, & Chesbrough, 2010; Normann, 2001). Global competition has increased and sources for innovation are very diffuse. To overcome these challenges, companies turn to each other. The easiest and most dependable way to stay connected is by locating firms on the same grounds (Gupta, Tesluk, & Taylor, 2007). Campus-based ecosystems, or business ecosystems, result from this need (Eisenhardt & Galunic, 2000; Iansiti & Levien, 2004). The most important advantage is the exchange of knowledge in the research and development phase. Together, creativity is more easily changed into innovation and physical proximity is conditional to a fruitful and creative debate. Van der Borgh et. al (2012) state the following with regard to campus-based ecosystems: "*Business ecosystems* (campus-ecosystems, red.) *offer individual companies an environment that thrives on heterogeneity, learning, connectivity, and mutually influencing interactions*" (Borgh van der, Cloodt, & Romme, 2012, p. 151). Again, we see that the important aspects of a campus-based ecosystem are learning and developing together. When location can be chosen freely, a company will thus go for a location shared with others.

Besides initial advantages, further research on topic of the influence of campus-based ecosystems lacks in academic literature. It remains unclear what the effect of such ecosystems is on the ultimate success of companies. Crucial are the business strategy and organization of companies present in an campus-based ecosystems to reach the full potential of such a system (Borgh van der, Cloodt, & Romme, 2012)**.**

3.1.2.2 Critical aspects of a campus-based ecosystem

Prof. dr. Romme, expert in the field of campus-based ecosystems from the TU/e, has been involved with the High Tech Campus Eindhoven (HTCE) from the start. The HTCE can be described as a highly successful campus-based ecosystem. In his paper, 'Toward the blueprint of campus-based ecosystems for innovation' he defined five conditions of the HTCE which were of importance for achieving its success. Romme describes how these conditions are developed at HTCE and how the more than 160 companies situated on the campus, benefit from being part of the ecosystem. Combined, the conditions result in unique benefits to residents of HTCE (Romme, 2017). Below, the conditions are formulated as (sub)goals of the HTCE system. As the HTCE and the Automotive Campus share context and culture, these aspects are very relevant for this thesis.
The conditions are the following:

1. Minimizing distances to facilitate direct interaction:
   the greatest strength of a campus is the physical connection it creates between its residents. The residential proximity allows contact and a close connection.
2. Informal networks and knowledge sharing:
   a campus creates the feeling of brotherhood amongst its residents. People live in the same community and this improves informal relationships and trust bonds.
3. Managing the ecosystem's diversity and reputation:
   a diverse campus results in diverse knowledge input and thus creativity. Besides, a good reputation will create a desired position in the market.
4. Connectors that initiate and manage collaboration:
   connections between residents must be guided to make them easier. Accessibility of other companies must be improved.

5. Responsiveness to what residents need:
   management of the campus must see what residents need to flourish and use this to improve campus facilities.

Other literature supports that the strength of the HTCE lies within facilitating individuals and connecting the community (Romme, 2017). Value of a campus can be created by first facilitating the innovation process for individual companies. When companies have their own innovation process improved and managed, the creation of an innovation community is the key (Borgh van der, Cloodt, & Romme, 2012). So, after individually managing innovation processes, residents must be connected and helped by learning from each other and developing together.

3.1.2.3 Innovation ecosystems

Beside the conditions for a successful campus-based ecosystem, is also important to understand what the key processes of the location-based ecosystems are, before an innovation system can be created.. Location-based ecosystems, as in campus-based form, influence innovation by management and policy. An 'innovation system' relates to the process of innovating and the ecosystem where innovation takes place. Due to the technical focus and thereby the high amount of technical companies present at the Automotive Campus, literature about technical innovation (eco)systems (TIS) is consulted. Bergek et al. describes a TIS as follows *"socio-technical systems focused on the development, diffusion and use of a particular technology (in terms of knowledge, product or both)"* (Bergek, Jacobsson, Carlsson, Lindmark, & Rickne, 2008, p. 2). The focus of the Automotive Campus is to develop smart and green solutions for the automotive industry. Furthermore, there are knowledge development companies and prototyping companies present at the campus.

Bergek et al. (2008) find seven key processes in the evolution of a technological innovation system. The seven key processes have been further developed by Hulscher (2017), who did a general inductive analysis with several experts on innovation ecosystems to define the important aspects of the key functions, see Table 5.

Table 5 Seven key functions of a technological innovation ecosystem (Bergek, Jacobsson, Carlsson, Lindmark, & Rickne, 2008)

Function	**Important aspects**
Entrepreneurial activities	(1) The entrepreneurial culture of people. (2) Which actors pursue the entrepreneurial activity? (3) Non-financial support activities present in an innovation ecosystem.
Knowledge Development	To what extent is knowledge being developed in a closed or open setting within the innovation ecosystem?
Knowledge diffusion trough networks	(1) The condition of the physical network links in the innovation ecosystem. (2) The level of formality of intangible networks.
Guidance of the search	To what extent and in which forms the government is supporting the innovation ecosystem with regards to R&D funding, regulatory pressures?
Market formation	(1) The level of competition present an innovation ecosystem and the effects of it. (2) The dominant players and to what extent are they dominating the innovation ecosystem?
Resources mobilization	(1) The mobilization of (corporate) Venture capital. (2) What kind of human capital is present in the innovation ecosystem?
Creation of legitimacy	The barriers to innovation with regards to regulations of different actors.

This theoretical model is chosen due to the relevance of all these seven functions to the Automotive Campus as this social-technical system facilitates innovation by different technical companies.

3.1.2.4 Expert interviews

A campus must focus on a particular topic to connect residents by common goals (E1, E2, E3, E4). Another aspect of a campus is the proximity of different companies. The residents must by easily accessible to share knowledge and ideas (E2, E4). This successful collaboration is also important in contact with government of knowledge institutes. Besides, there is room for easier collaboration to create products and services due to the network and inter-resident knowledge (E4). For example, having students on a campus improves innovation, creativity and activities, which is positive for the campus life. This is the same for start-ups.

Before the campus can be successful, a 'critical mass' is needed to maintain its growth, reputation, knowledge level and technological innovation (E4). This critical mass provides the campus with an attractive force which is conditional to being independent and self-sustained. Funding must not be crucial when it comes to maintaining the campus. Targeted acquisition can be done to attract only the most valuable companies to the campus (E1, E4). Companies that can either support the ecosystem socially, for example by facilitating networking events, or technologically, by creating shared facilities or investing in shared facilities on the campus (E1, E4). For a successful campus the residents need to be supportive of the ecosystem because the residents must make the ecosystem a success.

A potential disadvantage of a campus can be too much focus on other firms within the campus-based ecosystem and thereby failing to note the market and potential partners outside the campus (E4). Campuses are also relatively closed environments (E2), so in case of an open innovation ecosystem, campus organization must be aware of this risk.

3.1.2.5 Conclusion on campus-based ecosystems

A campus-based ecosystem is defined as "*an ecosystem that involves a group of firms that have some linkages and synergies with each other in order to increase their general competitiveness*". Campus-based ecosystems are the perfect place for open innovation because they stimulate linkages and synergies with residents, created by the shared location, the joint industry focus and the social and technological facilities. The easiest and most dependable way to stay connected is by firms sharing the same grounds.

Successful campuses facilitate their residents in two ways. Firstly with research and development by providing access to shared resources and facilities. Secondly, with an innovation community which improves knowledge sharing. For a successful campus-based innovation ecosystem, Romme (2017) describes five conditions to be met, in order to create value for residents. These are facilitation of knowledge sharing and informal networking, minimizing distances on campus, manage ecosystem diversity and reputation, attracting and hosting connectors and being highly responsive to questions. Next Bergek et al. (2008) define seven key functions of an innovation system, which are knowledge diffusion trough networks, entrepreneurial activities, knowledge development, guidance of the search, market formation, resources mobilization and creation of legitimacy.

3.1.3 Theoretical target situation Automotive Campus

3.1.3.1 Combining open innovation and campus-based ecosystem literature

The literature review and the data from experts on open innovation and campus-based ecosystems are merged into a framework. This framework consists of the most important properties of open innovation and campus-based ecosystems. The framework will be used to assess the Automotive Campus on these critical properties of a campus-based open innovation ecosystem and to build the value proposition.

Derived in the previous section there are: six important factors for open innovation; seven key functions of an innovation ecosystem and five conditions of a campus-based ecosystem. The three models overlap on three different properties, see the colors in Table 6.

- All three topics state that networks are important for knowledge sharing and diffusion of knowledge (Yellow)
- Entrepreneurial activities is an important factor for open innovation and is one of the seven campus-based innovation ecosystem functions (Green).
- Knowledge development can be seen in the same two categories too (Blue).

Table 6 Important factors for a campus-based open innovation ecosystem

Open Innovation	**Campus-based innovation ecosystem**	
6 factors	**7 functions**	**5 conditions**
Knowledge networks	Entrepreneurial activities	Minimizing distances on campus
Knowledge development and students	Knowledge diffusion trough networks	Facilitation of knowledge sharing and informal networking
Startups entrepreneurial activities	Knowledge Development	Manage ecosystem diversity and reputation
Community building	Guidance of the search	Attracting and hosting connectors
Social facilities	Market formation	Being highly responsive to questions
Technical facilities	Resources mobilization	
	Creation of legitimacy	

3.1.3.2 Final framework

Because of the overlap between the different models, duplicates are removed from the framework. ‘Knowledge networks’, ‘Startups entrepreneurial activities’ and ‘Knowledge development and students’ are combined focus points in the total of 14 properties. These three properties were mentioned in two or three models. This makes them more important for an open innovation ecosystems.

The result is a framework which combines the factors, functions and conditions and renames them to 14 properties of an campus-based innovation ecosystem (Table 7, pag. 37). This framework answers sub-question one and two. It combines literature analysis and expert knowledge into one. The framework will be used create the value proposition of the Automotive Campus by assessing the characteristics of the Automotive Campus relative to these important properties developed by literature and expert analysis.

Table 7 Final framework for assessing the Automotive Campus

Essential properties for a campus-based open innovation ecosystem		
Knowledge networks	Guidance of the search	Minimizing distances on campus
Startups entrepreneurial activities	Market formation	Ecosystem diversity and reputation
Knowledge development and students	Resources mobilization	Attracting and hosting connectors
Social facilities	Creation of legitimacy	Being highly responsive to questions
Technical facilities	Community building	

3.2 Assessment of the Automotive Campus on the theoretical framework

In this section, the first part of sub-question three "*What is missing to realize open innovation?"* will be answered.

The Automotive Campus is assessed using the framework shown in Table 7. The 14 properties are presented with a 'desired' situation, derived from literature and experts in the previous chapter, and an 'actual' situation, provided by the data from the semi-structured interviews with residents, potential residents and former residents, and the field study (stay at the Automotive Campus, visits to the HTCE and the Automotive Congress). The 'desired' and 'actual' situations are then compared with each other (the assessment) and a 'gap' between the two is defined.

After the assessment, an overview is given, where the gaps of the 14 properties are rated with three colors. Green stands for 'present', orange stands for 'underdeveloped' and red stands for 'missing. This rating shows how well the desired factors are present on the actual Automotive Campus.

Finally, the rated framework is checked by the Automotive Campus director and acquisition manager to validate the outcome.

3.2.1 The assessment of framework properties

Knowledge networks

Desired: 1.The presence of physical network links in the innovation ecosystem. Informal networks and knowledge sharing: a campus creates the feeling of solidarity amongst its residents; 2. The level of formality of intangible networks. People live in the same community and this improves informal relationships and trust bonds.

Actual: The Automotive Campus has some informal knowledge networks. R2 states that there is a closed club of people who arranges matters among themselves (in Dutch: 'ons kent ons'). R8 notes that there is networking and small collaboration takes place. The general area, the Brainport region, is a very knowledge intensive area (R3). The TU/e is located nearby and many research institutes are present in the region (PR1). However, formal networks are missing on the campus (R2, R4, R5, R7, R8, ER1, PR1).

Gap: The presence of physical networks is insufficient and there are no official (informal) networks present at the campus.

Startups and entrepreneurial activities

Desired: 1. The entrepreneurial culture of people; 2. Actors that facilitate entrepreneurial activity. 3. Non-financial support activities for startups are present.

Actual: There is an entrepreneurial culture amongst the residents. There are a currently three startups on the Automotive Campus and one startup incubator (R6). There are limited supporting facilities present for startups. The only place currently available is the open office space for startups (R6). There are no non-financial activities present for startups on the campus (R1, R6). Important to note is that rental guarantees are given for startups on the campus, these are facilitated by the government (Boon, 2018).

Gap???

Knowledge development and students
Desired: 1. Knowledge being developed in an open setting; 2. Students teams and student projects are present. The main focus of student teams and projects is developing knowledge (often in collaboration with business). This is done in a relatively open setting (E4).

Actual: TNO, a major research institute, is present which plays also a neutral role in open innovation projects (R1, R2, R3). Altran and Tass also develop knowledge but in a closed setting. Other smaller firms on the campus are mostly unaware of the definition and benefits of open innovation (R4, R5, R6, R7, ER1).

There are two educational institutes which is unique to a campus in general and should be used as an advantage for developing the interaction between the students and the companies present (R1, R5, R7, R8). Also, there are two student teams located: InMotion and Team Fast (R4).

Gap: Very little knowledge development in an open setting.

Social facilities
Desired: 1. Presence of open meeting places and an attractive inspiring environment; 2. Events, canteens, restaurants and shared facilities.

Actual: Currently there is only one fixed social facility present: the canteen. This is not a very attractive place to meet. Also there is not a nice place for informal socializing like a good coffee bar (R1, R2, R3, R4, R5, R6, R7, R8, ER1). Events are hosted all year round and are generally viewed by residents as successful (e.g. the open day, the technology seminar on autonomous driving). Resident would like more events (R2, R5).

Gap: Lack of open meeting places and an attractive inspiring environment, insufficient amount of events and few shared facilities.

Technical facilities
Desired: 1. Facilitation of specialized equipment for SMEs and startups; 2. A testing infrastructure which companies can use.

Actual: There are technical facilities present although it is unclear to residents what kind of facilities are present on the campus. Most of the facilities are private (R3, R5, R6).

Gap: Insufficient specialized equipment and absence of an open testing infrastructure.

Guidance of the search
Desired: 1. Support of the government with regards to R&D funding; 2. Guidance of regulatory pressures, estimates of future growth, articulation of interest by leading customers (Industry leaders or OEM's).

Actual: TNO and AutomotiveNL are often point of contact for industry and government on topic of funding or subsidies and their interests with regards to regulation, growth estimation and articulation of interest (R1, R2, R3).

Gap: Desired and actual situation overlap, no gap.

Market formation
Desired: 1. Balanced level of competition present and dominant players present; 2. Growth of market.

Actual: No internal competition between residents and only little cooperation (R2). The market is growing due to the high demand for innovative solutions (Parkin, Wilk, Hirsh, & Singh, 2017).

Gap: Missing competition and cooperation on the campus.

Resources mobilization
Desired: 1. The mobilization of (corporate) venture capital; 2. Presence and availability of human capital.

Actual: In the Brainport region there are venture capital resources like Bright Move. There are no such facilities on the campus though. There are however human capital agencies on the campus like Automan and Yacht. Human capital is also inter-residential knowledge which lacks, often residents do not know who other residents are and what kind of business they have (R2, R4, R7, R8).

Gap: Missing venture capital and inter-residential knowledge on the campus.

Creation of legitimacy
Desired: The legitimized need and acceptance for innovation in the technical or social society (Bergek, Jacobsson, Carlsson, Lindmark, & Rickne, 2008).

Actual: High legitimacy due to competitive and demanding market, see 3.1.1.2.

Gap: Desired and actual situation overlap, no gap.

Community building
Desired: A close community that facilitates networks and builds trust among its members.

Actual: There is a real cooperative mentality in the Netherlands (E4), especially in the south of the Netherlands, shown by the success of the Triple Helix collaborations in the Brainport region. However, on campus inter-resident knowledge is lacking which degrades a community network (R2, R4, R6, R7, R8).

Gap: Lacking inter-resident knowledge and thus a community.

Minimizing distances on campus
Desired: Minimized distances to facilitate direct interaction.

Actual: The campus is currently very compact, all facilities are within walking distance. There is one central location, the Automotive House, around which the campus is developed. Furthermore, the campus organization gives the perfect example by letting the office door always open. Residents can thus always come in which eases the connection (R7).

Gap: Desired and actual situation overlap, no gap.

Manage ecosystem diversity and reputation
Desired: A high diversity within a certain industry focus and a good reputation.

Actual: R3 notes that the diversity among its residents is one of the key characteristics of the campus even though they are all related to the automotive industry. R2, R3 and R6 note that there is too much diversity. The focus of the campus is too broad which weakens its potential. More focus is better for long term survival of ecosystem (R1, R2, R6, R7). R6 notes that the reputation is sufficient (R6).

Gap: Missing industry focus.

Attracting and hosting connectors
Desired: Connectors that initiate and manage collaboration between residents.

Actual: AutomotiveNL is the perfect example of such a connector (R1). TNO also functions as a connector for the automotive industry (R2).

Gap: Desired and actual situation overlap, no gap.

Being highly responsive to questions
Desired: High responsiveness to what residents need. Management of the campus must see what residents need to flourish and use this to improve campus facilities.

Actual: The Automotive Campus organization is highly approachable. The decision making process is slow though due to the many stakeholder involved (R5, R6, R8, ER1).

Gap: Unable to react quick to resident needs due to slow decision-making.

3.2.2 Rating the framework properties

The actual situation is rated against the desired situation which produced the gap. This is done by first creating a concept rating on the gap which was then further defined with the campus organization to create the final rating. The ratings are given by means of color coding:

- Green: the desired and actual situation are congruent, the desired situation is present and there is no gap.
- Orange: there is a partial overlap between the desired and actual situation. The actual situation needs development. The gap is limited but present.
- Red: the desired situation and the actual situation do not overlap at all. The desired situation is missing i.e. a gap is present.

Table 8 Rating the essential properties of the Automotive Campus

Essential properties for a campus-based open innovation ecosystem	
Knowledge networks	Resources mobilization
Startups entrepreneurial activities	Creation of legitimacy
Knowledge development and students	Community building
Social facilities	Minimizing distances on campus
Technical facilities	Manage ecosystem diversity and reputation
Guidance of the search	Attracting and hosting connectors
Market formation	Being highly responsive to questions

Conclusion of the framework assessment: 4/12 properties are present, 6/12 properties underdeveloped, and 4/12 properties are missing. In Table 7 the results of rating can be seen.

To answer the first part of sub question three, "*What is missing to realize open innovation?"*: There are ten properties missing or underdeveloped at the Automotive Campus, the red and orange properties in the framework. Important to note is that 'Knowledge networks' is rated as missing and 'Startups entrepreneurial activities' and 'Knowledge development and students' are rated as 'underdeveloped'. These are the most important properties as they were mentioned multiple times in open innovation and campus-based ecosystem literature, see 3.1.3.1.

This rating confirms the earlier statement that the campus is still in its growing phase, i.e. is not a mature campus.

3.3 Value proposition

In this section, the second part of sub-question three will be answered, "*what is the unique value proposition of the Automotive Campus?".* This is necessary due to the fact that the value proposition of the Automotive campus is outdated and underdeveloped. The mission and vision of the Automotive Campus have also been revised because they more clearly state 'what' the campus does.

3.3.1 The 'old' value proposition

The original value proposition, which was last updated in January 2018, of the Automotive Campus is relatively vague (Figure 7). There is not a clear offering and this value propositions focus is too broad. Also the vision only states a very general strategic view and fails to translate this into more tactical and tacit representation for the Automotive Campus. For the outdated value proposition, see appendix C, for a complete description.

Figure 7 'Old' Value proposition Automotive Campus

The 'old' mission and vision related to this 'old' value proposition are stated below.

Automotive Mission and Vision (last updated January 2018)

Vision*; In everything we do, we aim to make a substantial contribution to the quality of life and work in green and mobility automotive solutions.*

Mission*; We make this contribution by questioning the current reality. Thinking differently and being transparent and open and establishing this community of automotive innovation.*

Based on this, we develop a high-quality network organization. With a big focus on mobility solutions for people roads and vehicles. As an international hotspot creating an ecosystem for today and tomorrow, to make changes necessary in the automotive industry.

3.3.2 The (new) Value Proposition Canvas

To create a new value proposition, the goal was to make it more specific and tangible for the services that the Automotive Campus provides. The Value Proposition Canvas tool (VPC) is iteratively used (Osterwalder A. , Pigneur, Bernarda, & Smith, 2014). For the backbone of the VPC, the 14 properties found in the literature are used, see Table 7 in chaptor 3.1.3.2. These are filled in with the results of the field study (stay at the Automotive Campus, visits to the HTCE and the Automotive Congress).

After this initial concept the value proposition is iteratively tested with resident interviews and experts. Thereafter it was iteratively fine-tuned in brainstorm sessions with fellow graduates and the campus management. The fellow graduate student gave a fresh insight and the campus management was used to define the services present.

Starting at the customer profile, which is created by observing the customer segment. In the customer segment (potential) residents of the Automotive Campus are observed by asking three questions:

1. The customer jobs are defined by asking the question: *what are customers trying to get done?* The customer jobs are separated in functional and social jobs. A functional job is when the customer tries to perform or complete a specific task or problem. A social job is when a customer wants to gain power or status or just wants to look good. i.e. how customers are perceived by others. This framework of functional en social aspects is further used during the development of the VPC.
2. Pains are observed by asking: what obstructs their task? The pains are also separated in a functional and social part.
3. Gains can be noted from the answer to: what outcomes and benefits does the customer want?

After the customer profile map is observed, the value map is designed by answering:

1. What products and services are offered by the Automotive Campus?
2. How do the products and services alleviate specific customer pains?
3. How do products and services create customer gains?

After all questions are answered, a complete VPC results. This canvas offers the opportunity to easily see the connection between the company's values and the customer's profile. From this completed overview, the specific value proposition can be derived by using the value map from the VPC.

Below, the VPC tool is used as a template to map the Automotive Campus, which is shown in Figure 8.

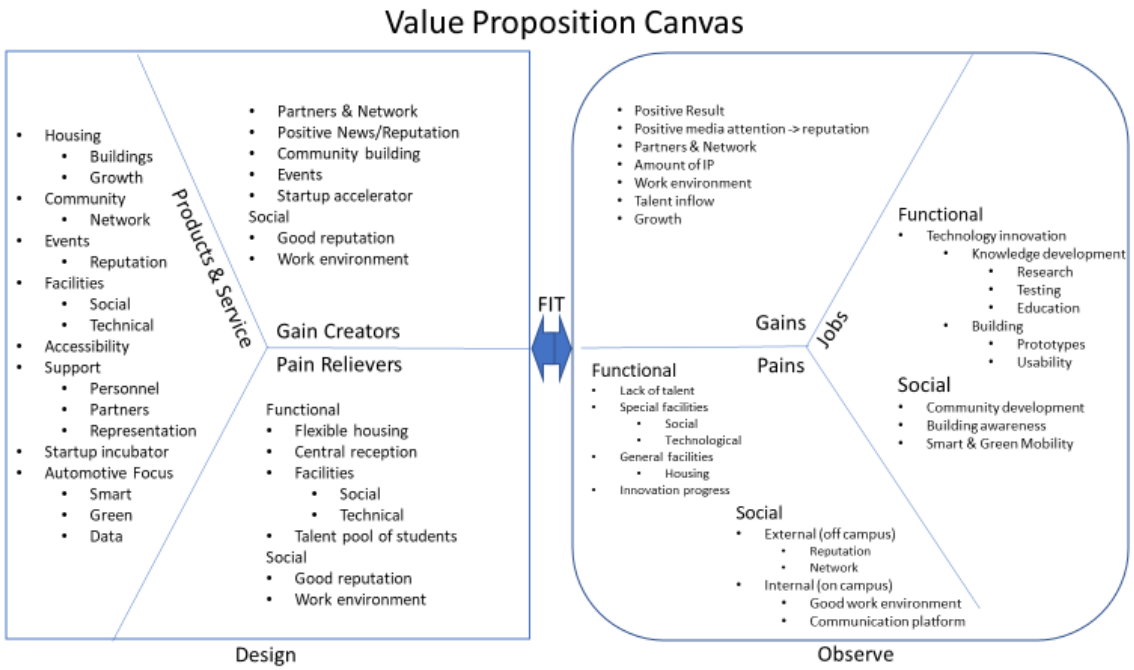

Figure 8 Value Proposition Canvas

Next the questions asked above are answered. First, the right side of the canvas shows the perspective from the customers jobs, pains and gains in 3.3.2.1. Second, the left side of the VPC, the customer profile map is discussed in 3.3.2.2.

3.3.2.1 Right side VPC - The customer profile

Jobs:

The jobs for residents (customers) on the Automotive Campus can be divided in a functional and social part. The Functional part is technological innovation by knowledge development and building. Residents like TNO develop knowledge with research for the industry and governments, residents like Tass by testing and experimenting, and residents like Innova by education the industry. The second technology innovation is building, this is mainly prototyping and usability testing for companies like Altran and Light Year.

Social jobs are applicable to all residents, they need a community to function, they need awareness for their products or services, and last they work for smart and green mobility.

Pains:

The residents experience the following pains which can also be divided in a functional and social part. The following pains have been observed:

Functional pains are lack of talent, the lack of specials facilities both social and technological, general facilities like housing and innovation progress.

Social pains can be divided in two external (off campus) and internal (on campus). External pains are reputations and networking, internal pains are a good work environment and a communication platform to connect with other residents.

Gains:

The desired outcomes for the customers are positive results, positive media attention which leads to a better reputation trustworthy partners, a high quality network, the amount of intellectual

property, a nice and inspiring work environment, amount of talent available, and last business growth.

The left side of the canvas shows the value design of the Automotive Campus by their products and service, gain creators and pain relievers.

3.3.2.2 Left side VPC - The value map

In the VPC the value map on the left side provides an answer to the customers jobs, pains and gains. By maximizing the fit between these two a value proposition can be created. Below the three questions asked in 3.3.2 for the value map are answered.

Products & Service:
Together with the campus organization the following products and services have been defined. The link with the 14 properties is indicated between brackets e.g. (see:…).

- Housing, this is the main product and service that the Automotive Campus provides for its customers. This is done by providing buildings and room for expansion. Room for expansion is important, the only 20% of the space available is currently developed. Residents confirm the importance of growth space in the interviews.
- A large service the Automotive Campus provides for its resident is the community. This community and network, although currently underdeveloped, is an important attraction for residents. (see: community building and knowledge networks).
- The campus organizes and houses around 150 events every year, this provides a positive reputation gain for its residents due to brand awareness.
- The campus has two kinds of facilities: social and technical. Social facilities are currently only the general canteen (see: social facilities). Technical facilities on the campus are currently sparse due to the unawareness and privatization of them (see: technical facilities).
- Accessibility is also a service of the campus. The Campus is located just east of Eindhoven in the center of the Dutch automotive industry and located near to the German border where a large amount of the European automotive industry is located. Furthermore the campus is compact which makes traveling between companies on the campus easy (see: minimizing distances on campus).
- The campus provides different forms of support for its residents namely: personnel, partners and a positive branding which provides a positive reputation. It proves personnel by housing two human capital agencies and it provides partners by housing a community and network and managing the ecosystems diversity (see: resource mobilization, guidance of the search and managing the ecosystems diversity and reputation).
- The campus houses a startup incubator (Shift2Start). Together with the campus organizations housing for startups can be arranged (see: Startups entrepreneurial activities)
- The Automotive Campus provides an automotive focus in its products and services. This focus is the backbone of the community and network present. The focus is smart, green and data driven (see: creation of legitimacy and Knowledge development and students)

All of these products and services are in support of the property ‘attracting and hosting connectors’.

Pain Relievers:
The products and services act as pain relievers for the customers, these are also divided in functional and social pain relievers. Functional pain relievers are the flexible house that the campus offers and expandability options. This also consists of shared meeting rooms and an open office. Next is a

central reception which is, especially for smaller companies, a nice feature. Further the campus has three different facilities for its residents: social, technical, and supporting.

The social pain relievers are a good reputation and a nice and inspiring work environment.

Gain Creators:
The products and services provide the following gain creators:

- Potential business partners and a large network to connect to.
- Positive media attention by being on the Automotive Campus media platform and thereby better reputation.
- The campus organization is actively building the community of which the residents are a part of. The community can provide them with new ideas, business partners, etc..
- The housing and organization of events at the Automotive Campus provides the positive (media) attention for residents.
- Startup accelerators are gain creators due to the many advantages startups have in an ecosystem
- A nice and inspiring work environment is a gain creator because it attracts talent and enhances the community.

3.3.3 The value proposition

The output of the value map is in the VPC tool used to create a conceptual version of the value proposition. The value proposition concept was iteratively fine-tuned and validated during the semi-structured interviews with residents (residents, potential residents and former residents).

The products and services, pain relievers and gain creators have all been positioned in a clear overview, the value proposition.

Comparing this value proposition to the 14 properties of a campus-based open innovation ecosystem, it is obvious that most aspects overlap. Together with the value proposition the mission and vision statement where redeveloped in a continuous iterative process with the campus management. The new value proposition and the mission and vision now complement each other. The value proposition states the benefits for the customer (residents) and the mission and vision statement show 'what' the campus is and does.

Automotive Campus: Mission and Vision (August 2018)

Vision: *To contribute to the environment and face economic challenges, by facilitating the automotive industry with innovation on the topics of both smart and green mobility and data driven solutions.*

Mission: *To be an international hotspot for innovation in the automotive industry by facilitating organizations with social and technical facilities to improve their core business.*

The Value proposition

- *The Automotive Campus strives to be an open innovation eco-system and the Dutch hotspot for research/development and education, prototyping, engineering and testing in the field of automotive and mobility technology with a focus on Mobility as a Service (MaaS), cooperative driving and connected mobility. To increase safety and traffic flow.*
- *The campus offers business partners, knowledge, talent, top facilities, and a community in an independent, neutral setting, close to the most important European automotive markets in an open innovation setting in a dynamic, inspiring environment with suitable accommodation options, park management and excellent services and facilities.*
- *The campus is part of the Brainport Eindhoven region where numerous pilots, practical tests and concrete applications of mobility technology can be found.*

The graphic version of the Automotive Campus value proposition is shown in Figure 9. Smart, Green and Data Driven is the overarching focus of "*Mobility as a Service (MaaS), cooperative driving and connected mobility to increase safety and traffic flow".* Data is supporting the smart and green focus of the Automotive Campus.

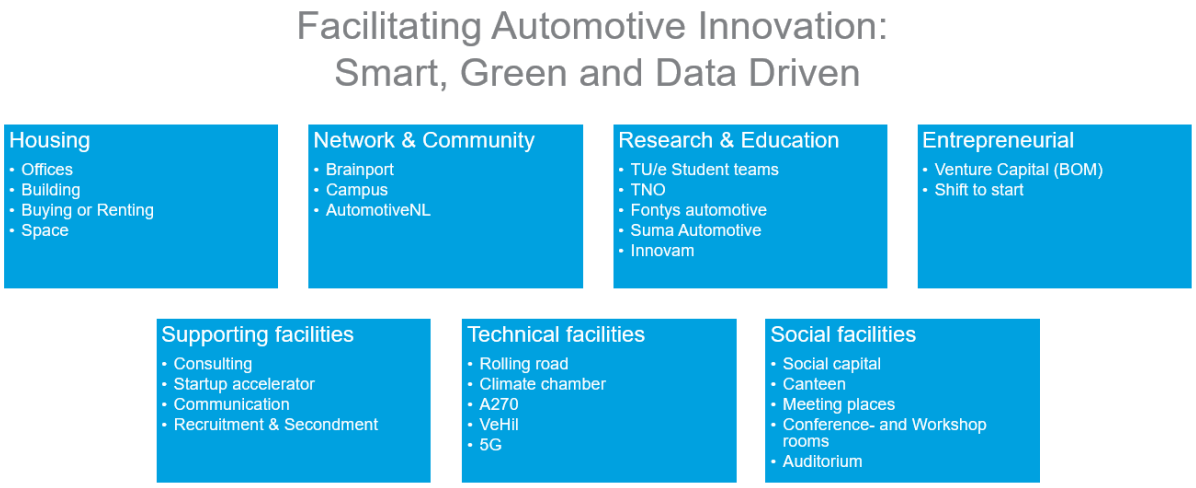

Figure 9 Automotive Campus value proposition

A complete overview of the new value proposition can be found in appendix D.

To conclude, sub-question three is answered by stating the unique value proposition, an assessment of the campus-based open innovation ecosystem framework. The value proposition gives a clear statement on what the campus should proclaim.

The assessment showed the importance of the further development of the Automotive Campus as ten of fourteen properties are underdeveloped or missing. Besides, the urgency to start improving knowledge networks, social facilities, technical facilities and market formation becomes obvious. In the value proposition, the same aspects are seen in the framework with essential properties.

4 Conclusion and Discussion

This thesis provides the answer to the research question: *"How can the Automotive Campus organization facilitate the development of an open innovation ecosystem at its campus in the next five years?"* First, the three sub-questions will be answered.

1. *What is open innovation and what are important boundary conditions for successful implementation?*

Open innovation is defined as "a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model". In practice, open innovation is more the motivation of social capital, people need to meet first to exchange knowledge and ideas. Six important properties conditional to success are defined as follows: knowledge networks, startups entrepreneurial activities, Knowledge development and students, community building and social facilities. The automotive industry is traditionally very closed. Therefore a shift in mind-set is necessary to evolve towards an open innovation model. Furthermore, current companies in the automotive industry are unaware of the definition and advantages of open innovation.

2. What are campus-based innovation ecosystems and what makes them successful?

A campus-based ecosystem is defined as 'an ecosystem that involves a group of firms that have some linkages and synergies with each other in order to increase their general competitiveness'. Campus-based ecosystems are the perfect place for open innovation because they stimulate linkages and synergies with residents. Success of campuses comes with research and development by providing access to shared resources and facilities. Besides, success comes with an innovation community which improves knowledge sharing. For a successful campus-based innovation ecosystem, Romme (2017) describes five conditions to achieve, that create value for residents by facilitating. These are: facilitation of knowledge sharing and informal networking, minimizing distances on campus, manage ecosystem diversity and reputation, attracting and hosting connectors and being highly responsive to questions. Next Bergek et al. (2008) define seven key functions of an innovation system, which are: knowledge diffusion trough networks, entrepreneurial activities, knowledge development, guidance of the search, market formation, resources mobilization and creation of legitimacy.

3. What is missing to realize open innovation, and what is the unique value proposition of the Automotive Campus?

On the Automotive Campus, the following properties need more development: startups entrepreneurial activities, Knowledge development and students, resources mobilization, community building, management of ecosystem diversity and reputation, and being highly responsive to questions. The properties that are insufficient and thus high priority are knowledge networks, social facilities, technical facilities and market formation. The following four properties are present at the campus and thus do not need (immediate) development: guidance of search, creation of legitimacy, minimizing distances on campus and attracting and hosting connectors. The unique value proposition is that these last four properties and the six underdeveloped properties are present in an attractive composition for the automotive industry. The value proposition for the Automotive Canvas can be seen in section 3.3.3.

Answers to the sub-questions bring up the answer to the main research question:

"How can the Automotive Campus organization facilitate the development of an open innovation ecosystem at its campus in the next five years?"

The development of an open innovation ecosystem at the Automotive Campus will be the reaction to the theoretical framework assessment in section 3.2. The most important properties that need attention are knowledge networks, social facilities, technical facilities and market formation. Specific recommendations for improvement of those properties follow in the next sub-chapter.

4.1 Recommendations

The recommendations are formulated for the properties that are rated as missing or underdeveloped. The recommendations have been derived from the field study, the interviews with residents and experts, as well as literature. Statements that are missing a source are solely from the field study.

Knowledge networks

To develop a backbone for knowledge networks, a formal network has to be started by the campus organization. On this central and official Automotive Campus platform, residents can find other residents. Search options on capabilities, experience, knowledge and Know-how must be available to find a specific person (E1, E2, R2, R7).

Several options are available to realize such a platform.
First is the website of the Automotive Campus. This website can be updated such that people from inside and outside the campus can find campus residents. Basic information about residents must be provided, like a short description of what their business is.
Second, an Automotive Campus community can be established via social media. Especially LinkedIn can provide a professional, easy and inexpensive solution. Here, residents can search for people with certain knowledge or knowhow. The advantage of using LinkedIn is that everyone in the community updates their own résumé, which makes it low maintenance.

Startups entrepreneurial activities

Create housing for startups and organize open workshops where starters can work and thrive. This can be developed with the present actors on the campus. Currently, Shift2Start and Summa College share the initiative to house and facilitate startups (R5, R6). This collaboration can be supported by the Automotive Campus organization for the general interest of the campus.

Knowledge development and students

The knowledge development can be supported by educating the residents on the advantages and methods of the open innovation model. It is important that the wish for open innovation comes from within the company (E1, R2). To educate the residents on the benefits of open innovation an open innovation seminar can be organized. This could be done in collaboration with other campuses in Eindhoven, like the HTCE or the Brainport industries campus to thereby show the benefits of working to gather. Furthermore, the Automotive Campus can be made more attractive to knowledge institutes. Events are important to stimulate its reputation in this respect and residents must be prepared to offer knowledge institutes an attractive setting.

Facilitate more diverse student teams (MBO, HBO and WO) (R1, R5) and improve the connection with TU/e by locating a (small) department on the Automotive Campus (E4)

Social facilities

To further develop the social facilities, residents have to be able to contact each other easily and

informally. A good coffee bar is the perfect place for this to happen. Besides, networking events and a shared week activity, like a Friday afternoon drink, create an approachable moment to connect. Also part of the social facilities is the environment. This needs to be attractive and inspiring to keep people motivated and attract talent (E1, E2, E3, E4).

Technical facilities
The campus should be developed as one big testing facility for residents (E1, E4) with among others different communication networks. Also it is important that people know of and can find the technical facilities (R6, R7). Therefor an inventory can be made of the current facilities. Which can be advertised to increase awareness among residents and potential residents or users.

Market formation
To improve the market formation, a multiyear program of investment and development needs to be created (E4). This, so the Automotive Campus can focus more on specific topics (E2, E4, R1, R6. The current focus of smart and green mobility is now still interpreted very broadly. A more narrow focus could positively influence the development of a critical mass (E1, E2, E4, ER1). The technical focus could be on Mobility as a Service (MaaS), cooperative driving and connected mobility (E4, R8). The social focus can be on safety and increasing traffic flow (E4). The focus should be on system-level innovation by creating a pre-competitive environment (E4).

Resource mobilization
Stimulate the improvement of human capital present. Again, creating more events for and with the residents. The solutions for ‘knowledge networks’ and ‘social facilities’ can also contribute to the resources mobilization.

Community building
See solution for ‘knowledge networks’, ‘social facilities’ and ‘resources mobilization’.

Manage ecosystem diversity and reputation
Focus acquisition on companies who fit in the focus of the campus and who can complement each other’s business (E4, R6), preferably, who are willing to invest in campus, in technical or social facilities (E1, E4). This is only possible when the focus of the Automotive Campus is narrowed down (E4, R6). Within the borders of the focus, the organization, or another qualified party, can select future residents.

Being highly responsive to questions
The campus organization has limited decision making capabilities because of the four stakeholders. Those stakeholders should give more rights to the campus organization to properly manage the campus. When the organization has more responsibility, they will be able to react faster and easier on residential demands.

Conclusion recommendations:
Ten properties need to be further developed on the Automotive Campus to facilitate open innovation and to be an attractive ecosystem. The most important properties that need attention and are the currently missing: knowledge networks, social facilities, technical facilities and market formation. Recommendations are formulated for each property that is missing or underdeveloped.. These focus points should be used to create a multi-year program for the development of the campus. This plan provides a broad overview of developmental activities of the campus, the opportunities for creating the open innovation ecosystem and how to overcome barriers. The body of such a multi-year plan describes each of the development programs, providing a roadmap for the organization work over the next five years. This thesis can be of value for the realization of such a plan.

In general, the recommendations can be summarized in terms related to community, social and technological facilities, and knowledge infrastructure. Due to the fact that the campus management has a limited development budget, focus should be on low cost additions that improve one of those four general terms. The practical application of the recommendation varies, some can be implemented quite easy, like social facilities, others are more difficult to implement.

4.2 Scientific relevance

First, the research shows the current state of the open innovation in the automotive industry sector. This thesis makes the implementation for open innovation more approachable for other campus-based ecosystems. Besides, the matter of changing the way of innovating in the automotive industry will be made urgent.

Second, the literature study and the interviews with experts on open innovation and campus-based ecosystems are largely in consensus. The interviews with experts did not give any new insights. The expert interviews showed that theoretical knowledge is less, or not, present in practice. In general, companies focus more on practical implications compared to theory, which is to be expected.

Third, this thesis provides a framework of essential properties to facilitate open innovation on a campus-based ecosystem. When awareness is raised in the automotive industry, this thesis gives the opportunity to implement practical changes from a grounded scientific research report and shows the way towards industrial development. The framework of essential properties provides the automotive industry with an easy tool to assess the current status of their own innovation strategies.

Last, this research creates a tangible approach between the academic theory of open innovation ecosystems and practice. It provides a connection between a theory and the current automotive industry. By showing the literary background, general knowledge will be increased and companies will have the opportunity to build their own development program around this academic analysis. Besides, the connection between real-life processes and theoretic field is made clear and thus more relatable.

4.3 Future research

In future research, evaluation of the recommendations with proposed improvements can be done to check the outcome of their implementation. By more qualitative research, the impact on human capital, innovative mindset and view on cooperation can be assessed. Besides, quantitative research by means of a questionnaire or survey can check intermediate improvement and ultimate impact as well. Outcomes can be used to see whether all improvements have the same impact and whether they target the issue as suspected.

For analysis of the mind shift that is needed to be realized for open innovation, more psychological research towards openness to collaboration can be done. This would be a study related to change management instead of industrial engineering. In future situations, it would be very relevant to know the most optimal way to motivate residents to start collaborating together.

Furthermore, analysis of the difference between the automotive industry and other industries that are openly innovating, to see where the crucial difference in nature lies. By studying the different sectors, it can be made clear what specific part of the automotive industry must be targeted and how other fields can easily adopt change. At last, the organization of the Automotive Campus can be trained and supported in their management of open innovation. Outcomes of such a training can be analyzed in the future as well.

4.4 Limitations

The literature review failed a systematic approach. This resulted in a time pressure and an overlap with resident interviews. Besides, literature review could be optimized by finding more grounding theory on the specific sub-properties and aspects of open innovation and campus-based ecosystems.

Furthermore, the literature analysis and the interviews with residents have partially overlapped. This resulted in limited data from residents for the assessment of the 14 essential probabilities. In the future, a better validated framework can be created by an earlier literature study.

Due to the limited duration of the thesis, the recommendations for the development of the Automotive Campus are only concisely formulated. This is however a first framework to work with.

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Appendix

A. Interview protocol experts

Inleiding interview:

- Introductie onderzoek
- Dit interview wordt opgenomen voor wetenschappelijke doeleinden.
- Introductie vragen van de geïnterviewde.

Open innovation

How well does is it work? Is it the future?

In theory and in practice

You are familiar with the HTCE, does OI work there?

Can it work there? Why or why not?

Can it be location (Campus) based or should I be bigger (Region)

Automotive industry

Status quo Open innovation

Future of Open innovation in industry

Compared with other industries

Automotive companies in the region:
DAF, VDL, NXP, TOMTOM, TNO, Tass, Altran, Nedcar,

Campus

Level of High-tech at the Automotive Campus?

What do you think of students on a campus (MBO/HBO/WO)

Automotive Campus

What do you think the AC has (unique capabilities)?

What do you think the AC needs?

Priorities growing or selecting?

What is the Value proposition of the AC

B. Interview protocol residents

Begrippen: Automotive Campus (AC), Open Innovatie (OI), Hightech Campus Eindhoven (HTCE)

Inleiding interview:

- Introductie onderzoek
- Dit interview wordt opgenomen voor wetenschappelijke doeleinden.
- Introductie vragen van de geïnterviewde.

Deelvraag 1: Open Innovatie

- Hoe zou u OI omschrijven?
  Presenteer eigen definitie en check voor akkoord.
- Komt u in uw werk in aanraking met OI?
- Wat is volgens u nodig voor OI?
  NB: bij residents/potentials ingaan op hun bedrijf:
  - Hoe innoveert men nu?
  - Hoe vinden discussies plaats?
  - Hoe hiërarchisch is het bedrijf?
  - Wat zijn de huidige samenwerkingsverbanden?
  - Hoeveel kennis gaat naar buiten of komt binnen?
  - Hoe gaat het beheer van IP?
  - Haalt men externe experts in huis? Hoe?

Deelvraag 2: Campus-based Ecosystems
Bij residents/potentials:

- Hoe ziet u een campus?
- Wat zijn de voordelen van een campus? (netwerk, evenementen etc)
- Wat zijn de nadelen van een campus?

Bij experts/campus organisatie:

- Hoe zou u een CBE omschrijven?
  Presenteer eigen definitie en check voor akkoord.
- Hoe ziet u de voor- en nadelen van CBE?
- Wat zijn de randvoorwaarden voor een CBE volgens u?

Deelvraag 3: Automotive Campus

- Wat zijn volgens u de kenmerken van de AC? (breedste zin van het woord)
- Wat zijn de campus aspecten/kenmerken die de AC heeft? (CBE focus)
- Wat zijn de OI kenmerken die de AC heeft? (OI focus)

Presenteer Value Proposition en bespreek deze. **Pak oude protocol erbij!**

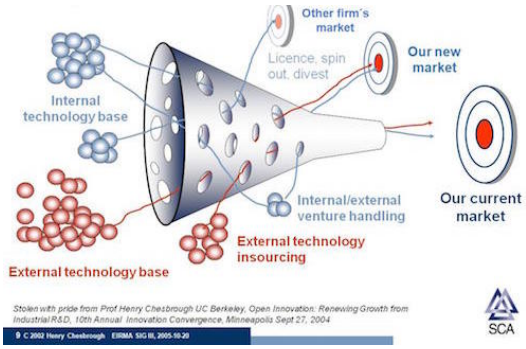
- Wat heb je zelf voor idee?
- Wat vindt je van de huidige VP?
  Wat zijn daar de belangrijkste punten in?

Deelvraag 4:

- Hoe denkt u dat de AC dient te ontwikkelen om een CBE te worden?
- Hoe denkt u dat de AC dient te ontwikkelen om OI te realiseren

Heeft u zelf nog vragen, opmerkingen of toevoegingen?

The definition used for open innovation:
"A distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model of the campus organizations (residents)" (Chesbrough, Bogers, & West, 2014, p. 17).



Function	Important aspects
F1 Entrepreneurial activities	(1) The entrepreneurial culture of people. (2) Which actors pursue the entrepreneurial activity? (3) Non-financial support activities present in an innovation ecosystem.
F2 Knowledge Development	To what extent is knowledge being developed in a closed or open setting within the innovation ecosystem.
F3 - Knowledge diffusion through networks	(1) The condition of the physical network links in the innovation ecosystem. (2) The level of formality of intangible networks.
F4 - Guidance of the search	To what extent and in which forms the government is active in the innovation ecosystem with regards to R&D funding.
F5 -Market formation	(1) The level of competition present an innovation ecosystem and the effects of it. (2) The dominant players and to what extent are they dominating the innovation ecosystem.
F6 - Resources mobilization	(1) The mobilization of (corporate) venture capital. (2) What kind of human capital is present in the innovation ecosystem.
F7 - Creation of legitimacy	The barriers to innovation with regards to regulations of different actors.

Seven key functions of an innovation ecosystem as a result of the general inductive analysis.

Campus-based ecosystem definition:
An ecosystem involves a group of firms that have some linkages and synergies with each other in order to increase their general competitiveness (M.M.A.H. Cloodt, 2015)

C. Value proposition Automotive Campus January 2018

The automotive campus

The Dutch automotive and mobility hotspot, where business and knowledge come together in a spirit of cooperative innovation.

- Research and engineering (Green & Smart mobility).
- Education cluster (Summa Fontis, TU/e)
- Excellent facilities (In-house, canteen, Lab, Test)
- Home of the Dutch automotive cluster organisation AutomotiveNL.

AUTOMOTIVE CAMPUS

The Dutch hub for automotive & mobility

Automotive House
Thé place to be for meetings and events.

AutomotiveNL
Thé branche organisation for the Dutch Automotive Cluster and entrance to the sector.

Triple Helex
Industry, Education and Authorities are all present on the campus and form the backbone for successful innovation.

Residents
Our residents are an informal community with very relevant know how and experience.

AUTOMOTIVE CAMPUS

Ambition

The Automotive Campus Foundation is a public-private development with participation of two public investors (City of Helmond and Province of North-Brabant) and two private investors (Hurks vastgoedontwikkeling and Bouwbedrijf Van de Ven).

The Automotive Campus is growing and innovating and under constant development. In the coming years the campus will grow into a flourishing international hotspot (70-75 companies and 1,000 jobs),

As from 2018 the realization of the central campus park structure and new infrastructure and entrances will be carried out.

The development of the campus is supported by AutomotiveNL, BOM and Brainport Development.

Gemeente Helmond
Provincie Noord-Brabant
hurks
v.d.VEN BOUWBEDRIJF
AutomotiveNL
BOM

AUTOMOTIVE CAMPUS

Automotive Mission and Vision

Vision; In everything we do, we aim to make a substantial contribution to the quality of life and work in green and mobility automotive solutions.

Mission; We make this contribution by questioning the current reality. Thinking differently and being transparent and open and establishing this community of automotive innovation.

Based on this, we develop a high-quality network organization. With a big focus on mobility solutions for people roads and vehicles. As an international hotspot creating a ecosystem for today and tomorrow, to make changes necessary in the automotive industry.

WORLD ECONOMIC FORUM

Topic Green, smart, IoT, connected, Sensoring, Monitoring, New wit of working, Big Data, connected, 3D, Participation for the individual, Robots, Privacy, eco-systemen, partnerships, sharing, trust.

AUTOMOTIVE CAMPUS

Who we are

- Automotive Campus in Helmond is the place for innovation in the field of smart and green mobility and thus an important pillar of Brainport.
- A cluster of top facilities, leading companies and knowledge institutes has been established on the Automotive Campus along the N270 (Helmond-Eindhoven).
- Automotive Campus aims to develop into a full-fledged and complete campus by further strengthening the triple helix of industry, education and government.
- A campus where learning, research, knowledge exchange and marketing go hand in hand with commercial activities for top players, people and starters. Various automotive companies, knowledge institutions, education and government organizations have already found their way to the Automotive Campus.
- Our goal is the unique opportunity here at the Automotive Campus in Helmond to expand the network and to bind new parties to the Automotive Campus in the area that is now known as 'Green and Smart Mobility'.

AUTOMOTIVE CAMPUS

Facts & Figures Automotive Campus

25 Labs & Test facilities

Dutch Region — NATIONAL SIGNIFICANCE
50 % Dutch automotive industry is situated in Brain port Eindhoven

600 Engineers And research specialists Netherlands

New Development
11.000 M2 and growing
140.000 M2 to be realised

Majority business SUPPLIERS

500 Automotive students All educational levels

OEM **For** Trucks busses and cars

45 Companies On the premise

INNOVATION AWARD **WINNER** x1
High-Tec Piek Award "Knaller 2018"

THE MOVIE

Industry's BROADEST **NETWORK**

100 events / year
20.000 visitors / year

AUTOMOTIVE CAMPUS

D. Value proposition Automotive Campus August 2018

Value Proposition

AUTOMOTIVE CAMPUS

Automotive Campus: Mission and Vision

Vision; To facilitate new mobility with innovative, smart / green and data driven connected sustainable mobility solutions, thereby contributing to the environment and economic challenges

Vision; To contribute to the environment and face economic challenges, by facilitating the automotive industry with innovation on the topics of both smart and green mobility and data driven solutions

Mission; To be an international hotspot for innovation in the automotive industry by facilitating organisations with social and technical facilities to improve their core business.

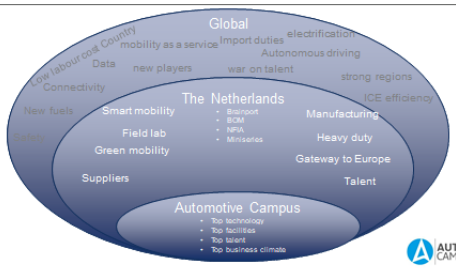
Overall Campus Strategy; To set up a network of both technical and social facilities that supports companies realising their goals in automotive industry;

- Developing the Automotive Campus
  - Shared technical facilities (rolling road, testing, labs, technology seminars)
  - Shared social facilities (Canteen, work space, events, workshops, sport & leisure
- Aquisition of potential residents
- Community building with current and future residents

To create a campus based ecosystem, that embraces open innovation and knows a balance between campus support and residential demands

AUTOMOTIVE CAMPUS

The ecosystem



AUTOMOTIVE CAMPUS

Business Model Canvas

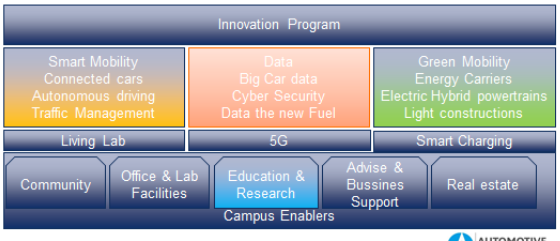
AUTOMOTIVE CAMPUS

1.6 Positioning ➔ The Value proposition

- The Automotive Campus strives to be an open innovation eco-system and the Dutch hotspot for research/development and education, prototyping, engineering, testing, assembly & production in the field of automotive and mobility technology with a focus on smart/green mobility data/cyber security and education.
- The campus offers business partners, knowledge, talent, top facilities, and a community in an independent, neutral setting, close to the most important European automotive markets in an open innovation setting in a dynamic, inspiring environment with suitable accommodation options, park management and excellent services and facilities.
- The campus is part of the Brainport Eindhoven region where numerous pilots, practical tests and concrete applications of mobility technology can be found.

AUTOMOTIVE CAMPUS

2.1 Strategy A4



AUTOMOTIVE CAMPUS

E. Automotive Congress 2018: Crossing borders

Evoluon Eindhoven, 23 Mei 2018

The Automotive Congress is now for 12 time a yearly international gettering of automotive companies to "connects and inspire at an international level with developments, interaction and expertise, from suppliers to OEMs to material specialists and everything in between" (Automotive Congress, 2018)*. 13 international speakers give lectures on change, energy, industry R&D, global automotive development, trends, etc. Also there is a large exhibition for companies to promote their business and network. The event is organized by AutomotiveNL, the Dutch automotive cluster organization, and Mikrocentrum, a knowledge and networking organization*.

During the event all of the congress lectures where attended and more than a two dozen companies were visited and briefly interviewed on their motivation to be there and on their thoughts on open innovation in the Automotive Industry. Also two speakers from the event where more in-depth interviewed on open innovation.

Congress speakers

The congress opened with a lecture of Carlo v/d Weijer, director at the TU/e of smart mobility and vice-president of TOMTOM traffic solutions, who emphasized that the industry is changing. With the arrival of electric cars and the transformation to autonomous driving the automotive industry is facing its greatest change sins its origin. Then Leo Kusters, director of AutomotiveNL, spoke about the huge challenge the industry faces, in terms of the change from mass production to tailor made high-tech products. The theme of the congress is "crossing borders" which means the companies border and secondly the country borders. He explains the power of working together on different focus points in the industry. Across the Dutch border in Aachen Germany and Belgium are institutes and companies working and researching on different focus areas like lightweight materials which can be very interesting for Dutch parties who are also working on similar technologies.

Exhibition

Most of the company exhibitioners where there solely for the networking and promotion of their company and product. One of the companies stated: I'm only here because last year it got me a mayor order". Just two stated that the recruitment of personnel was also one of the motivations to be there.

Interviews

Marc Hendrikse, CEO NTS-Group, Boegbeeld Topsector HTSM

With Marc Hendrikse, the CEO of NTS-Group, a short interview on open innovation was held. He is familiar with the definition of open innovation as given by Chesbrough 2006. He believes that open innovation is very difficult in the automotive industry, especially with the German OEM's. In the Netherlands it could be possible but a major cultural shift would be necessary. He says TOMTOM is one of the companies that could be interesting for Open Innovation because it is more in high-tech software development.

Carlo van de Weijer, Moderator Automotive Congress, TU/e + Singularity University + TomTom

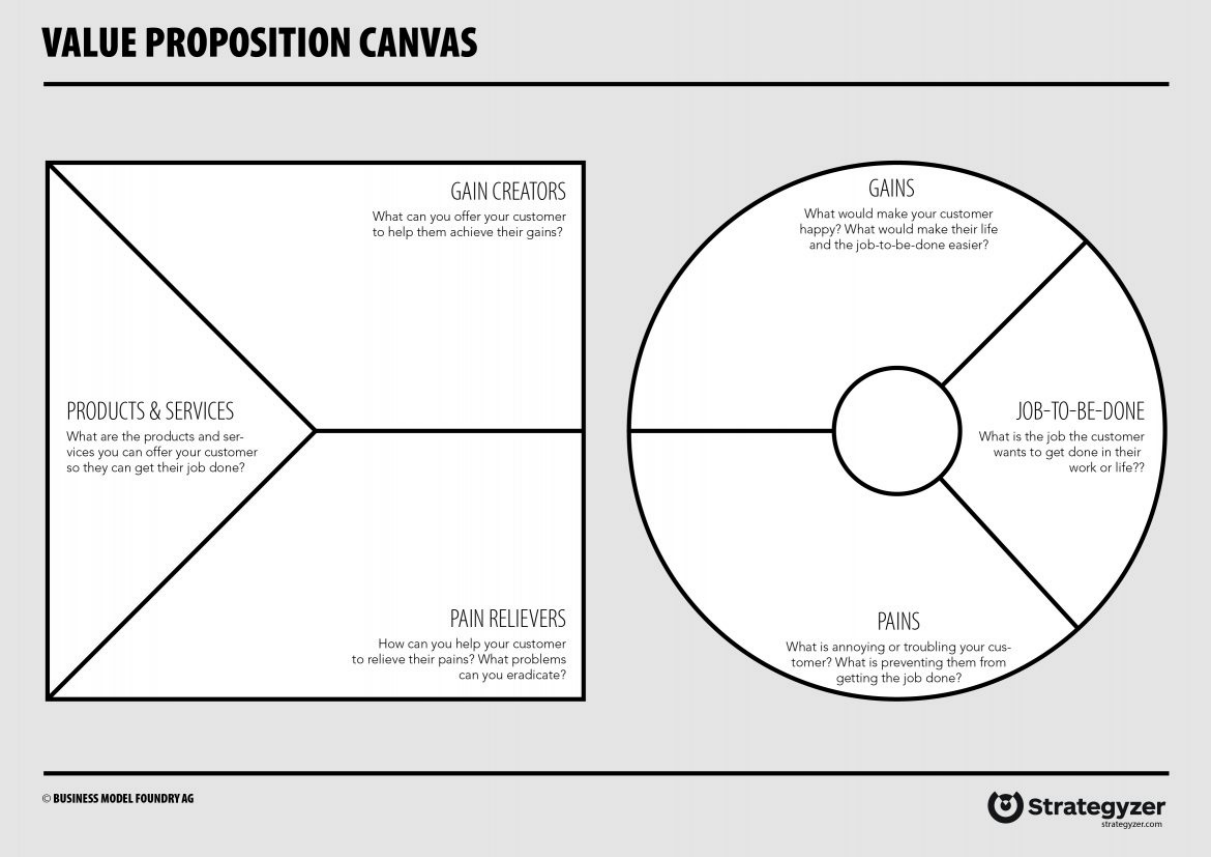
Carlo van de Weijer is unfamiliar with the definition of Open Innovation, he has heard of it but thought it to be a short-term trend in academia. After explaining open innovation he is not enthusiastic about it. The idea that businesses open up there R&D department and make money by doing so does not fit in the current industry, the automotive industry is very closed he explains, business will only do something when they can see what the get out of it.

Key points from learned from the Automotive Congress are:

- Automotive industry is still very closed in its innovation process.
- Open innovation unfamiliar in the industry
- The need for collaboration has to come from within the company's

The current mindset in the automotive industry is not supporting open innovation.

F. Value Proposition Canvas tool



G. Schematic overview of summaries Residents

	Open Innovation		
Code	Description OI	Contact with OI	What is necessary for OI
R1	Publicly available knowledge & knowhow	Facilitating contact between companies	awareness that together we are stronger, mindset change, Trust, network of contacts, a need from companies
R2	moderately known	One triple helix project	Trust, clear deals, a necessity from within company's
R3	Expert, Sharing knowledge and Know-how to create better products	TNO is neutral partner in facilitation OI	Realization for need from businesses, separate pre-competitive from competitive, Basis is trust in knowledge and knowhow, respect for each other's business
R4	unfamiliar		
R5	unfamiliar	Experiences the struggles	Open and accessible environment (like a school), a mindset change to this collaborative culture
R6	Collaborative innovation, especially for triple helix	Facilitates OI for startups	Open mindset, network of external expertise, facilities, funding
R7	moderately known, marketing term	is a startup, shares much but is very picky	Contact with companies who can supplement each other
R8	familiar	work with government and other parties to realize large infrastructure projects	Mindset and atmosphere for people to speak freely, inspiring environment, realization that together stronger, necessities from within companies for OI
ER1	Sharing innovation/knowledge	Only with education	Mindset change, realization that together stronger, Reciprocity among business partners,
PR1	Open source like	Indirect	separation of completive and re-completive and an interface for knowledge sharing
	unacquainted	limited, only internal and with customers	inspiring environment, open facilities, good coffee,

	Campus-based ecosystems		
Code	How do you see a CBE	What is de advantage of an CBE	What are the disadvantages CBE
R1	place for triple helix, purposeful, can be public, private or a combination	Network and facilities, people,	secrecy, obligated social behavior in ecosystem,
R2	Like TU/e campus, open doors, SME's and startups, large network	involvement and being part of a community, easy access to other companies, branding of the AC	-
R3	Location with a specific theme, linkages and synergies between firms,	easy meeting, knowing each other's activities,	to much focus of campus residents on other campus residents
R4			
R5	Place where the triple helix is present and where there is a nice atmosphere	The connection between education and business, the place facilitates	no general
R6	facilitating domain with same theme	Reputation, shared facilities, networking, easy informal meeting,	Being blind for outside world
R7	big coffee machine where people randomly meet each other to innovate, being surrounded by knowledge and knowhow	Easy contact, being spontaneous like innovation	
R8	A place with companies who have synergies	The easy reachable companies on the campus, network,	
ER1	Nice enclosed workspaces, startups do OI	availability of knowledge (people), nice living environment, attraction for talent, easier contact between different companies	
PR1	Companies within the same industry	Easy contact, cheaper facilities, easier subsidy	Secluded from rest of the world

	Automotive Campus		
Code	What are the charactaristics of the AC	Characteristics OI	Characteristics CBE
R1	Triple helix represented, students,		
R2	close culture among residents (Ons kent ons), isolation of AC, positive involvement of city Helmond, students with a fresh perspective		
R3	Near Dutch and German business, international oriented, knowledge intensive area, forerunner in infrastructure, Students for talent and entrepreneurs,		
R4			
R5	The triple helix representation which supports OI, accessibility of the campus sufficient	All student arrive with public transportation which is no problem	
R6	bad accessibility, focus is good, presence of education, potency	small budget, many stakeholders, slow decision- making	
R7	Grow capability for everyone, not suited for commercial purposes, Network of AutomotiveNL, very universal office building only name creates automotive,	Knowledge and Know-how available, students	networking and open days inter-resident knowledge
R8	Triple helix presence, knowledge institute TNO, Students, slow decision- making	networking and small collaborations	
ER1	Diverse offer of automotive companies, many students, bad accessibility, canteen is small and unattractive, coffee is terrible, bad communication, slow organization,		
PR1	two education institutes, shared facilities, proactive stance of Helmond		

	Value proposition			
Code	What is your idea	What is important	How should the AC develop to become a CBE	How should the campus develop to facilitate OI
R1		Housing is important, very universal	Creating more diverse student teams (MBO, HBO, WO)	capitalize more on the students, focused acquisition on companies who can complement the ecosystem, further develop a focus
R2	Triple helix collaboration with many automotive companies	Complete	scaling for future profing, balance small and large companies, improve inter-resident knowledge by community, business club, evets, bi-monthly lunch for executive, active location of TU/e student teams,	OI needs to be borne by the companies, acquiring/facilitating more startups
R3	Create multi-year plan for acquisition and development of AC		Focus AC on MaaS, investing millions in infrastructure and facilities, increase connection with TU/e, more focus	focus on system-level in a pre-competitive environment who is attractive for business by student and facilities, AC should be a testing space,
R5	The campus is very universal, the name mostly states its automotive.	The campus should have a broader focus for other market party's	A campus meeting with residents, Education need to develop together on the campus, improve appearance, quicker decision making,	
R6	Data driven is good, clear representation		Triple helix collaboration, intensifying connection with TU/e, accessibility	intensify collaboration with AutomotiveNL, facilitation informal consultation (coffee), improving canteen, community building, events, be unique in facilities, alternative fuels,
R7	Three pillars, smart green and education and a connection between business en education	Housing is important, very universal	sharing what other business do on the campus,	Proper coffee machine or bar
R8		IoT(internet of things) is missing, more focus on sustainability	Growing the campus, attracting more startups, involvement of residents with strategy, having a clear position in the society,	Creating an attractive ambiance, developing a clear vision for acquisition, facilitating networking/communication with events or projects
ER1	Vision is okay, although many competitive initiatives in the region		Better facilities, actively linking companies, actively bringing focus to the campus,	The cooperation between campus organization and AutomotiveNL
PR1		pleasant environment	Improve appearance, more activity, pleasant work environment, aggressive sales, acquisition of Asian company	

Table 9 Questions schematic overview of summaries Residents

Topic	Question
Open Innovation	How would you describe OI?
	Do you come into contact with OI in your work?
	What do you think is necessary for OI?
Campus based ecosystems	How do you see a campus?
	What are the advantages of a campus?
	What are the disadvantages of a campus?
Automotive Campus	What do you think are the characteristics of the AC?
	What are the campus aspects / characteristics that the AC has? (CBE focus)
	What are the OI characteristics that the AC has? (OI focus)
Value proposition	What do you have for idea?
	What are the most important points in this?
	How do you think the AC should develop in order to become a CBE?
	How do you think the AC should develop in order to realize OI?