CHALMERS
UNIVERSITY OF TECHNOLOGY

Autonomous City

The vehicle electronics and connected services industry cluster in western Sweden towards 2030

Master's Thesis in the Master's Programme
Quality and Operations Management

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Abstract

The traditional automotive sector is changing rapidly with new innovations within electronics and software, due to the digitalization. Mobility as a service, autonomous cars, big data, smart lanes and cars that can be upgraded are just some examples of how the industry will change more in the next 10 years than it has in the past 50. Therefore, the purpose of this study is to give recommendations for how to develop a cluster within the vehicle electronics and connected services industry in western Sweden. Furthermore, scenarios for the future were developed, together with estimations of how employment in the cluster could be affected.

This study was performed using both qualitative and quantitative methods i.e. a mixed methods approach. To fulfil the purpose of the study, a theoretical framework was presented to achieve a common understanding of cluster and scenario planning theory. Moreover, semi-structured interviews were used to collect data about the perquisites in the region for a cluster within the chosen industry. Also, scenario planning was used to develop four possible scenarios for the future, with estimations of how the scenarios would affect the employment. Data used for these estimations was sourced from the Statistics Sweden (SCB).

Furthermore, findings from interviews and industry reports were analysed with the theoretical framework. Together with results from scenario planning, these findings were used to develop recommendations of how the cluster development could be facilitated in the region. The recommended actions included bridging gaps with assistance from a cluster organization and other facilitators, developing a shared goal and strategy, finding pre-competitive collaboration projects, and helping small companies and startups with applications for funding.

Keywords: cluster, cluster life cycle, scenario planning, employment forecasting, vehicle electronics

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Lydia Brengesjö

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Table of Content

Table of Figures

Table of Tables

Abbreviations

OEM	Original Equipment Manufacturer
RISE	Research Institutes of Sweden
VICTA	Vehicle ICT Arena
VGR	Västra Götalandsregionen
LSP	Lindholmen Science Park
SCB	Statistics Sweden (Statistiska centralbyrån)

1. Introduction

In this chapter, the introduction for the study can be found. It contains a background, purpose, limitations, and the research questions, which will be answered in the study.

1.1 Background

Many years have passed since Henry Ford first introduced his world-famous car in the beginning of the 20th century. He had a vision that the automobile would allow people to travel between larger geographical distances than what the traditional horse and carriage had enabled before (Butler & Martin, 2016). Besides from dashboards screens and other interfaces nowadays implemented inside cars, allowing the driver to manage some functions, little has happened with the car model from the 20th century (Viereckl et al., 2016). The same goes for the traditional supply chain of the automotive industry, which is built around two main players; suppliers, namely Tier 1/2/3, and vehicle producers, namely Original Equipment Manufacturers (OEMs) (Wee et al., 2015).

Another important invention besides the car that has greatly affected our way of living is the internet. It is becoming a more important part of our daily life. We are constantly provided with data through our smartphones and computers. McKinsey and Stanford University (2016) state that this digitalization has revolutionized industries and that all sectors are facing challenges with new business models emerging. They also argue that the automotive industry will be no exception. Servitization is yet another thing rapidly changing the environment for manufacturing companies (Baines & Lightfoot, 2013), which of course the automotive industry is an example of. The authors further explain that there is a paradigm shift. The traditional way of viewing a manufacturing business is that revenues come from cost reductions and product innovation. With this paradigm shift, services can offer a new way for manufacturing companies to compete.

Thus, from the above-mentioned changes in the industry, change is also appearing with new innovations within electronics and software, due to the digitalization of vehicles and traffic systems. Mobility as a Service, autonomous cars, big data, smart lanes and cars that can be upgraded are just some examples of how the industry will change more in the next 10 years than it has in the past 50 (World Economic Forum, 2016). In this new era, the traditional supply chain with OEMs and Tier 1s will be facing new business models (Wee et al., 2015). Also, companies from other industries enter the automotive market along with new technology startups, challenging the traditional position of OEM's (Viereckl et al., 2016). Examples of such companies are Apple and Google, having spent many years developing customer interfaces. Here, technology companies have a great advantage over traditional OEMs, since they are better at developing user-friendly interfaces (Butler & Martin, 2016). It is also worth mentioning that supplier revenues in this new phase will partly shift from traditional mechanical parts in vehicles, for example chassis and engines, to electronics, software, and cloud services (Viereckl et al., 2016). Another disadvantage of traditional vehicle producers is thus that they currently rely on third parties to deliver software solutions, for example infotainment (Butler & Martin, 2016).

In western Sweden there are several geographical regions, where one is Västra Götalandsregionen, with its largest city Gothenburg. Responsible for this region is the local authorities, Västra Götalandsregionen. To avoid misunderstanding, the geographical area will

in this study be called “the region” and the local authorities will be called “Västra Götalandsregionen” (VGR).

Many of the actors within the automotive sector in Sweden are located in the Gothenburg area. For example, Lindholmen Science Park (LSP) is gathering valuable players within the vehicle electronic and connected services industry in a network. The network is called Vehicle ICT Arena (VICTA) with a purpose to develop the industry into a leading cluster (RISE Viktoria, 2017), through collaboration and development within the industry. The vision for VICTA is to establish a cluster in the region within the vehicle electronic and connected services industry, which can attract both Swedish and international suppliers of software. The aim for VICTA is to operate in a global market and at the same time have the Swedish automotive manufacturers as key customers.

1.2 Definition of a cluster

In literature, there is a vast number of definitions about what a cluster is, what it should include, and what important requirements need to be fulfilled in order for a cluster to function. There are also many concepts similar to clusters, for example national innovation systems, regional innovation systems, sectoral innovation systems, technological systems, (Alänge, 2008; Klein & Sauer, 2016), and ecosystems (Clarysse et al., 2014). These concepts will be further explained in the chapter, *1.2 Similar concepts to cluster*. To facilitate a common understanding and avoid misinterpretations in the following chapters of this study, a definition of cluster needs to be formulated.

“Clusters are geographic concentrations of interconnected companies, specialised suppliers, service providers, firms in related industries, and associated institutions.... in particular fields that compete but also co-operate.”
(Porter, 1998, p. 197)

“… the term cluster refers to a group companies and other institutions in related industries that are co-located in a specific geographic region.”
(Ketels et al., 2006, p. 9)

“In the literature on economic geography, researchers have developed a model of the industrial district or regional cluster as a group of firms tied together by geographical colocation and complex social interaction, in which informal understandings contribute to sharing technological knowledge.”
(Tallman et al., 2016, p. 261)

"A geographically bounded concentration of interdependent businesses with active channels for business transactions, dialogue, and communications, and that collectively shares common opportunities and threats"
(Rosenfeld, 1996, in Rosenfeld, 1997, p. 10)

“... we refer to as clusters, where sustained competitiveness is based on innovation capabilities linked to a particular location. Clusters are not seen as fixed flows of goods and services but rather dynamic arrangements based on knowledge creation, increasing returns and innovation in a broad sense.”
(Sölvell, 2015, p. 68-69*)*

With inspiration from these quotes, a cluster definition has been developed. However, since the borders between industries have started to blur, this study will focus on related industries. Further on in this study, the concept of clusters is therefore defined as:

A cluster refers to geographically co-located businesses and institutions, collaborating and sharing technological knowledge within related industries.

1.3 Purpose

The purpose of this study is to give recommendations for how to facilitate cluster development within the vehicle electronics and connected services industry. Furthermore, scenarios for the future will be developed, including estimations of how the employment in the region will be affected.

1.4 Delimitations

The study will not concern the market side of the industry, thus not focusing on distributors, dealers, or users of vehicles. Furthermore, it will not take into consideration suppliers that are producing parts and components that are not directly linked to the electronics side of the vehicle; i.e. not containing software. Furthermore, when calculating job opportunities in the region, the researchers do not take into consideration if the positions can be filled or not.

1.5 Research questions

To fulfil the purpose of the study, the following four research questions have been developed.

Since there are already many players within the automotive industry in the region, a lot of competence exists. Nevertheless, there is a technology shift that is happening so therefore, the players in the region need to adapt. For this reason, this study aims at finding learnings about how clusters have undergone change during times of technological shifts. These learnings will later be used to give advice how the vehicle electronics and connected services industry cluster can evolve in the region. Therefore, research question one was developed.
RQ1: What learnings can be found from theory about how clusters can evolve over time?

A study must be done to create an understanding about the future of the vehicle electronics and connected services industry. To ensure a comprehensive picture, both findings from industry reports and interviewed people's view need to be considered. The second research question is designed as following:
RQ2: What distinct scenarios can be outlined depicting how the cluster in the region could evolve in the future?

This study aims at estimating the cluster's impact on employment in the region. To find accurate estimations, the different scenarios found in research question two will be used to calculate possible outcomes on the demand for employment. Based on this, research question three is:
RQ3: How will each of the scenarios affect the demand for employment in the region?

With learnings from the above research questions as a base, it will be of importance to know how the cluster development could be facilitated and what actions need to be taken to prepare for the different scenarios. Therefore, research question four is formulated:
RQ4: How could development of the vehicle electronics and connected services industry cluster be facilitated in the region?

1.6 Outline of the study

This study will first contain a theoretical framework, where the researchers presents theory as a base for the study. Then, a method chapter will outline the selected research strategy and methods chosen to undergo the study. Empirical findings will present findings from industry reports and interviews. Theory and findings from interviews will be discussed in the discussion chapter, followed by the outlined scenarios. Lastly, recommendations and a concluding discussion will be presented.

2. Theoretical Framework

In this chapter, the theories building up a theoretical framework will be presented. First, similar concepts to cluster, followed by cluster theory. Furthermore, the life cycle of industries and clusters, together with an example of a cluster that has undergone a transformation are explained. Lastly, the concept of strong and weak ties and scenario planning are presented.

2.1 Similar systems to a cluster

National innovation systems, regional innovation systems, sectoral innovation systems, technological systems, ecosystems and triple helix systems are similar systems to a cluster. Therefore, each one of these systems will be further described to provide a deeper understanding of the theory about clusters presented in the theoretical framework.

2.1.1 National innovation system

Friedrich List was the first person who introduced theory about national systems (Klein & Sauer, 2016). He was referring to that "wealth, culture and power of Germany would have to be fostered in a national economic way" (List, 1844 in Klein & Sauer, 2016, p.8). Christopher Freeman was the first person to present National Innovation System (NIS), almost 150 years after List´s introduction. In addition to Freeman, Richard R. Nelson and Bengt-Åke Lundvall were also founders of the theory of NIS. However, the researchers had different perspectives. Freeman and Nelson looked from the outside at a specific NIS and described the borders of the country that surrounded it as given. Lundvall, in contrast, looked at the NIS from an inside perspective and suggested that national borders encircled networks of technological interactions, which characterize NIS (Klein & Sauer, 2016). Below is a definition of NIS, made by Niosi et al.:

"A national system of innovation is the system of interacting private and public firms (either large or small), universities, and government agencies aiming at the production of science and technology within national borders. Interaction among these units may be technical, commercial, legal, social, and financial, in as much as the goal of the interaction is the development, protection, financing, or regulation of new science and technology"
(Niosi et al., 1993, p. 212)

2.1.2 Regional innovation system

Philip Cooke was the first person to discuss Regional Innovation System (RIS), based on the work of Nelson and Lundvall on NIS. Cooke's idea was that the region should be seen as a subnational sphere for innovation. Depending on the model of regional technology transfer, different regional technology regulations need to be formed. Other researchers have focused on creating the correct understanding of technological development and the distribution throughout society and economy (Klein & Sauer, 2016). RIS does not have a generally accepted definition but can be seen as:

"A set of interacting private and public interests, formal institutions, and other organizations that function according to organizational and institutional arrangements and relationships conducive to the generation, use, and dissemination of knowledge"
(Doloreux & Parto, 2005, p. 134)

2.1.3 Sectorial innovation system

Sectorial Innovation System (SIS) was first presented by Franco Malerba. The SIS approach discusses important questions, for example what main characteristics the networks of innovation consist of. Different sectors will have different path dependencies when it comes to technological innovations. Consequently, the sectors will have characteristics that are formed by knowledge, actors and institutions. The approach has evolved and been shaped by two processes; *selection* and *variety creation*. The *selection process* is relevant for technologies, products and firms and includes the reductions of heterogeneity in the sector. On the other hand, the *process of variation creation* describes the strategies and behaviour and is referring to technologies, products, institutions and organization. It is important for the dynamics of a SIS that new actors enter the sector. This, since new organizations can create new varieties, for example new approaches, knowledge and specialization (Klein & Sauer, 2016).

2.1.4 Technological innovation system

The first authors that published theory about Technological Innovation System (TIS) were Carlsson and Stankiewicz (1991). The initial idea about TIS was that economic growth in a country will depend on various technological systems, in which in turn various economic agents can participate. In addition, the boundaries of the technological system can be encircled by the national borders and can differ between techno-industrial areas. The definition of TIS can be described as follow:

> *"Technological systems are defined in terms of knowledge/competence flows rather than flows of ordinary goods and services. They consist of dynamic knowledge and competence networks. In the presence of an entrepreneur and sufficient critical mass, such networks can be transformed into development, i.e. synergistic clusters of firms and technologies within an industry or a group of industries."*
> (Carlsson and Stankiewicz, 1991, p. 111)

2.1.5 Ecosystem

The definition of an ecosystem heritages from biology, and refers to an environment containing all organisms living in a certain area (Mercan & Götkas, 2011). It also includes all non-living physical components that the organisms interact with in the environment, for example sunlight, air and water. In a similar way, innovation ecosystems include economic relations, economic agents and non-economic components such as culture, technology, social interactions and institutions. An innovation ecosystem that is highly developed, facilitates the transformation of knowledge into innovations and can function beyond organisation boundaries.

Ritala et al. (2013) state that innovation ecosystem is a widely-used term in both industry and academy. Occasionally, the term itself can refer to the concept of clusters. However, in some cases the term is associated with business ecosystems created around common business objective and motivation comes from innovation-driven goals.

2.1.6 Triple helix

An analysis of the economic situation of Boston in the 1930's was the first step towards developing a widely-used model, called the triple helix. The concept aims at explaining the collaboration between the components; university, industry and government (Etzkowitz, 2002 in Etzkowitz & Klofsten, 2005), see Figure 1, and is one of the key factors for regional development (Etzkowitz, 1995).

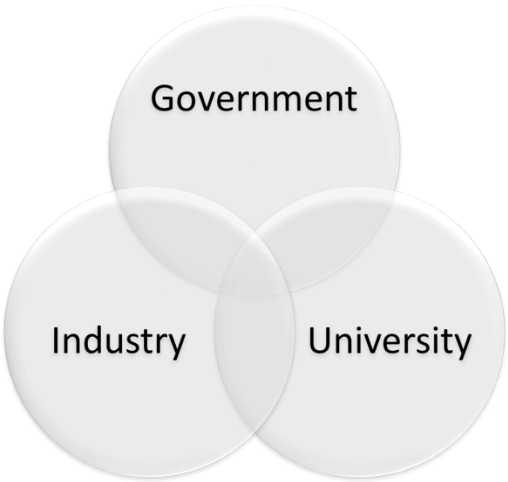


Figure 1. Triple helix system

The triple helix system consists of three different parts. The first one is configurations of the components, which include spheres of university, government and industry with a wide range of actors. The second one is the activities of a triple helix system, for example technology transfer, collaborative leadership and networking. The third and last part is the functions, which refers to the university, government and industry's competencies, and thus determine the performance of the system (Etzkowitz & Ranga, 2013). These three parts of a triple helix system will be further explained below.

Configurations in a triple helix system

Etzkowitz and Ranga (2013) explore the roles of the university, industry and government in relation to each other. According to them, there are three different main configurations; *statist*, *laissez-faire* and *balanced*.

The government takes the lead role in the *statist configuration* to drive industry and academia, but can also limit their capacity to develop innovative transformations. In a *laissez-faire configuration*, the industry is the driving force and the other spheres are functioning as support and have limited roles in innovation. The universities contribute mainly with human capital, and the government takes the role of a regulator of social and economic mechanisms. Universities and other knowledge institutions collaborate with industry and government and sometimes take the lead in a *balanced configuration*. This configuration is the most beneficial environment for innovation creation. It is also here creative synergies are created, new ways of interactions are formed and new organizational formats are established. Furthermore, if one actor in the triple helix is weak or performing worse than usual, another actor can, in addition to its own role, add the role of the weaker actor (Etzkowitz (2003) in Etzkowitz & Ranga, 2013). For example, a university can in addition to its traditional role, provide support and funding to encourage entrepreneurial ventures, which is a typical activity for the industry (Etzkowitz & Ranga, 2013).

Etzkowitz and Ranga (2013) highlight the importance of having individual innovators as part of the triple helix system. Schutz (1964 in Etzkowitz & Ranga, 2013) describes two different roles: the innovation organizer and the entrepreneur scientist. The innovation organizer is usually occupying a key institutional position and has large respect and authority to lead and bring the actors within the system together. The entrepreneurial scientist combines business and academic components and aims to improve the frontier of knowledge. This person can take

different levels of involvement, for example taking a leading role in the formation of a spin-off, playing a supporting role, or being a useful source in developing technology.

Activities in a triple helix system

One of the key activities of a triple helix system is technology transfer (Etzkowitz & Ranga, 2013). The reason for this is that universities are, to a greater extent than before, creating and transferring technology. For universities to facilitate capitalization of knowledge and interaction with the external world, negotiator elements need to be created, such as startup accelerators, science parks, venture capital capacities and business incubators. The universities' involvement in technology transfer have improved their ability to provide graduates, who possess talent and entrepreneurial education. By firm formation and job creation, the graduates contribute to economic growth. In addition, academic entrepreneurship can benefit faculties since it can receive more funding for projects within academia. Thanks to this, faculties can improve their research laboratories, can fulfil the needs of local businesses to a greater extend, and can test their expertise outside the university walls. These possibilities usually have an impact on the national and regional economy. Benefits are also shown at the community level because of positive effects on the economy by job creation. Furthermore, tax revenues from university start-ups provide both social and cultural benefits, for example stronger connection between community and university, as well as increased attractiveness of the region and university by international and national investors and talents. For many cities, it is important to gain the label "university city" since it attracts venture capital investments and skilled employees and entrepreneurs. The result is often that the region transforms into a world-class entrepreneurial ecosystem (Ranga et al., 2013 in Etzkowitz & Ranga, 2013).

Collaboration and conflict moderation is a special type of interaction in the triple helix system. It has a higher possibility to convert conflicts and tension into converging interest. Collaborative leadership has an important part of the collaboration and conflict moderation capacity. In this type of relationship, the innovation organizer, either individual or institutional leaders, have a crucial role. Some examples of the tasks that the organizer need to perform are bridging gaps by connecting people from different sectors, finding new ways of knowledge creation, and accommodating different views (Etzkowitz & Ranga, 2013).

Networking can be both formal and informal, and occur on regional, national or international levels. However, it is not exclusive for the triple helix system but is a recurring phenomenon. Depending on the network's activities, visibility for the public, age and scope, the aggregation is either stronger or weaker (Etzkowitz & Ranga, 2013).

Functions of a triple helix system

The triple helix system consists of three main functions; knowledge, innovation and consensus spaces. *The knowledge space* is located in universities, government labs and firms and consists mainly of research and development in technology and science (Etzkowitz & Ranga, 2012). Also, it includes the competences of knowledge creation and how the components of the triple helix are used. The purpose of this space is to develop and create the knowledge resources to improve the knowledge base at local, regional and national level. Through creation of new resources or relocating of existing ones, knowledge resources can be aggregated locally within a region, nationally or internationally across regions. *The innovation space* consists mainly of multi-sphere institutions, which include government and university research laboratories, business- and financial support institutions. The purpose of the innovation space is to develop local innovative companies, attract talents and innovative companies from elsewhere, and create competitive advantage for the region and the nation.

In *the consensus space,* actors in the triple helix system will be interdependent, rather than isolated from each other. When consensus between actors is achieved, they see themselves as part of a larger system. In contrast to environments without consensus where resources are left unexploited, environments that achieve consensus can use its resources to accomplish social and economic development (Etzkowitz & Ranga, 2013). Steiber and Alänge (2013) define the consensus space as:

> "*In the consensus space, the triple helix actors can come together to formulate strategies for realizing and enhancing local growth potential.*"
> (Steiber and Alänge, 2013, p. 581)

2.2 Cluster theory

As a large part of this study concerns clusters, theory is presented as a base for future analysis and recommendations.

2.2.1 Actors of a cluster

Porter, one of the most noticeable authors within the field, introduced in 1990 the term cluster and explains it as a formation of firms and industries linked together through vertical (buyer-seller) or horizontal (common customers, technology etc.) relationships located in the same area. In 1998, Porter also included institutions, such as universities, in his definition of clusters. Sölvell (2015), who was the first one together with Porter to introduce the term cluster in Sweden, describes the cluster as a collection of different actors; companies, small and large, national and multinational, suppliers and buyers, and other connected firms that have formal and informal interactions. Furthermore, he states that six actors exist within the cluster and two actors outside (see Figure 2). *Firms* are the most important actor in the cluster, since they take innovations to the market and test them against competitors and demands. *Research organizations* or laboratories are another type of actor, important in the beginning of creating innovations. *Education* is the third actor and includes schools and polytechnics. Universities play the role as both research and education actor. *Capital providers* are the fourth type and consist of banking institutions, public and private funding and business angel networks. A fifth type is the *government* and *other public organizations* that make decisions about regulations, public infrastructure etc. The sixth actor, *bridge builders*, is of great importance for the cluster and consists of organizations such as science parks, incubators, innovation offices and cluster organizations. The *actors outside of the cluster* include firms and organizations in other industries and global markets.

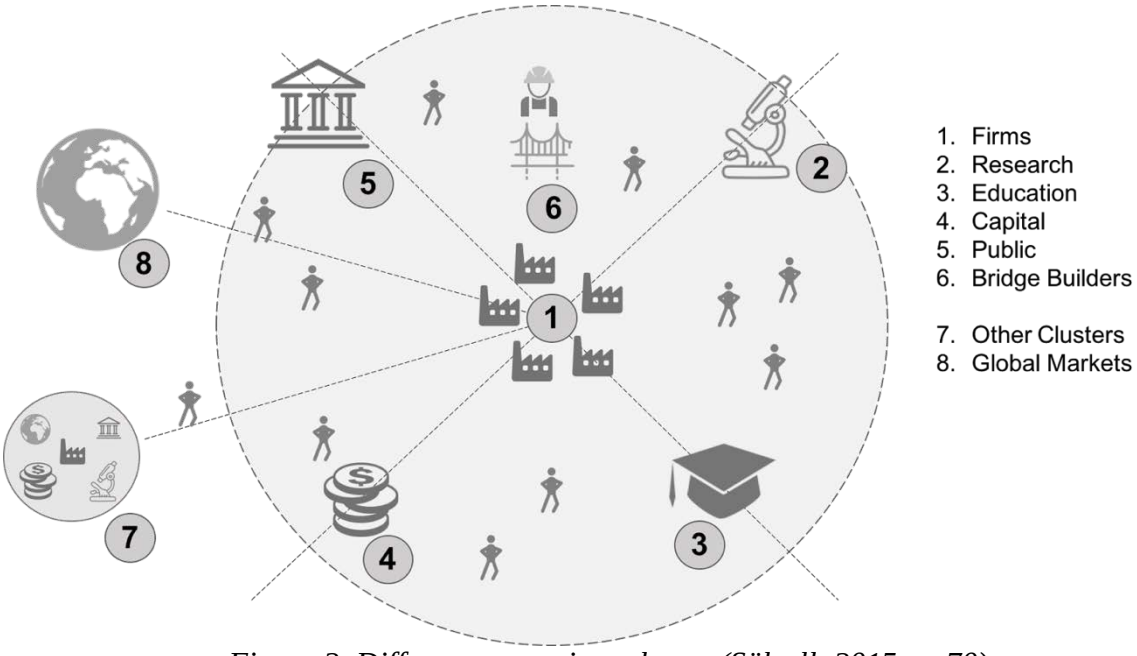


Figure 2. Different actors in a cluster (Sölvell, 2015, p. 70)

2.2.2 Relationships between actors

According to Porter (1998), social interaction binds a cluster together. To access the competitively valuable information and resources, personal relationships and face-to-face contact is necessary. In addition, communication amongst cluster members, exchanging information, formulating common strategic objectives, and agreeing on a joint developing strategy are all important elements for building an efficient cluster (Cegile, 2003 in Karaev et al., 2007). To develop a successful cluster, it is crucial to increase the level of trust between actors in the cluster (Karaev et al., 2007). A high level of trust can also lower transition costs, decrease the costs for legal disputes, and administrative procedures.

One important element of cluster dynamics is the interaction of competitive and cooperative behaviours (Porter, 1998). Also, the connection between cluster actors results in a whole, that is greater than the sum of its parts. Furthermore, clusters affect competition in three ways. Firstly, it increases productivity for the firms located in the area. Secondly, it drives the direction of innovation, which decides the future productivity growth. Thirdly, it gives opportunities for developing new businesses, which will increase the size of, and strengthen the cluster.

Members within the cluster will gain cost advantages and receive resources that are not available for the competitors outside the cluster (Pouder and St John, 1996 in Karaev et al., 2007). Firms within a cluster can also accomplish higher levels of knowledge creation and innovation. In addition, innovations tend to diffuse rapidly within the cluster. Another advantage for the members is the environment that the cluster creates, where different resources, such as individuals, technologies, capital etc. can quickly be reshuffled, skills can be transferred across organizations, and spin-offs can be created, as shown in Figure 3 (Sölvell, 2015).

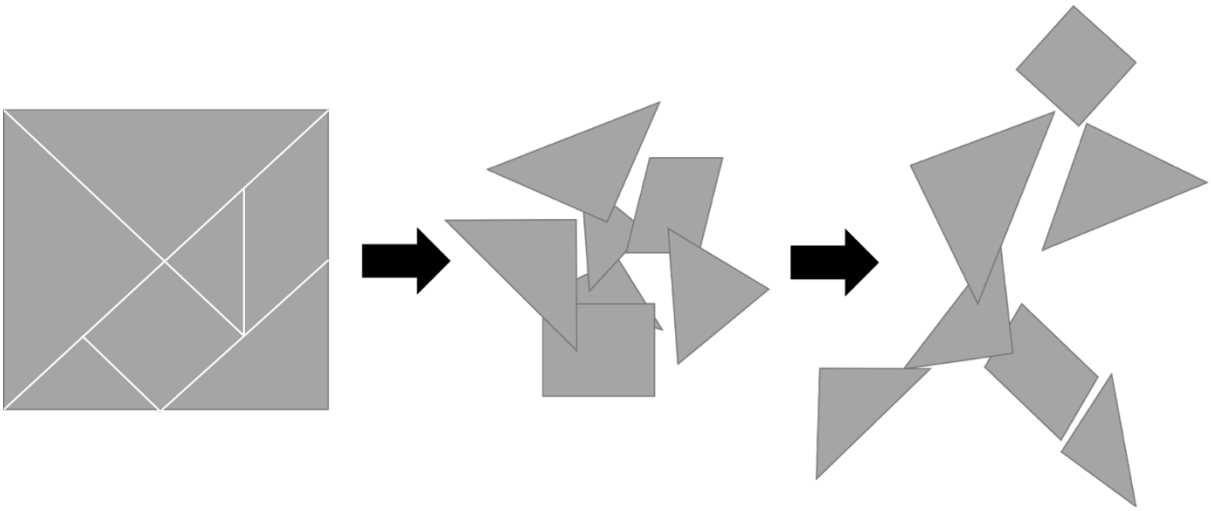


Figure 3. A cluster's ability to reshuffle resources quickly (Sölvell, 2015, p. 72)

In an ideal world, all actors within the cluster integrate with each other. People change jobs between actors, share information in informal and formal meetings, and collaborate with others in the cluster. The result is knowledge creation that is mediated and shared, and resources in the cluster are optimally utilized. However, this is not how it looks in the reality since communication between the actors is imperfect. Small innovative firms that think they have something revolutionary to offer, have trouble even scheduling a meeting with a suitable person at a large firm. Large enterprises search for large international suppliers, rather than small innovative firms located in the same area. Moreover, policy makers are not familiar with firms' plans and needs, and researchers are often more focused on academic publishing than to commercialize their findings (Sölvell, 2015).

2.2.3 Gaps and bridges

Most clusters possess enormous potential but do not take advantage of it. The reason for this is that interaction between actors is not as easy in practise as it is in theory. There are a lot of barriers to the interaction, for example lack of trust and knowledge between members of the clusters. In turn, this makes it difficult to start collaborations, share knowledge and to communicate with other actors. These barriers create gaps instead of links, and these gaps have a large influence on the innovation and competitiveness in the cluster. This is because people do not take advantage of the opportunities around them since they lack knowledge of the possibilities. The result is that the cluster fails to be innovative (Sölvell, 2015).

Sölvell (2015, p. 80) points out seven different types of gaps between actors within the cluster.

1. The firm-to-firm gap, including the interaction between firms within the cluster, for example among small and large firms.
2. The firm-to-research gap, including the interaction among firm and research institutions and laboratories within and outside of universities.
3. The firm-to-education gap, including the interaction among firms and education organizations.
4. The firm-to-capital gap, including the interaction between firms and capital providers.
5. The firm-to-public actors gap, including the interaction among firms and government and other public organizations.
6. The firm-to-cluster gap, including the interaction with enterprises in other clusters.

7. The firm-to-global market gap, including the interaction with global markets and value chains.

Cluster organizations, which is a quite new phenomenon, can help to overcome different failures of knowledge, collaboration and network. They play the role of connecting academia with businesses, education and industry, bringing together small and large firms and increasing the awareness of the cluster. To create these interactions, cluster organizations arrange meeting places and activities for actors in the cluster to come together and meet, discuss common issues, solve them jointly, share information and ideas, and cooperate and discuss resource mobility. Cluster organizations also try to create new projects across the above-mentioned cluster gaps. However, other organizations can also act as bridge-builders, for example science parks and incubators (Sölvell, 2015).

2.3 Industry and cluster life cycle

Cluster life cycle with its different phases are described by Sölvell (2015), and can be seen in Figure 4. The early phase of a cluster life cycle often contains a lower number of entrepreneurs, here called heroes. The heroes act like role models, and if they are successful they will attract new players to enter the business. In this stage of growth, both upstream and downstream businesses can enter the area.

The second phase is maturity, where economies of scale will be an important factor for the cluster. It is not rare for a few firms dominating in this stage. A cluster can stay in the maturity phase for a long time, becoming a static agglomeration. There, it can face a variety of internal constraints (Sölvell, 2015). These are for example various types of investments that reduce flexibility, limitations of information from decision-makers, rigid institutions hindering technological change, and overconcentration around one dominant firm. One example of an external constraint is technological shifts (Sölvell, 2015).

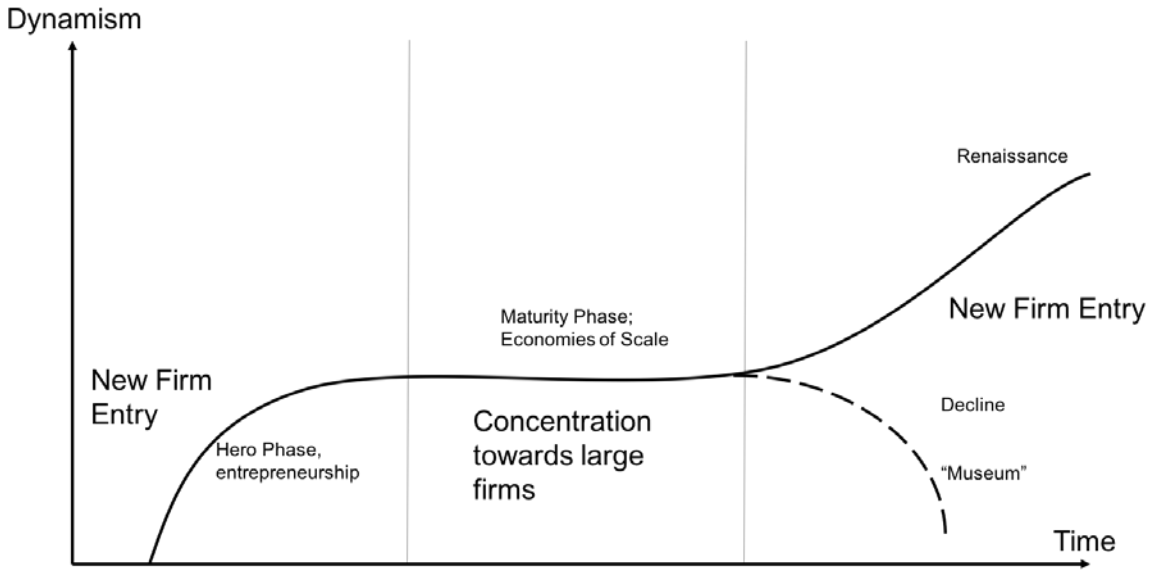


Figure 4. Cluster life cycle (inspired by Sölvell, 2015, p. 74)

After the maturity phase, the cluster can enter two different stages. Either the decline stage, when the cluster starts to decrease and enters a "museum" mode. Another possibility is for the cluster to jump into a new cycle thanks to new technologies emerging and new firms entering the clusters that changes the way of making businesses.

Cluster dynamics related to industry life cycle have been presented by Menzel and Fornahl (2009). They visualize the different development stages of companies in clusters, as well as companies outside of clusters, during the industry life cycle, see Figure 5. According to them, the benefits of being member of a cluster is greater between two points in the diagram. After the cluster have appeared when there is a critical mass of companies, until the point where companies in the cluster are not enjoying positive effects from the cluster anymore. This happens a while after the industry has matured. Nevertheless, it does not have to be the end for the cluster. Menzel and Fornahl (2009) describe that by adopting new technologies and integrating new knowledge, clusters can move back to earlier phases of the cluster life cycle, entering new growth phases.

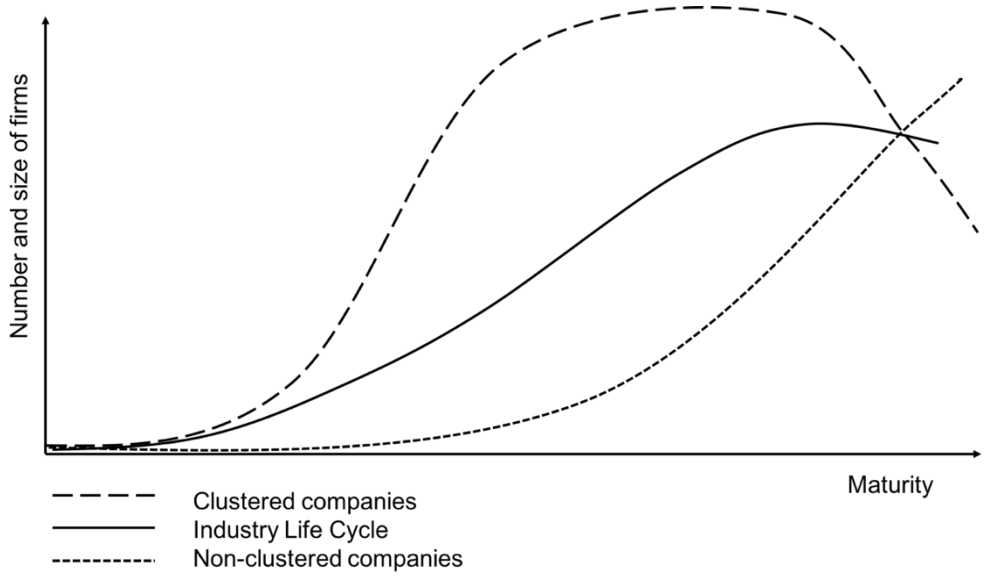


Figure 5. Clustered and non-clustered companies during the industry life cycle (Menzel & Fornahl, 2009, p. 211)

In their research, Menzel and Fornahl (2009), also propose four steps in the life cycle of clusters. These are *Emergence, Growth, Sustainment*, and *Decline*. In this life cycle, clusters are distinguished by two components; quantitative and qualitative. The quantitative dimension describes the number of active companies and employees. The qualitative dimension on the other hand, describes the heterogeneity of companies' competencies inherent in the cluster. As can be seen in Figure 6, heterogeneity is greatest in the emergence and growth steps when all companies bring their own knowledge into the cluster, while the number of employees is greatest in the sustainment phase.

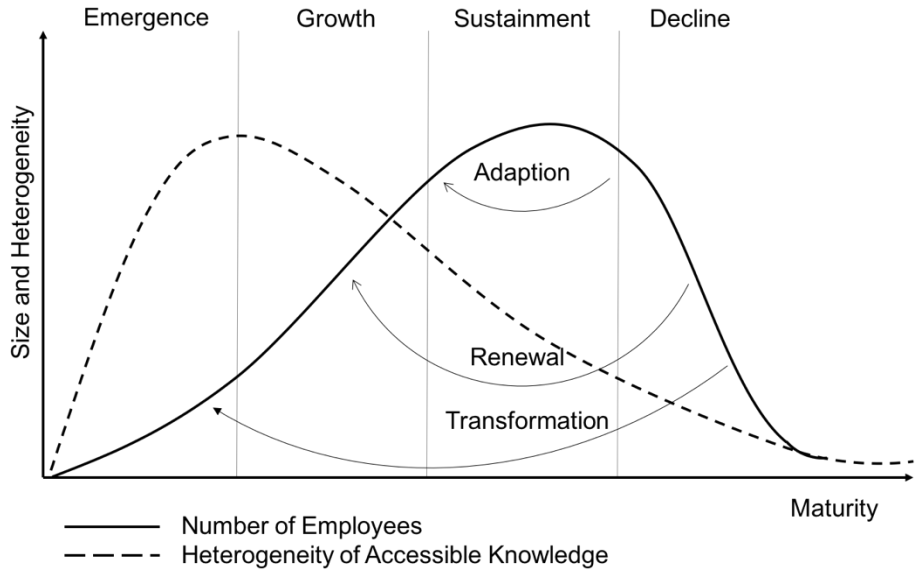


Figure 6. Quantitative and qualitative dimensions of the cluster life cycle (inspired by Menzel & Fornahl, 2009, p. 218)

Heterogeneity of accessible knowledge is driver for the cluster development. When heterogeneity declines, the cluster goes into the decline stage. But, when heterogeneity grows, the cluster will move back to the growing stage of the life cycle. Heterogeneity can be increased by, for example, integrating knowledge about new technologies in the cluster. By keeping a level of heterogeneity of knowledge, in other words integrating new knowledge into the cluster, the cluster itself can adapt to a changing environment. The development of a cluster is not determined to move from the left to the right in Figure 6, i.e. from low maturity to high maturity. Instead it is a steady movement back and forth to the left and the right of the figure (Menzel & Fornahl, 2009).

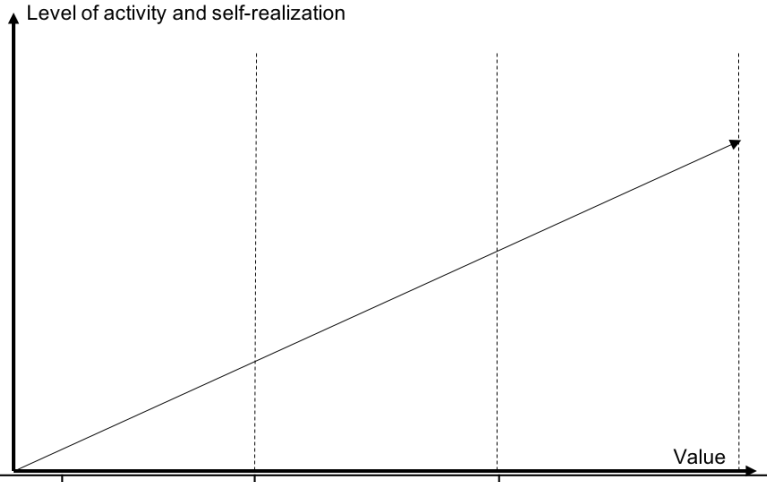
In addition to previously mentioned cluster life cycles, Enright (2003) describes different stages for the level of development in clusters. These are *working clusters, latent clusters, potential clusters, policy driven clusters,* and *wishful thinking clusters. Working clusters* are the ones with the highest level of development. Here, there is a critical mass of knowledge, expertise, resources etc. that create agglomeration economies (benefits of co-location), leading to a competitive advantage over companies outside of the cluster. *Latent clusters* also have a high level of development, and do benefit from clustering. But, there are not sufficient levels of interaction to truly benefit from co-location and the associated opportunities. There can be for example lack of knowledge about other firms in the cluster, lack of interaction and communication within the cluster, or lack of sufficient trust to build strong relationships. *Potential clusters* are the ones with only some potential of developing a successful cluster. This potential must thus be further developed and broadened in order to benefit from co-location. *Policy driven* and *Wishful thinking clusters* are both chosen by government, but they lack a critical mass of firms. Wishful thinking clusters also lack any specific advantage (Enright, 2003).

2.3.1 Cluster facilitators in the life cycle

Ingstrup and Damgaard (2013) built further on the life cycle proposed by Enright (2003), with focus on the working, latent, and potential clusters, and what role cluster facilitators must take in each phase. Cluster facilitators are, according to Ingstrup and Damgaard (2013), defined as:

"Individuals or a team of individuals who are seated in a formal cluster secretariat within a cluster, facilitating and coordinating cluster development through trust building in order to promote cooperation and sharing of activities and resources among the participating actors of the cluster."
(Ingstrup & Damgaard, 2013, p. 562)

The authors stress the need for understanding that cluster facilitators have different roles during different stages of the cluster life cycle. This, since they play a critical role in continually improving the competitiveness and potential of clusters. They say that one disadvantage with their framework is the lack of a decline-stage of the cluster, and thus the model itself can be limited. A visualised model of the framework, with the stages and roles of facilitators, can be seen in Figure 7.



	Potential Cluster	**Latent Cluster**	**Working Cluster**
Facilitator Role	Framework-setter Networker	Entrepreneur Relationship Builder	Business seeker Integrator
Facilitator Focus	Create Social actor bonds Framework conditions Locate New Actors Trust Building	Create professional actor bonds Cooperation Locate actor needs Trust expansion	Create business actor bonds Business creating activities Locate actor opportunities Trust exploitation
Facilitator Competencies	Communicator Credible Networker Originator Political Flair Seller	Analyzer Communicator Credible Entrepreneurial Networker Problem solver	Business understanding Communicator Credible Innovative Industry Knowledge Managerial Skills Networker Organizer Problem Solver
Facilitator Tasks	Branding Funding Lobbying Matching of Expectations Networking Events Seminars Social Events	Branding Business idea workshops Funding Knowledge Sharing Networking Events Seminars Small-scale cooperation projects	Branding Cross-cluster cooperation Innovation and business projects Knowledge sharing Market analyses Networking events Project portfolio management Seminars

Figure 7. Cluster life cycle framework for cluster facilitators (Ingstrup & Damgaard, 2013, p. 569)

As can be seen, the role of cluster facilitator changes during cluster development, and the role is not static but dynamic (Ingstrup & Damgaard, 2013). The role, focus, competence and tasks of the facilitator changes during cluster development stages.

2.4 A case study of an industry transformation

The shipyard industry in Europe has undergone a transformation during the last decades. Therefore, this is an example worth mentioning since similarities can be drawn to the changes facing the automotive sector.

The shipbuilding industry in Europe has, since the oil crisis in the 1970's, undergone some major changes (Giovacchini & Sersic, 2012). Around that time East Asian countries grew their knowledge and capacity about shipbuilding, and there was a decline in the demand of ships in Europe. Ever since, East Asian countries like China and Japan are providing the majority of larger ships and vessels around the globe. Nevertheless, the shipbuilding industry is facing some major changes in competition and revenue sources, and for this reason, European shipbuilders are trying to find opportunities in the future development of the industry. In order to transform itself, the European shipbuilding industry must work with diversification and re-capacitation of infrastructure and local expertise in the area (Giovacchini & Sersic, 2012).

In Europe, there is an ongoing process to both physically and conceptually transform the shipbuilding industry. It concerns, for example, how to use and redevelop existing shipyards and take advantage of already experienced labour (Giovacchini & Sersic, 2012). All of this is done for the European shipbuilding industry to compete globally. Nevertheless, the transformation is taking place at different pace in different regions and therefore it is possible to see some trends in the growth cycle of the industry. In Figure 8, trends in the growth cycle of the industry in Europe discovered by Giovacchini and Sersic (2012) are presented. The trends depend on two factors, namely the degree of change and the connections to the former know-how in the industry.

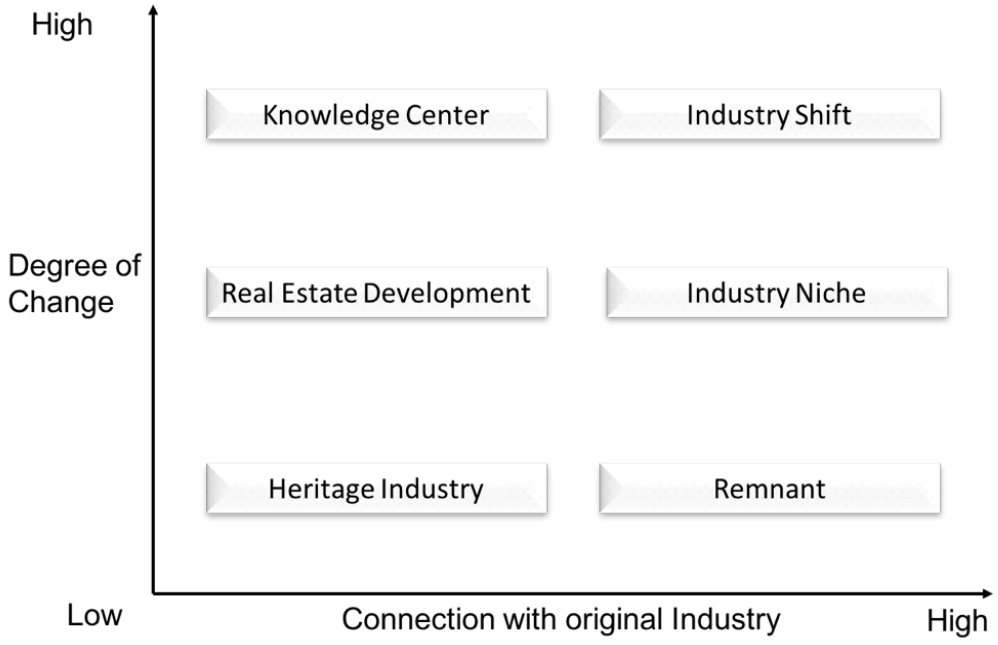


Figure 8. Industry transformation matrix (Giovacchini & Sersic, 2012, p. 13)

Industry shift occurs, as the name implies, when a completely new industry takes over the old shipbuilding activities (Giovacchini & Sersic, 2012). There are vague links back to the shipbuilding industry and the new industry might employ a small part of the local knowledge or facilities from the old industry, for example when existing expertise for ship building have been used in energetic sectors. A shift towards an *industry niche* has happened in some of the European shipyards, giving them a competitive advantage. Examples of niches are yachts, icebreakers and offshore support vessels. Some shipyards in Europe have realised that their position, together with for example developed technology and infrastructure, can give them a competitive advantage, called a *remnant* (meaning fragment*)* trend. This, by making a fragment of the shipbuilding industry into an industry of its own. One example of a remnant shift is the repair and maintenance of ships. Some European cities with ports and strong tradition in the shipbuilding sector have undergone a transition from an industrial intensive economy towards a knowledge intensive economy; *a knowledge centre*. Some examples of this transformation is the development of science parks, universities and research institutions around the shipbuilding areas. *Real estate development* is taking place in many European port cities, since the properties from the shipbuilding industry can be redeveloped and give huge profits. Last but not least, the trend called *heritage industry* means that historic buildings and infrastructure can contribute to the attractiveness of cities and regions. For example, they can attract tourism and small business incubations. Heritage industries often occurs together with knowledge centres and real estate development, which is mentioned above (Giovacchini & Sersic, 2012).

Giovacchini and Sersic (2012) give the Gothenburg area as an example of how the shipbuilding industry has transformed thanks to new industries emerging. Nevertheless, the process of shifting industry is not organic, but requires a great deal of support from institutions. In the Gothenburg area, the vision of changing the local economy from industrial to knowledge-intensive was the enabler for the emergence of new industries. Chalmers University started a new campus in the area in 2000, and it was followed by the Lindholmen Science Park initiative which in 2011 involved over 300 companies with up to 9000 employees.

2.5 The concept of strong and weak ties

The concept of strong and weak ties was first introduced by Granovetter in 1973, an American sociologist and professor of Stanford University. He claims that small-scale interactions between people in a network can be translated into large-scale interaction, thus forming a bridge between micro and macro levels. These small-scale interactions are referred to as interpersonal ties, and can differ in strength. He defines the strength of ties as:

> *"The strength of a tie is a (probably linear) combination of the amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal services which characterize the tie."*
>
> (Granovetter, 1973, p. 1361)

Granovetter (1973) then puts strong emphasis on weak ties and their effects. He claims that weak ties have greater potential of linking members of different groups together than strong ties. This, because strong ties tend to be found within groups, and not between them. Weak ties can therefore be referred to as bridging ties, since they constitute a bridge between groups.

Since Granovetter introduced the concept of weak and strong ties, many others have built further on his work (McEvily & Zaheer, 1999; Jack, 2005). McEvily and Zaheer (1999) have an embeddedness perspective in their research, which means that they view the company not as acting alone, but with social, economic, and professional networks. They show how a firm's

embeddedness in geographical clusters can lead to its competitive advantage, thus stressing the importance of understanding how a firm's pattern of network ties can relate to its competitive capacity. In this area, two types of ties become evident, bridging ties and linkages to regional institutions (McEvily & Zaheer, 1999). The view of bridging ties by McEvily and Zaheer (1999) differ from the one of Granovetter (1973), claiming that a bridging tie does not have to be weak. The network of ties to external actors and institutions will expose the company to other ideas, information and opportunities which can create competitive advantage. Also, linkages between companies in geographical clusters are vital for renewing and updating a firm's skills, competences and routines (McEvily & Zaheer, 1999).

Jack (2005) studies the concept of ties from an entrepreneurial point of view, by asking what the role of ties are, and how they can be used and activated. The study proves that strong ties are important for business activity and are links to social contexts outside of the focal company. Strong ties can also be latent and inactive in networks.

The role of weak and strong ties can be seen in Figure 9. The entrepreneur activates the strong ties (that are latent in the networks) to attract information and resources to the focal company. In turn, the strong ties activate their links further out in the network. Links in the network are defined by mutual trust towards one another, which leads to information exchange. The study by Jack (2005) implies that instead of frequency of contact by Granovetter (1973), the importance when building a relationship is the function and utilization of a tie.

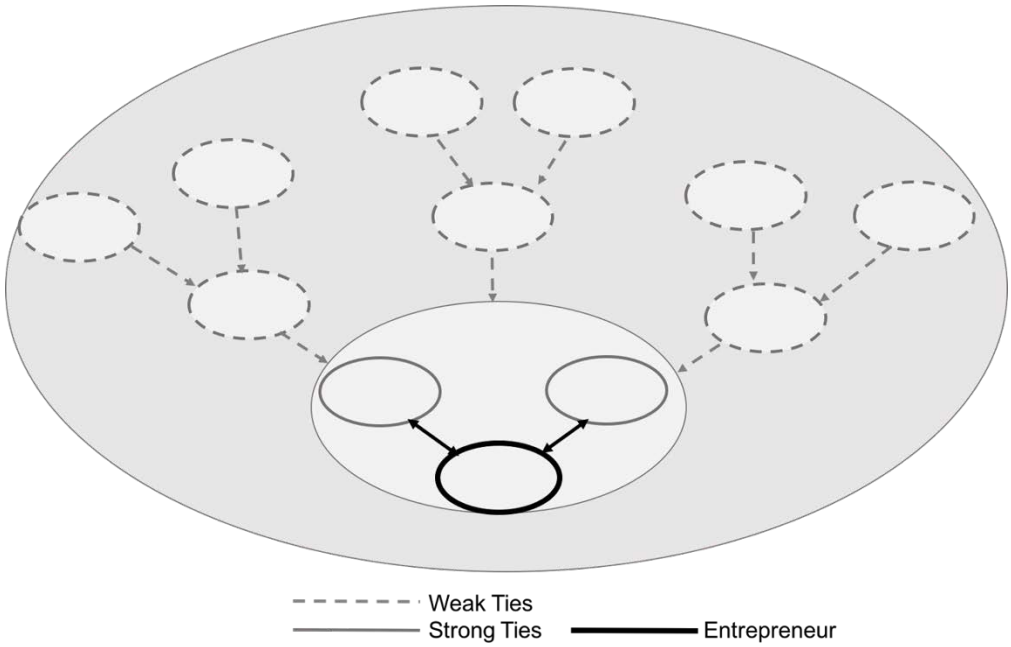


Figure 9. The role of strong and weak ties (Jack, 2005, p. 1252)

2.6 Scenario planning

In literature, numerous researchers and authors have described the concept of scenario planning and analysis. One major influencer of the concept is Schwartz (1991). In his book "The art of the long view", he describes eight steps for developing scenarios. The steps first defined by Schwartz (1991) are the following:

1. Identify focal issue or decision. In this step, you should ask what issues are important for the future of the company/industry.
2. Identify key factors in the local environment. Here, all key factors that can influence the future of the focal issue in the micro level must be listed.
3. Identify driving forces. Driving forces are external, and influencing the key forces identified in step two. One method to determine the driving forces in the external environment is to use the STEEP-analysis that contains forces in five areas; Social, Technological, Economic, Environmental, and Political. This step is the most crucial for creating scenarios.
4. Rank by importance and uncertainty. In this step, the driving forces are to be ranked in a diagram, where the axles are importance and uncertainty. See example in Figure 10 below. The forces located in the upper left corner of the figure are *trends*. The purpose of this diagram is to select which forces that are both most important, and most uncertain, *critical factors* (upper right corner). The number of selected forces should be around two or three, and will be used to create the scenarios.

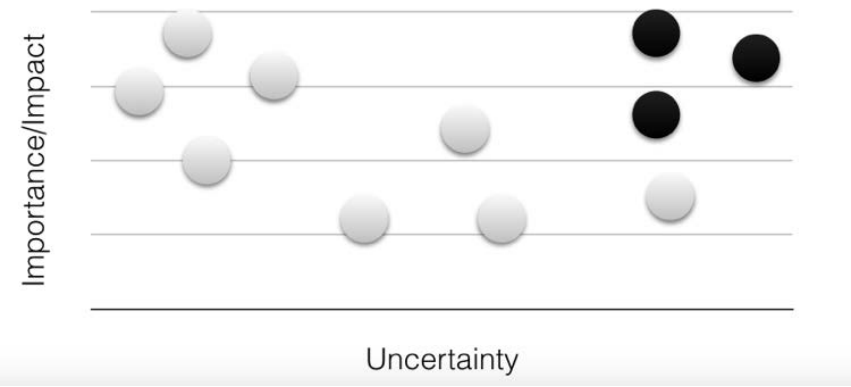


Figure 10. Factors ranked by importance and uncertainty

5. Selecting scenario logics. Forces that were selected in step four will now be combined in a matrix, see Figure 11, to view different scenario logics. This is done by giving each force a "high and a low" value. For example, if fuel price is one of the factors, it should have high price in one end of the matrix, and low price in the other end of the matrix. By combining high and low values of forces, different scenarios can be seen.
6. Fleshing out the scenarios. Here, the "skeleton" of the scenarios should be developed by taken the initial factors and forces from step two and three into consideration, and how they would be affected by the scenario.
7. Implications. Here, a strategy that is robust for all the different scenarios needs to be formulated. It is important to understand that for ensuring the future of the focal issue, one must be prepared for all possible futures.
8. Selection of leading indicators and signposts. It is important to identify some indicators of how the future will unfold. If one of the indicators will occur, then it can give the company an insight of the future, in other words gaining competitive advantage over competitors that do not see this indicator.

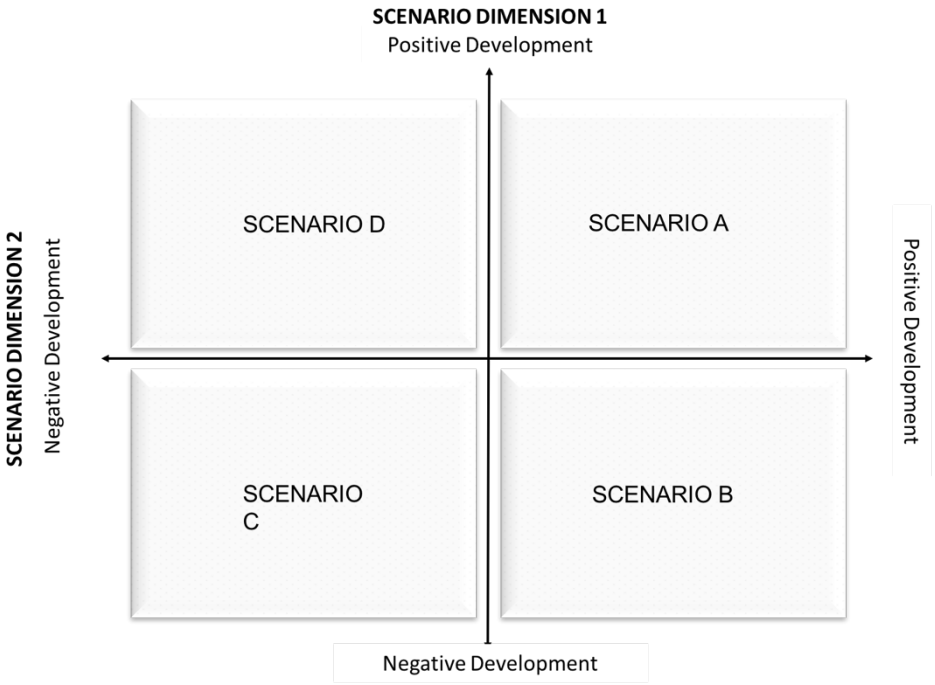


Figure 11. The scenario planning matrix (by Schwenke & Wulf, 2013, p. 106)

3. Method

This chapter will include the chosen methodology strategy for the study, how data will be collected and analyzed to answer the research questions. Furthermore, limitations, trustworthiness and ethical aspects will be discussed.

3.1 Research strategy

The researchers do not possess personal knowledge of developing technical and software solutions for the vehicle electronics and connected services industry, and therefore the study will mainly have a qualitative approach. This approach is appropriate to receive the view of main players and involved persons in the industry (Bryman & Bell, 2015). A qualitative research strategy also enables the study to be conducted in the natural environment of those involved players and persons. Even though a qualitative approach will be of most importance for the study, a quantitative approach will also be of use to estimate demand for employment.

Derived from the above argumentation, it can be concluded that this study will have a mixed methods approach. A mixed methods research combines both quantitative and qualitative methods, which is typically used in business and management research (Bryman & Bell, 2015). The specific working method used in this study is called convergent parallel design, which is one type of mixed method approach, see Figure 12 (Bryman & Bell, 2015). It means that one part of the study will be of a qualitative approach, since it concerns interviewing and collection of qualitative data. The other part of the study will be of a quantitative approach, since the researchers will collect statistical data about employment in the region to see the potential growth of jobs in the future. Lastly, quantitative and qualitative data will be combined to give recommendations of how to facilitate the cluster's development.

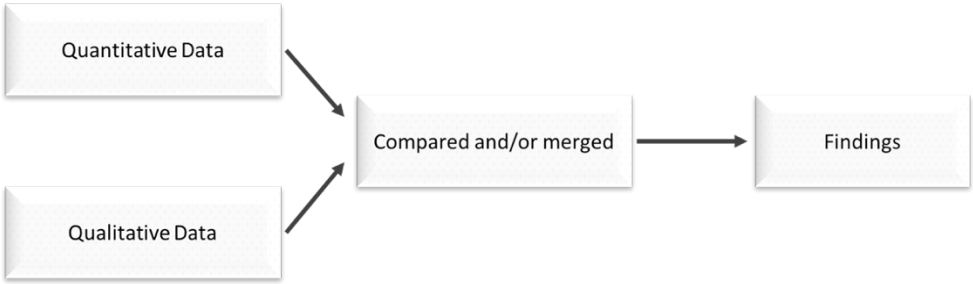


Figure 12. Convergent parallel design (Bryman & Bell, 2015, p. 647)

3.2 Research design

First, a short description of used methods is presented, and then in-depth explanations of how they were adopted in the study can be found in the following chapters.

The most beneficial approach for collecting first-hand data to the study is by using semi-structured interviews. A semi-structured interview is suitable for conducting several interviews, as is true in this study, and will facilitate comparability between answers (Bryman & Bell, 2015).

Secondary data will be collected through browsing the internet, as well as analysing industry reports, mainly written by consultancy firms. The collected secondary data will be used, together with the first-hand data from interviews, to create an understanding of the current and future situation of the vehicles electronics and connected services industry.

A part of the study is to estimate possible scenarios of developing a cluster in the region. A method for forecasting various scenarios, first introduced by Schwartz in 1991, is scenario planning. Peterson et al. (2003) say that scenario planning should be explored in a series of workshops, with various types of experts and industry people. Because of this, as a part of the interviews in this study, workshop as a format will also be used. The authors state that involved persons in these workshops should consist of research scientists, managers, policymakers and other stakeholders. The persons to interview was therefore chosen with this as a base, but their names and positions are kept anonymous.

To ensure the quality of forecasted scenarios, a workshop was held together with a group of experts within the area, after the interviews were completed. This to assure the quality of the collected data with further explanations and discussion about the result.

A more detailed process scheme of conducting the study can be seen in Figure 13.

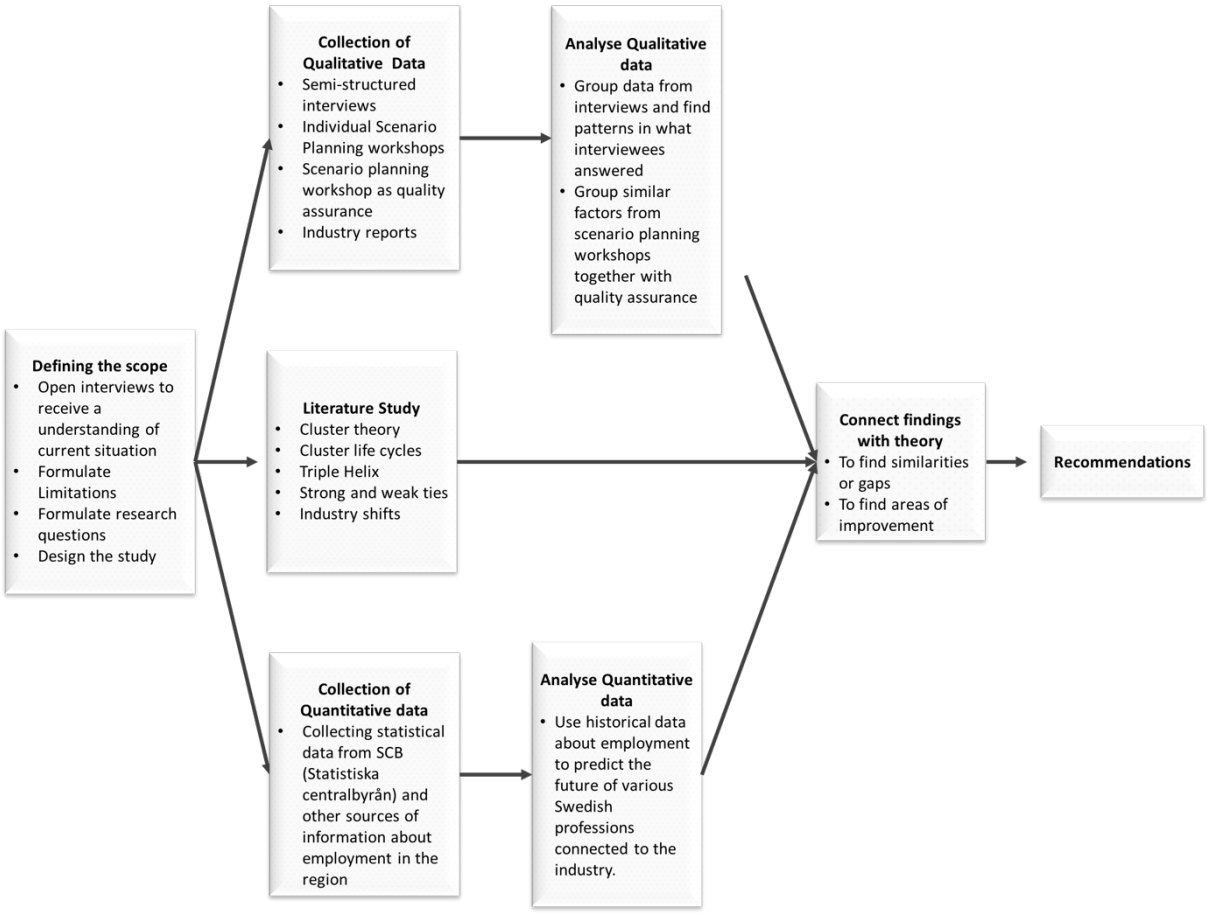


Figure 13. Process scheme of the conducted study

3.2.1 Semi structured Interviews

Semi structured interviews were used at two times in this study. First, a handful of experts in the area were interviewed to define the scope of the study. Secondly, semi structured interviews were used in the data collection part. Both of these will be further explained below. Table 1 shows the interviewees' gender, position in the cluster and what type of interview that were conducted.

Table 1. Interviewees of the study

Gender	Actor in the cluster	Type of interview
Man	Startup	Initial interviews
Man	Startup	Initial interviews
Man	Consultancy firm	Initial interviews
Man	OEM	Initial interviews
Man	OEM	Initial interviews
Man	Tier 1	In depth interviews
Man	AstaZero	In depth interviews
Man	OEM	In depth interviews
Man	Lindholmen Science Park	In depth interviews
Man	Representative for Tier 1, 2, 3…	In depth interviews
Man	Representative for Tier 1, 2, 3…	In depth interviews
Woman	Representative for Tier 1, 2, 3…	In depth interviews
Man	Supplier of operating system	In depth interviews
Woman	OEM	In depth interviews
Man	OEM	In depth interviews
Man	Research	In depth interviews
Man	University	In depth interviews
Man	University	In depth interviews
Man	Capital provider	In depth interviews
Man	OEM	In depth interviews
Man	Company in the telecom industry	In depth interviews
Man	Company in the telecom industry	In depth interviews
Man	Local authorities	In depth interviews
Man	Local authorities	In depth interviews
Man	Local authorities	In depth interviews
Man	Local authorities	In depth interviews
Man	Local authorities	In depth interviews

Initial interviews for defining the scope

In the beginning of the study, the scope and purpose had to be narrowed down in order to facilitate a suitable workload and find limitations of the study. Therefore, five initial interviews were conducted with five involved persons of VICTA, namely members of the "creative team" which is a group of experts in vehicles electronics and connected service industry. Three of the interviews were conducted face to face, and two of them via conference call due to geographical distance. The purpose of these initial interviews was to give the researchers a broader view of the topic and a deeper understanding of the current situation of the industry in western Sweden

as well as in a global context. Each interview lasted for around one hour, and had an open questions approach. Moreover, these interviews were discussion sessions, rather than explicit question and answering interviews.

In depth interviews
After the scope was defined and research questions were selected, semi-structured interviews were designed and performed by the researchers. In total 19 interviews were conducted and lasted around one to two hours. The contact details for these persons were provided by VICTA since it has a large network within the industry. The first half consisted of purely interview questions, and the last consisted of a workshop where steps 2 to 5.1, described in *3.2.3 Scenario planning*, were conducted. The interviews took place face to face, except for two occasions where conference calls were used due to geographical distance.

A template with questions (see Appendix A) for the interviews was developed and quality assured with help from the supervisors. The focus of the chosen questions was first about the interviewee's background to receive a view of their mental picture. Then, questions concerned the respondents' view of the industry, what changes might happen in the future and what competencies will be required. Furthermore, questions concerning the current state of the industry in the region, for example how companies are currently collaborating and areas of improvement. The participants were asked about specific prerequisites in the region for developing the cluster and foster innovations. Lastly, questions concerning what areas in which companies and institutions in the region that have a particularly high level of competence and that could be used to develop the cluster in the future. During the interviews, the same template of questions was used but some questions were added during the interview, for example when asking interviewees to explain their answers better. Also, some questions were modified depending on the interviewee's position in the industry. It was, for example, not possible to ask the exact same questions about the industry to researchers and to CEOs. The interviews were both recorded, with permission from the respondents, and one of the interviewer took notes. After each of the interviews, the interviewers wrote down their reflections that occurred during the interview and how they perceived the respondents. This was done so that when reading through notes in the future, it would be easy to remember the specific situation. Also, it was done as a quality assurance procedure, since it was sometimes easier to understand why the respondents answered in specific ways.

After all interviews were carried out, they were analyzed. First, notes were printed on paper and read through once more to create a sense of what themes might be found from the answers. During the reading, important quotes and views were highlighted and written down on separate sticky notes. All the sticky notes were then collected and organized into groups, depending on their subject, during a discussion between the researchers. The number of such groups found were 24, which in turn were categorized into four larger categories which are *Future of the industry*, *Education and competence*, *The region*, and *Marketing of the cluster*.

One example of this is the sticky note with the quote *"To attract international companies, it is important that there are available housing opportunities" which* was first placed in the group Housing, that in turn together with other groups is included in the category The Region

3.2.2 Method for scenario planning

The list of steps explained by Schwartz (1991) in section *2.6 Scenario Planning*, have been used to define scenarios. But Peterson et al. (2003) suggest, that consistency of scenarios can

be tested with help of experts. Therefore, one additional step has been added, called "quality assurance". This step will ensure that the chosen scenarios are feasible. Below is a more detailed explanation about how the various steps were carried out.

1. Identify focal issue or decision. [done in workshops]

The purpose of VICTA is to develop a cluster within the vehicle electronics and connected services industry. Therefore, how the industry will change in the future of the region was chosen as a focal issue.

2. Key forces in the local environment. [done in workshops]

Together with the interviewees, the key factors have been identified. The respondents were asked to first identify those factors in their local environment, for example in their company or daily work, that they could influence when it comes to the future of the cluster in the region. For example, one of the identified factors was *"to arrange for strategic partnerships with other companies in the region"*. Factors were written on sticky notes.

3. Driving forces [done in workshops]

In this step, respondents were asked to identify driving forces on a regional level that influence the factors that they found in step two. The STEEP-analysis was used to facilitate for the participants to come up with factors. Sometimes it was hard for the participants to understand the task, but it helped when the researchers encourage them to "think out loud" because it led them to brainstorm. One example of a driving force on a regional level was *"the autonomous drive development and rate of acceptance"*. Driving forces were written on sticky notes.

4. Rank by importance and uncertainty [done in workshops]

The respondents were given a large paper with a graph, where the y-axis was marked as Importance and impact, and the x-axis was named Uncertainty. They were then told to place the driving forces in the graph to identify trends (high level of importance, low level of uncertainty) and critical factors (high level of importance, high level of uncertainty). When the participants plotted the factors in importance and uncertainty graph, the axes were not numbered.

5.1 Selecting scenario logics in workshops

Not all respondents had time left for this step, but in some cases, there was time enough to selecting scenario logics. This meant that the critical factors identified in step four were given a high and low value to see if the scenarios that were developed are logic to happen or not. Factors used to develop the scenarios were gathered from results of the scenario planning workshop. There, the factors were presented as trends, critical or neither trend or critical. Scenario logics that were developed in each workshop were discussed with the interviewee, and important thoughts were used when the researchers did this step after all workshops were completed in step 5.3.

5.2 Quality Assurance of factors and scenario logics

After all interviews and workshops had been carried out, the researchers conducted a quality assurance workshop with a group of experts in the industry. There, data from previous interviews and workshops were presented and they were given the opportunity to develop their own factors on both micro and macro level (in other words they did step 2, 3 and 4). This quality assurance workshop resulted in a few more factors that were added to the data. Then, the researchers went through all the data to find the most

critical factors. These were *attractive region* and *rate of development and social acceptance of autonomous vehicles.* A scenario matrix was developed and tested with the experts to see if they had any thoughts about scenario logics. Valuable inputs were later used to define the final scenario matrix.

5.3 Creating final scenario logics (done by the researchers)

As mentioned before, scenarios were developed depending on the most critical factors, and to find them some critical factors were combined. The reason for combining several critical factors into one "meta-factor" was the fact that some factors were mentioned many times, and that some factors aims at describing approximately the same thing but just using different words. Also, the researchers believe that the chosen factors are the most important and interesting among all critical factors identified in interviews. The first chosen meta- factor to use when developing scenarios is *attractive region* where four original critical factors are included; Region is an attractive place to live, housing opportunities, house holding and infrastructure, and housing availability for people moving to the region. The other factor chosen is *testing, development and social acceptance of autonomous vehicles*, and it includes: Autonomous drive development and rate of acceptance, allowing for competitive research by setting the right legal set-up, and testing self-driving cars.

6. Fleshing out the scenarios

Here, the scenarios defined in step 5.3 were defined in accordance to the trends. In each scenario, the state of the cluster in the year of 2030 were described. Employments in each scenario were calculated in chapter *3.2.3 Employment possibilities in each scenario*, and the clusters position in the value pyramid was also determined.

7. Implications

It is up to the actors of the cluster to define a robust strategy, but the researchers will give important inputs on what issues needs to be taken into consideration when developing such a strategy.

8. Selection of leading indicators and signposts.

This step will also need to be carried out by actors of the cluster and is not in the scope of this study.

3.2.3 Employment possibilities in each scenario

Data used for calculations of future employment possibilities in the cluster was gathered from Swedish Statistics (SCB), which is the Swedish statistical institute. Data was found both by extracting information from the web-based tool, and additional statistics that was not available was sourced with help from representatives of SCB. The data can be seen in Appendix B. Since regional level is the lowest level to extract data from SCB, the data concerns Västra Götalandsregionen, and the SNI-codes; *29-30 Transportmedelstillverkning* and *62-63 Dataprogrammering, datakonsultverksamhet och informationstjänster*.

Swedish standard industrial classification, SNI, classify companies after what activity they carry out. However, one company can have several activities, SNI-codes. Standard for the classification of Swedish professions, SSYK, is a system that categorize individuals' professions. First, codes of industries, SNI-codes and job-titles, SSYK were selected and statistics about them extracted from the year of 2008 and forward. Table 2 shows the old system

SSYK 96 converted to the new system SSYK 12. To avoid misunderstandings with the translation, the researchers chose to keep the systems in their original language.

Table 2. The translation between SSYK 96 and SSYK 12

SSYK 96	**SSYK 12**
1236 IT-chefer	131 IT-chefer
1225 Driftchefer inom finansiell verksamhet, fastighetsbolag, företagstjänster m.m.	
1315 Chefer för mindre företag inom finansiell verksamhet, fastighetsbolag, företagstjänster m.m.	
1225 Driftchefer inom finansiell verksamhet, fastighetsbolag, företagstjänster m.m.	134 Chefer inom arkitekt- och ingenjörsverksamhet
1226 Verksamhetschefer inom offentlig förvaltning m.m.	
1315 Chefer för mindre företag inom finansiell verksamhet, fastighetsbolag, företagstjänster m.m.	
1316 Chefer för mindre enheter inom offentlig förvaltning m.m.	
2143 Civilingenjörer m.fl., elkraft	2143 Civilingenjörsyrken inom elektroteknik
2144 Civilingenjörer m.fl., elektronik och teleteknik	
2139 Övriga dataspecialister	2511 Systemanalytiker och IT-arkitekter m.fl.
	2516 IT-säkerhetsspecialister
	2519 Övriga IT-specialister
2131 Systemerare och programmerare	2512 Mjukvaru- och systemutvecklare m.fl
	2513 Utvecklare inom spel och digitala media
	.2514 Systemtestare och testledare
	2515 Systemförvaltare m.fl.
3113 Elingenjörer och eltekniker	3113 Ingenjörer och tekniker inom elektroteknik
3114 Ingenjörer och tekniker inom elektronik och teleteknik	

However, some of the categories in SSYK 12 are not interesting for this study. Therefore, some of them have been left out and the final chosen categories in SSYK 12 and SSYK 96 are presented in Table 3.

Table 3. The chosen categories from SSYK 96 and SSYK 12

SSYK 96	SSYK 12
1236 IT-chefer	131 IT-chefer
1225 Driftchefer inom finansiell verksamhet, fastighetsbolag, företagstjänster m.m.	
1315 Chefer för mindre företag inom finansiell verksamhet, fastighetsbolag, företagstjänster m.m.	
1225 Driftchefer inom finansiell verksamhet, fastighetsbolag, företagstjänster m.m.	134 Chefer inom arkitekt- och ingenjörsverksamhet
1226 Verksamhetschefer inom offentlig förvaltning m.m.	
1315 Chefer för mindre företag inom finansiell verksamhet, fastighetsbolag, företagstjänster m.m.	
1316 Chefer för mindre enheter inom offentlig förvaltning m.m.	
2143 Civilingenjörer m.fl., elkraft	2143 Civilingenjörsyrken inom elektroteknik
2144 Civilingenjörer m.fl., elektronik och teleteknik	
2139 Övriga dataspecialister	2511 Systemanalytiker och IT-arkitekter m.fl.
	2516 IT-säkerhetsspecialister
2131 Systemerare och programmerare	2512 Mjukvaru- och systemutvecklare m.fl
	.2514 Systemtestare och testledare
3113 Elingenjörer och eltekniker	3113 Ingenjörer och tekniker inom elektroteknik
3114 Ingenjörer och tekniker inom elektronik och teleteknik	

3.2.4 Calculating employment

As shown in the Figure 14, there is a difference in employment between SSYK 96 and SSYK 12 that is not shown in the development of the total employment of the region between 2013 and 2014 (see Figure 15). Therefore, it is assumed that the data from SSYK 96 and SSYK 12 does not correspond and some modifications need to be done. Table 4 shows the difference between each category of individual's professions for the two different SSYK systems within the SNI code, *29-30 Transportmedelstillverkning*. The categories that differ the most are *2143 Civilingenjörsyrken inom elektroteknik* and the professions regarding IT *2131 Systemvetare och programmerare*, and *2139 Övriga dataspecialister* (SSYK 96). The reason for this is that SSYK 12 has more categories for some professions, for example *2513 Utvecklare inom spel och digitala media* is included in data from SSYK 96 but not in SSYK 12 since some of categories are new and not included in this study.

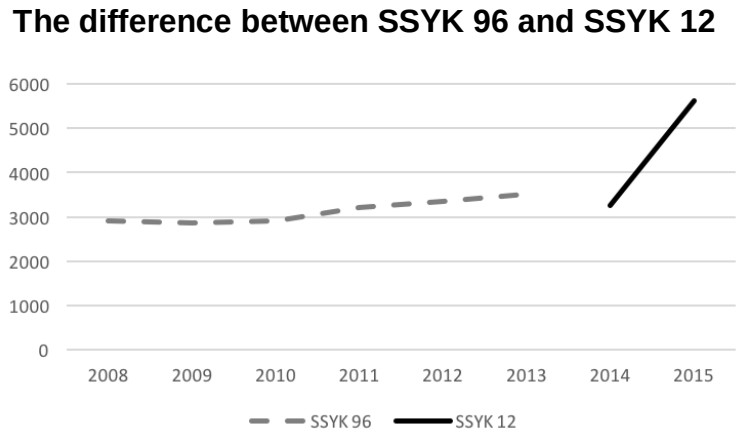


Figure 14. The difference in employment between SSYK 96 and SSYK 12 within the SNI code, 29-30 Transportmedelstillverkning

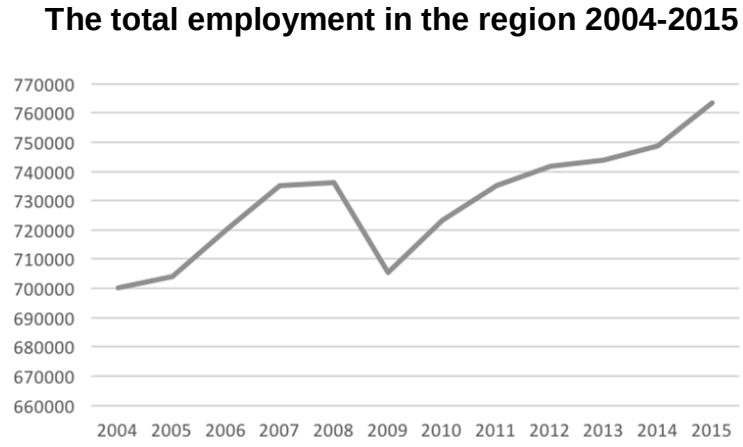


Figure 15. The total employment in the region 2004-2015.

Table 4. The difference in numbers of employees between SSYK 96 and SSYK 12 within the SNI code; 29-30 Transportmedelstillverkning

SSYK 96	Employees -13	SSYK 12	Employees -14
1236, 1225, 1315	118	**131**	60
1225, 1226, 1315, 1316	15	**134**	5
2143, 2144	637	**2143**	353
2131, 2139	613	**2511, 2512, 2514, 2516**	265
3113, 3114	471	**3113**	461

With the above reasoning as a base, the data from SSYK 96 have been slightly modified. The development from 2008 to 2013 have been applied on the data from SSYK 12 in 2014 and new numbers for 2008-2013 have been calculated. With other words, professions such as game developer have been withdrawn from the data from SSYK 96 since it is not relevant in this study. Moreover, the category 2143 Civilingenjörsyrken inom elektroteknik decreased unreasonable between 2013 and 2014 and therefore it was assumed that it was because of the change of SSYK system. Category 2143 and 2144 was merged in SSYK 96 and then the average percent of increase in jobs between 2008 and 2013 was calculated and applied on 2014. See the modified data in Table 5.

Table 5. Modified data.

Modified data	2008	2009	2010	2011	2012	2013	2014	2015
2511	56	57	58	58	59	60	60	121
2143 and 2144	503	516	520	613	583	637	670	2096

The employed persons in the *SNI 2007 code 62-63 Dataprogrammering, datakonsultverksamhet och informationstjänster* are often consultants, which can work in different branches. The researchers therefore had to make some assumptions on how many percent of them are working towards the vehicle electronics and connected services industry. To make this assumption, several consultancy firms in the region were contacted to answer this. However, only two of them answered and therefore this data could not be used. The researchers then made the assumption that 10 % of the employed persons in the *SNI 2007 code 62-63 Dataprogrammering, datakonsultverksamhet och informationstjänster* are consultants working towards the vehicle electronics and connected services industry. Then, the modified data from the two SNI codes; *29-30 Transportmedelstillverkning* and *62-63 Dataprogrammering, datakonsultverksamhet och informationstjänster* were added. With this data as a base, the average percent of the increase per year could be calculated. As shown in Figure 16, there is a large increase of employees between 2014 and 2015 compared to other years.

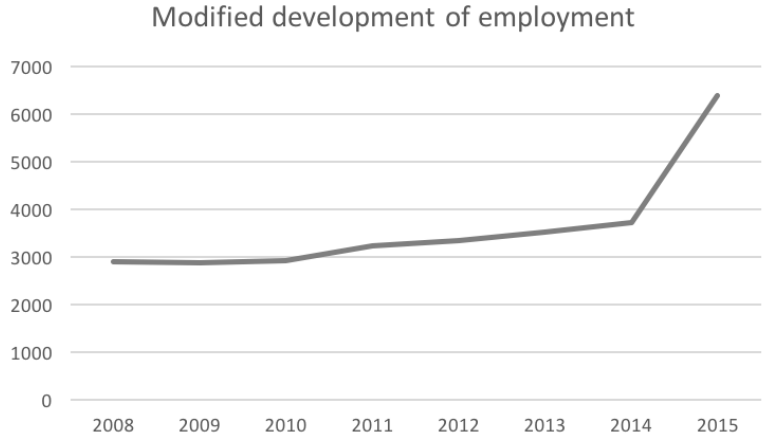


Figure 16. Modified development of employment 2008-2015

To receive a more accurate average between 2008 and 2015, the increase from 2014 to 2015 was not included in the calculation. The average increase per year was therefore calculated as 4,8 % per year. Calculations can be seen in Table 6.

Table 6. Average yearly increase in employment

Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	***2015***
Total number of employees [modified data]	2023,6	2030,5	2063,8	2317,7	2409,9	2550,1	2837,2	*4825,6*
Yearly increase	-	0,3%	1,6%	12,3%	4,0%	5,8%	11,3%	*70,1%*
Average yearly increase							4,8%	

3.3 Limitations

The researchers see a limitation in the number of firms and institutions that were used in the interviews. For a natural reason, not all companies and institutions within the electronics and connected services industry could be interviewed and it means that the researchers mental picture of the industry is strongly influenced by the interviewees' private thinking. Nevertheless, after around 15 interviews, the researchers found that answers from interviewees were no longer surprising or adding any new value to the study, which implies that the final number of interviews was sufficient since data was saturated (Glaser & Strauss, 1967).

However, it must be noted that all interviewees, apart from two, were middle aged men in high positions that had worked in this industry for several years. Many of them also knew each other. Moreover, as the interviewees were selected by, to the study well committed middle aged men, their selection might also have influenced the result of this study. It could therefore be argued that these men's perspective and opinions about what needs to be done in the region is greatly affected by each other.

When the interviewees plotted factors during workshops, the axes had no scale. However, when plotting the factors in the impact and uncertainty graph presented in chapter *4.3 Findings from scenario planning workshops*, each factor had to be given a specific value for the x-axis and y-axis. This is a limitation since the researchers had to estimate the values.

Data collected from SCB used for calculating the possible outcome of employment in the various scenarios is limited in several ways. First, as explained in previous sections, there is a difference between SSYK96 and SSYK12. They contain partly different job-titles and therefore the quantity of employment in the year of 2013 and 2014 will differ somewhat. This difference is not only described by a total increase in the number of employees, but also that the shift from SSYK96 to SSYK12 happened between the years of 2013 and 2014. When calculating an average increase of employments during the selected years, it might therefore be partly influenced by this difference between the years of 2013 and 2014.

Secondly, the new codes included in SSYK12 have only been used for two years, 2014 and 2015, and in addition to this there was a very large increase in the number of jobs compared to previous years between 2014 and 2015. This increase will influence the average increase of employments during the selected years. Therefore, the increase between 2014 and 2015 has not been included in the average increase, which can be seen as a limitation. Thirdly, the assumptions that 10 % of the employed persons in the *SNI 2007 code 62-63 Dataprogrammering, datakonsultverksamhet och informationstjänster* are consultants working towards the vehicle electronics and connected services industry is a limitation since it is an assumption and maybe is an underestimation. The question is if this number would have been for example five or 20 percent instead then it would have a large impact on the demand for employment.

3.4 Trustworthiness

To ensure trustworthiness for a qualitative study, there are four criteria to take into consideration; *credibility*, *transferability*, *dependability*, and *confirmability* (Bryman & Bell, 2015). In this research, *credibility* was guaranteed by triangulation, which was ensured by using two different methods of data collection. According to Shenton (2004), triangulation can also

include different types of informants. In this study, triangulation was therefore also guaranteed by holding interviews with a wide range of employees at different companies and positions within the industry. As mentioned in the limitations, the demographics of interviewees were to an extent similar, but nevertheless, respondents are working in various companies and institutions, and in various positions, which contributed to credibility.

To ensure *transferability*, the used methodology is clearly defined together with the formula used to calculate the employment expectations. Appendices of the interview questions is held available, to enable the possibility of conducting a similar research within a different industry.

The researchers used an auditing approach to ensure *dependability* and therefore all the interviews were recorded. Furthermore, notes were taken during all interviews and later information from recordings was added if something was missed during the point of interview. However, the researchers forgot to record one interview, but still notes were taken so dependability of that specific interviewed could still be ensured.

To guarantee *confirmability*, the procedure was documented during the study, to be able to go back and rethink about the data. The researchers' perception of the interviewee was also noted. Thanks to these notes, it was possible to remember what private view the interviewee had when answering the questions.

3.5 Ethical aspects

According to Easterby-Smith et al. (2015), ethical aspects are crucial to consider when conducting a study. Within research ethics, there are several principles that needs to be considered. These are for example ensuring no harm to participants, respecting dignity of participants, protecting privacy, and ensuring confidentiality.

Therefore, before holding the interviews, interviewees were given the opportunity to leave out confidential data. By doing so, confidentiality problems in the future study could be avoided. Several of the interviewees took advantage of this and wanted to leave out some confidential data. It was also expected that interviewees would answer in a more detailed way if they knew that confidential data would be left out. Thanks to this agreement, the study could generate a better result.

The research participants were given as much information as they needed to decide about whether they would participate in this study. The interviewees were also able to refuse answering, and to ask own questions during the interviews to achieve a clarification of the interview questions. The whole report is made anonymous to make it impossible to figure out who said what. The reason for this is to protect the participants of the study from any harm, respect their dignity and protect their privacy.

4. Empirical Findings

In this chapter, findings from interviews, industry reports, and scenario planning workshops will be presented.

4.1 Industry reports

In this section, findings from industry reports, mainly written by consultancy firms, are to be presented.

4.1.1 Technology trends

Weinelt (2016) in The World Economic Forum White Paper, talks about three digital themes that will drive *the change of value in the automotive industry*. These are the *connected traveller*, *autonomous vehicles* and *digitalization of the enterprise and ecosystem*. *The connected traveller* theme contains infotainment, user-based insurance (for example pay-as-you-drive policies) and multimodal integration (linking all players and seamless connectivity in mobility among the modes). *The autonomous vehicles* theme includes for example assisted driving and self-driving technologies. *Digitalization of the enterprise and ecosystem* contains for example a connected supply chain, digital manufacturing and connected infrastructure (Weinelt, 2016).

Viereckl et al. (2014) uses the term *connected car* and describes six product categories that will be of importance for it. The first product category is *mobility management*, which includes the systems that allows for the driver to reach its destination in a fast, safe and cost advantage way. It can be for example real-time on-board navigation, incorporated in a holistic transportation management. *Vehicle management* is the second category, and are for example on-board information about vehicle or service schedules. In other words, vehicle management are functions that helps the driver to lower running costs and maintenance. The third component is *entertainment*. It has been an important part of the car for many years, for example with radio, smartphone interfaces, Wi-Fi hotspots etc. *Safety*, which is the fourth product component of the connected car, concerns for example more sophisticated versions of warnings to drivers about weather and collision protection. *Driver assistance*, the fifth product category, means technology that can partly or fully take over the performance of the car; driving in highways, parking, speed up and down etc. This particularly product category also concerns autonomous driving, which is surrounded with many legal issues. The last product category for the connected car is *well-being functions.* These are used to keep the driver alert, for example by climate optimization, warning drivers when they are tired, and specific seat functions. In the future of the connected car, the car itself might even be able to monitor the heartbeat of the driver (Viereckl et al., 2014).

McKinsey and Stanford University (2016) claim that *digitalization and new business models* will, in the automotive sector, drive four disruptive technology trends; diverse mobility, autonomous driving, electrification, and connectivity. For example, the car will thanks to connectivity become a platform for its passengers. Instead of driving, they can use their time for more personal activities. Additionally, vehicles will need to be upgradable due to the high speed of innovation in software-based systems (McKinsey & Stanford University, 2016). Nevertheless, Viereckl et al. (2016) say that it is unlikely that vehicles of the future will take their place on streets and highways for the next 10 to 20 years. But, there are enough of innovations to already transform vehicles. Cars will have new levels of connectivity amongst

them, which in turn enables the development of services inside and outside of cars. Weinelt (2016) states that the new technologies have accelerated business model innovations that challenge the traditional value chain in the automotive sector, by extending it with offering new products and services.

McKinsey and Stanford University (2016) talk about a paradigm shift from traditional mobility towards mobility as a service. At the same time, Viereckl et al. (2016) explain that connected vehicles will contain a full range of technologies and services. *Consumer services* will include internet and cloud based digital services, enhancing the driving experience. Also, functions called *connected car package,* will contain features to manage the car's operations. Moreover, these packages will be offered to retail and commercial buyers as bundles. The systems that underlies consumer services and connected car packages will be the *supply-side technologies* which connects the car to the outside world.

4.1.2 Challenges for the traditional automotive sector

The industry's overall competitive landscape will face an increasing complexity thanks to companies like Uber, Apple, Google, and Tesla (McKinsey & Stanford University, 2016; Accenture, 2014). Weinelt (2016) describes that it is the digital transformation in the automotive ecosystem that is allowing non-traditional, technology-based companies to enter the automotive value chain. It results in a growing challenge for the business models of OEMs in all parts of the value chain. The Economist (2016) explains that companies like for example Uber, that concentrate only on personal transport, does not have any car manufacturing to protect unlike traditional carmakers. This lowers the risk for them to enter the industry.

Weinelt (2016) adds to the discussion about how shifts in the industry will disrupt business models, and state that existing players need to revaluate their businesses. Areas of consideration should be the company structure, skills of employees, hiring practices, collection and analyzation of data, and how to form partnerships inside and outside the ecosystem. Adding to this new complex arena for the traditional automotive industry, one of the most important factors that will differentiate the industry even further will be software competence (McKinsey & Stanford University, 2016). Both carmakers and suppliers must improve their transformation capability since their current innovation rate is too slow to keep up with new players entering the field. It will be especially important in areas of new technology capabilities, piloting and launching new products, and overcoming legacy mind-sets (Viereckl et al., 2016).

Viereckl et al. (2014) states that back-end and front-end integration is a challenge that the automakers must face in the future. They must think in new ways about IT-departments, because IT will shift from being an internal function towards playing an operational role. For example, IT will build the important systems that enable connected cars. Viereckl et al. (2014) further say that the integration of back-office technology with the technology developed for cars will be a critical capability, but probably a costly one. Furthermore, important capabilities for the automakers to fulfil must be interfaces that are safe, intuitive and user-friendly. To achieve it, automakers must compete with consumer electronics companies that has already achieved such an interface. Another important challenge to be aware of in the future of OEMs is to easily and in a coordinated way merge several different technologies together (Accenture, 2014).

McKinsey and Stanford University (2016) say that this shift towards mobility as a service along with new entrants to the market, will force traditional OEM's to compete in new areas.
Previously, supply-side technologies have been provided by traditional suppliers in the automotive industry (Viereckl et al., 2016). But in the future, these systems will be provided by new technology companies, or carmakers if they can integrate vertically fast enough. Suppliers in the automotive industry will shift their main income from engines, chassis and interiors, towards electronics, software and cloud services. Batteries will also be of great importance. In line with this thought, KPMG (2017) claims that the number one trend in the year of 2017, is the battery electric vehicle. Suppliers of these types of electronics and technologies will benefit from strong growth in volume, together with high margins from such sophisticated components (Viereckl et al., 2016).

4.1.3 Collaboration

Securing connected vehicles for the future must be a collaborative effort, due to the many players involved. In this collaboration, OEMs are suitable to lead the work but at the same time they must be willing to take responsibility for the task, meaning held accountable when things go wrong (Viereckl et al., 2016). Accenture (2014) adds to this discussion by saying that cooperation between main players in key industries (automotive, telecommunications and electronics) is of importance for the connected vehicle to become a reality.

To foster ecosystem collaboration, Weinelt (2016) recommends that municipal codes and national regulations should be viewed as possibilities, rather than barriers, for collaboration. The reason is that regulations are common for all players in the industry and is thus an opportunity for collaboration. With the help of both municipalities and strategic thinking and planning, organizations can create partnerships and learn how to collaborate in new ways. Innovation will also be stimulated by these types of strategic collaborations, for example finding new business models thanks to sharing data and experiences (Weinelt, 2016). Furthermore; OEMs, telecommunications operators, consumer electronic firms, and software & application developers all contribute to the development of a robust ecosystem, creating an environment which stimulates in-vehicle innovation (Accenture, 2014). New business models together with cooperation between players in the industry, facilitate business-to-business services. A standard platform, where third-party service providers can develop their own solution, will support this type of cooperation.

4.2 Findings from interviews

In this chapter, findings from interviews are to be presented as a compilation of answers from interviews The collected information is categorized as future of the industry, education and competence, collaboration, the region, marketing of the cluster, and direction of the cluster. The categories with their major findings can be seen in Table 7 as a summary.

Table 7. A summary of the major findings from the interviews

Category	Major findings
Future of the industry	– Both industry reports and the findings from the interviews agreed on the following trends: – Autonomous vehicles – Electrification – Connectivity – New business models
Education and competence	– Need for software engineers – How to attract international companies and competence – Attracting young people to engineering is important for the development of the cluster – The need for key individuals in the cluster
Collaboration	– Lack of collaboration between large and small firms – Fear of sharing technological knowledge – The need of initiatives for collaboration on a pre-competitive level
The region	– The need for an attractive region in order to attract national and international companies – The importance of available housing – Rules and regulations can sometimes force employees to move back to their original countries
Marketing of the cluster	– The need for more marketing, for example branding
Future direction of the cluster	– The cluster does already have high competence in integrating systems and therefore this can be a future niche – There are already several testing projects and facilities in the region and the interviewees see high potential in this area

4.2.1 Future of the industry

Three major trends for the future of the industry were identified from the interviews; *autonomous vehicles, electrification*, and *connectivity*. *Autonomous vehicles* are already present in the cluster by the DriveMe project, which is a pilot project with 100 self-driven Volvo cars driving in Gothenburg. The project is a common initiative from Volvo Car Corporation, Trafikverket, Transportstyrelsen, LSP and the City of Gothenburg. According to some of the interviewees, the cluster is quite far ahead in the development of autonomous vehicles. In addition, even if DriveMe itself is a small project, it has given the region great publicity and has been noted around the world. However, one interviewee stated that the DriveMe project has given more publicity than it actually deserves.

A couple of the interviewees believed that there is a strong trend within the industry to shift from combustion engines to *electric* ones. According to them, several advantages can be seen with an electric engine. For example, it is much cheaper to manufacture and it has shorter lead time. Another reason is that electrified vehicles contribute to lower emissions. However, some of the participants say that there is a limited amount of battery development in the cluster.

Connectivity is another trend foreseen by respondents, which customers have already been able to try. Now, it is possible for customers to download system upgrades to vehicles by themselves, and thus upgrades do not have to be carried out by the maintenance personnel. However, there are many speculations of what additional services the connectivity will bring. All respondents agreed that vehicles will contain more software, but some stated that one must not forget that

there still needs to be high quality vehicles from a hardware perspective. Furthermore, the vehicle will become a platform for software and the expectation is that the platform should be an open source software. With other words, vehicles will to an extent function as today's smartphone, which also enables downloading of applications for a more personal usage.

"To 90%, it [the car] will be software, algorithms, computers, sensors, radar, cameras, laser sensors and many other technologies"

In addition to the three major trends in the future, the interviewees mentioned several other technologies that will be important. The complexity of the vehicle will increase. Sensors, radars, cameras and laser sensors etc. will be important technologies for the autonomous vehicles perception of the world. To test that the vehicles perception is corresponding to the real environment, programming threat assessments and methods for simulating conditions, like for example rain, becomes a crucial part of the development in the future. Rules about camera surveillance could therefore be a risk in the development of autonomous vehicles and it is important that the industry and the government are collaborating around this question.

A couple of the participants believed that artificial intelligence will be an important area in the future. Consequently, employees with competence in the area will be needed. One example of where artificial intelligence will play a huge role is in autonomous vehicles, when the car will act on its own data. In addition, autonomous vehicles will both store and exchange a vast amount of data of how they perceive the world. One interviewee stated that vehicles will become data centres on wheels. Therefore, the industry will request engineers that can manage big data.

One respondent drew the picture in Figure 17, explaining how the value pyramid in the automotive sector will change. Traditionally, the OEM is closest to the customer in the value chain, thus benefiting from high returns. In the future, this value pyramid will change. Then, the service providers will be closest to the customers and thus OEMs are no longer the ones with highest profit. The position of OEMs and traditional Tier 1 will move down and give space for new entrants. This will be a huge challenge for OEMs and Tier 1; if they do not find ways to incorporate operating systems and services to their offering to customers, they will probably lose a lot of money.

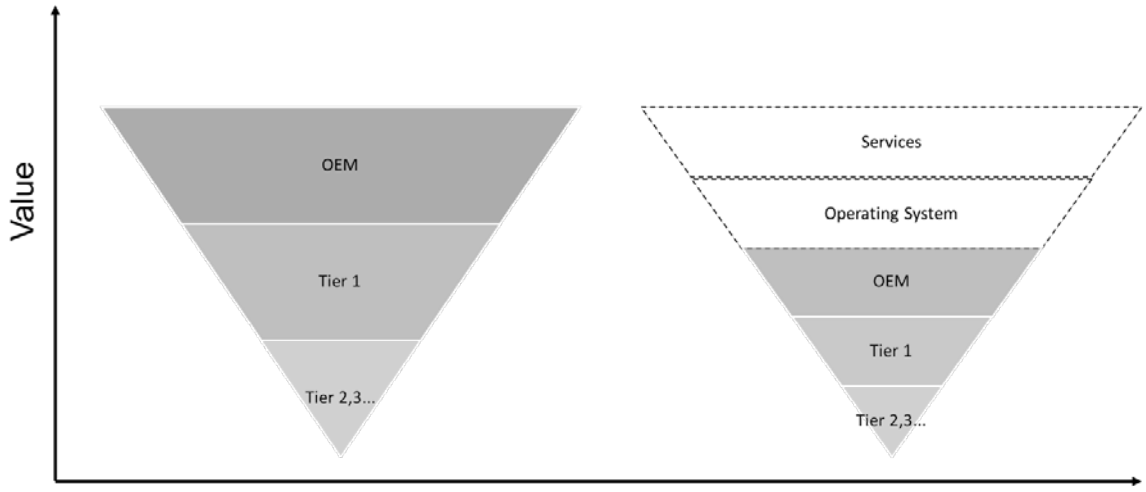


Figure 17. The current and future value pyramid of the vehicle electronics and connected services industry (inspired by Jonas Tisell, 2017)

These changes to the industry will consequently affect companies working methods and their business models. One participant believed that more and more companies realize that they do not possess all the necessary competence by themselves. As a result, it is expected for larger organisations to take over smaller companies or startups with certain expertise. Also, more collaborations like joint ventures will occur. For example, two of the large actors in the region, one OEM and one Tier1, have started a joint venture which will focus on creating a platform for a new operative system. Shared business models are mentioned as a future trend by several interviewees and they believed that customers will not own their own car, instead mobility services will appear and be used to a greater extent.

"We will not own our own car, and it will only need to exist 1/10th of cars compared with today, and we must deliver mobility services"

Previously, the industry has focused almost solely on selling products, however, mobility services will according to one participant change this mentality. In addition, customers usually purchase products that they need at one single point in time. In the future, this buying pattern will change towards buying over time instead. The business model for how suppliers deliver goods will also change completely as a result from above mentioned trends.

4.2.2 Education and competence

There is consensus among many of the respondents that Sweden has a unique position in the automotive industry. Even though it is a small country considering inhabitants, Sweden is the home of many various types of firms and institutions connected to the industry. It means that in Sweden, firms and institutions are working from research and development, all the way towards the production of vehicles, which gives Sweden a considerable advantage towards other countries. In the region, the main universities Chalmers University of Technology and Gothenburg University, are working together with research institutes and firms to develop new technologies to the emerging vehicle electronics and connected services industry. One example of this is the ElectriCity project, which is an electric bus driving through Gothenburg between the two campuses of Chalmers University. Respondents believe that it is vital for the region, in particular for the city of Gothenburg, to keep its research about the automotive industry, and in particular for the vehicle electronics and connected services industry. There could be a potential risk for the automotive sector if research decreases or even if research stops, since the main OEM's might then choose to move their production and development elsewhere.

To facilitate that research and development in the region continues to have a focus on the automotive industry, the right education must be available. This is a strong belief amongst the respondents, and was brought up in every interview. The industry is currently in need of software engineers and behaviorists, and the need will grow even more in the future. The need for knowledge in the social area will, according to some of the respondents, grow along with the growth of autonomous features of vehicles. It will support knowledge creation around how drivers respond to changing experiences, for example when the car turns and breaks autonomously.

"We have a common challenge to solve, that it is not that geeky to be an engineer"

Nevertheless, a great deal of the interviewees, apart from representatives from one larger company, felt that there is a gap between available workforce and open positions when it comes to engineers. A strong belief is that youngsters are not interested enough in software engineering

or other engineering subjects, which lead to fewer engineering students. One respondent even mentioned this as a common challenge for all companies in the cluster, and a possible subject to collaborate on. Also, Chalmers University must attract more students to their educational programs. But, as one respondent makes clear, it will not be a good solution to only increase the number of places in programs, since it might lower the quality of the education.

"We must inform young people that this is an exciting and cool industry, and that it contains all possibilities"

Furthermore, a common view in the industry is that available engineers, mostly software engineers, are hard to find and attract to the automotive sector. One reason could be that it is not traditionally a sector where software engineers see their future.

It becomes apparent that the respondents believe that employed engineers lack knowledge about business and sales. Competence in these areas become more important since the automotive industry is undergoing some major changes, and engineers must start to understand how their work is influencing the businesses of both the company where they are employed, and the cluster.

For the development of the cluster in the region, some respondents said that many people underestimate the importance of a few leading key individuals who develop the cluster forward and create new initiatives. These key individuals must lead the work of developing the technologies needed in future vehicles. Moreover, they can also promote the cluster in their daily work.

4.2.3 Collaboration

When asked about what collaboration means to them, and how they practice it in their daily work, interviewees answered in a coherent way, rather independently of their background. Many choose to view collaboration as the process to talk to other companies and share knowledge and experience. One participant thought that an important aspect is to meet in real life and not let all communication happen virtually. This because it helps to find new innovations and develop new ideas together. Several of the respondents share the idea that companies and institutions in the region are already collaborating to a certain extent.

When asked about how collaboration occurs between companies, many respondents said that it is usually the personal networks that is the driver for collaborations. When people have met before, for example previously working in the same company or working together in the same projects, they develop a certain level of trust for each other. It also creates a knowledge amongst people whom to contact when they have certain needs or want to start a collaboration. One reason for this is according to some respondents that the region is quite small and therefore you tend to meet the same people on networking events etc. Many companies are also located inside or near LSP arena, and thus can benefit from other companies that they meet there. LSP views itself as a cluster organization and has proven to be the reason for why companies locate their facilities in Gothenburg. There are also several funds and other institutions that can provide capital to collaboration projects, which company representatives believe are widely used.

"It is important that company leaders make decisions that not only benefit themselves, but acknowledge the ecosystem around them and make decisions that benefit smaller companies and startups around them"

According to interviewees, collaboration between large and small firms is of great value for the cluster. It is important that leaders of larger companies consider the ecosystem around them when they are making decisions. They must not only make decisions that benefit the own organization, but also that support small companies and startups in the region.

"We have been taught to mistrust each other; 'There are no legal bonds in place, then I will not have the courage to share anything'"

"It is hard to initiate projects because sometimes the time runs out before legal contracts are in place"

Nearly all representatives from large firms stated that they feel part of a cluster but respondents from small companies did not share the same feeling. Many respondents believe that collaboration with startups and small firms is a major cornerstone of the cluster. At the same time, several respondents often felt that this is an area where the region lacks. There is not enough of collaboration between larger and smaller firms at the moment, which can be a potential risk for the development of the cluster. A reason for this, mentioned many times in interviews, is the larger firms' bureaucracy and demand for a certain level of security around collaborations. They must for example always have specific legal bonds, and they do not often collaborate with companies that are not their direct suppliers. One respondent even gave the example that a project can sometimes run out of time before the legal contracts are in place and that legal contracts can take several months to establish. For a startup, this can be devastating.

Respondents from some of the larger companies state that they need to be better at experimenting and give up projects that do not prove to be profitable. Often they only focus on projects that are proven to be successful, but this mentality does not foster collaboration. Instead, it tends to make larger companies always go with the "safe" option, which does not stimulate new innovations. Adding up to this, there is usually no culture of creating startups or spin-offs when the company decides to reject an idea that is not their core business, but could be useful and successful for someone else in another context. It can lead to many great ideas being rejected and never used.

Furthermore, many interviewees mention that it can sometimes be difficult for companies in the cluster to collaborate if they are competitors. This, since employees are rather scared of crossing the thin line towards breaking the law, for example divide markets between them and setting product prices that will benefit both parties. One problem can be that lawyers on each company associate the word collaboration with breaking the law, and thus the company culture becomes anxious about collaborations. "Not invented here" mentality is yet another risk that can threaten collaboration in the cluster according to respondents. It can, in some cases, exist a fear of sharing technological knowledge and competence between companies.

To facilitate a better collaboration culture between companies and other parties in the region, respondents mention many ways of how the working methods must be changed or developed. One respondent mentioned that employees at all levels must understand that learning from others and sharing knowledge over company borders will both create better innovations and facilitate a better working environment for all involved companies and institutions in the cluster. Another interviewee said that a cluster organisation must in some way work with different gaps in the cluster, and this works should be supported by local authorities. Many of the respondents think that the automotive industry is undergoing major changes and that the region might need to do this transition in a conscious way. It will not happen by itself, and

therefore can a cluster organisation facilitate a smoother transition. One suggestion is that the cluster should become an acknowledge place for testing new technologies, for example autonomous driving. Another example is the need of a function that can help companies and institutions to apply for European Union financed projects. Currently, this process demands a lot of administrative work, that especially startups do not have time for and therefore hinders them to apply for this funding.

"It is ironic that Gothenburg is one of the most hostile cities against cars when the city is dependent on the car industry."

Furthermore, the respondents thought that there is a lack of innovation strategies from the VGR. One reason for this can be that the traditional role of VGR has been to work with companies that are in a crisis. Working with new technology is thus not something that the VGR is used to do, which requires a faster way of working than before. At the same time, VGR wants the industry to develop a plan for how areas of technology can be developed in the region. This can help VGR to change their way of working to support such development.

"It would be good if companies and institutions could land in an industrial plan for how areas of technology can grow, so that we as local authorities can change and improve our working methods…we must know what parts of the value chain that we want to and are able to keep."

Another area of collaboration for the cluster according to respondents, would be how to attack a specific market, not only specific products. Some of the respondents indicated that many collaborations concern a specific product, for example autonomous vehicles. But instead, the collaboration could be to investigate the market for autonomous vehicles, to see what challenges lie ahead in the future which need to be solved jointly. It becomes evident that it will be vital for parties within the cluster to identify challenges and areas which are pre-competitive, to find tangible projects where to collaborate and start working together. VGR should for example, in accordance to several respondents, create some type of initiative where firms and institutions can both initiate and find such pre-competitive projects described above. Such an initiative would improve the communication process between companies that might not have worked together before, since they then could find each other more easily.

One respondent gave the example that companies and institutions in the region could create and finance a sort of database with competencies in the region. It can be organized in such a way that it collects current and future project ideas, together with people and competencies linked to those projects. Thanks to this database, companies can "borrow" people with specific competencies from each other, and thus giving another way to collaborate. It would not only facilitate the right competence to be used to its maximum potential, but also facilitate that persons can move between companies and make a career. It will in turn create networks between people so that they can more easily contact other companies and start collaborations.

The same respondent also gave an example of when one large company within the telecom industry had to let several hundreds of people go, they then they called another large company in the region to give them the opportunity to employ these people instead. Another example of this type of resource utilization was when a national OEM had to close for some years ago, and the people that lost their jobs could use their competence in starting another OEM in the ashes of the old one.

4.2.4 The region

Almost all respondents highlighted the importance of an attractive region to attract national and international companies to the region. One of the interviewees suggested that three factors is needed for it to become an attractive region. Firstly, the cluster needs to be strong and successful. Secondly, the region has to offer an education with high quality, more specifically offer an international school competitive on a global level. Thirdly, the cluster needs to promote that employees can have good work-life balance, and that free time is as important as work. Another participant stated that the region must actively work to be an attractive place for individuals to live and work in, since it will lead to more companies wanting to establish their businesses there. Also, if the cluster offers challenging and stimulating working tasks and interesting projects, employees from other geographical areas are more likely to move to the region. Moreover, it is crucial to persuade international students to stay in the region after they have graduated. By having an attractive region, the chances for them to stay increase.

All interviewees point out that housing is a crucial part for the cluster's development. Neither national or international companies want to establish in the region if it is difficult to offer their employees housing. In addition, it is difficult to get newly graduated students to move to the region or stay there if there are no housing possibilities. Thus, companies in the region will have a smaller range of people to recruit from, which most likely will decrease the quality of the employees. One respondent believes that the region needs to take care of the high level of immigrants in a better way and adjust them culturally, which hopefully lead to more competent people to recruit from.

Another factor that is hampering the development of the cluster is rules and regulations. Some respondents state that when people need to move back to their original countries due to regulations. It can hinder international individuals and companies to establish in the region. Another aspect for international companies to overcome is the language barrier. However, some of the interviewees state that employees and companies in the region use English as working language most of the times.

Almost all the interviewees agree that the industry is in a successful phase right now but is impeded of the lack of working force. Therefore, it is high competition between companies, not only in the vehicle electronics and connected services industry but in all industries, for working force, especially of software engineers. The participants gave some suggestions of how to solve this problem. One person proposes that the cluster needs to get more girls and women interested in software to widen the range of people to apply for educations within software. In addition, more women should be included in management teams and boards to create a better composition of diversity. Another interviewee suggests to broaden the recruitment of students to persons that usually do not apply for higher education. This is crucial since one of the respondents states that the number of applications need to be at a certain level to keep high quality of the education.

4.2.5 Marketing of the cluster

During the interviews, many of the respondents talked about that the cluster should market itself so that it becomes attractive for both national and international companies in the vehicle electronics and connected services industry. In some interviews, opinions about the marketing made by Business Sweden to market Sweden and the region came up to the surface. It seems like respondents are not satisfied with Business Sweden and therefore it might need some

improvements. One respondent thought that the reason is that they do not have industry knowledge and thus does not know how to market the cluster.

"We must lose our Swedish mentality and be better at telling the world that we are good at this!"

A common view was that there is a high level of competence in the cluster but that resources are spread out. Therefore, it is vital for parties to come together and show what is specific for the region and what benefits can be utilized if located here. In addition to this, many participants also stated the need to overcome the Swedish mentality of being humble and quiet, and instead have a mentality that says "we are best" and work actively to spread the word about the cluster. Nevertheless, opinions about how this work should be done differs between interviewees.

There were many examples of how the marketing activities of the cluster could be organized discussed during interviews. Some respondents believe that the cluster must market itself through various types of social media. Here, a logo and a name for the cluster could be used to "spread the word" about what competencies can be found and utilized in the region. Also, presentation material should be developed that can be presented to visitors to the region. One respondent even mentioned that it would be preferable to welcome visitors during spring and summer to show the best side of the Gothenburg area. VGR can also actively work with marketing by hiring personnel that work as communicators. It can be their responsibility to both nationally and internationally market the region and the cluster. Representatives of the cluster must also be present at various types of conferences and trade shows to make sure that they compete with other clusters in the industry. Also, it is important that representatives for companies in the cluster are taking part of CHARM to interact more with students, which is Chalmers student union's career fair, held in February each year. One of the respondents said that his/her company does not have the tradition of attending CHARM.

The information that is spread when marketing the cluster must not only contain industry specific competencies that can be found in the region, but also focus on other important areas of interest for attracting companies. For example, if a company should move its facilities to the region, then it must know that the employees have somewhere to live, that their children can be offered a good education at high quality schools, that their partners can easily find jobs etc. One thing that came up in many interviews is that the cluster must, when attracting international competence, market the "way of living" in Sweden; that you do not live for your work and that there are many opportunities for hobbies, spare time and outdoor life, that the air quality is good compared to many other places, and that it is a stable and safe society to live in.

But, of course, not all respondents believed that marketing is an important issue for the cluster. Some believe that marketing activities barely needs to be carried out, since Volvo Cars and Volvo Group act like "magnets" that automatically attract engineers and other competencies to the region.

4.2.6 The direction of the cluster

When the interviewers asked what expertise the cluster possesses and what excellence it should develop in the future, almost all of the respondents answer that the ability to integrate systems make the cluster unique and successful. Other areas where the interviewees believe that the cluster has a high level of competence are system technology, signal processing, safety, autonomous driving and production technology.

"We are not good at anything specific but we are good at integrating systems"

A risk for the cluster is if one of the major actors move its development department outside of the region. To cope with this risk, one of the interviewees believes that a stickiness needs to be created in the region so that companies located there are connected geographically to the area. For example, it should be beneficial for IT-companies to operate in the region, even though traditionally IT-companies are not bounded to any geographical area due to their flexibility. Stickiness can be created through locating test and demo areas in the region, for example similarities to Asta Zero, which is a technically advanced test site, located outside of Borås.

4.3 Findings from scenario planning workshops

Appendix C shows all factors that were brought up in the scenario planning workshops conducted during interviews, which can be read about in chapter *2.6 Method for scenario planning*. In Figure 18, factors in the upper left corner are trends, factors in the middle are neither trends nor critical and factors in the upper right corner are critical. Also, the factors are sorted according to the STEEP model; social, technological, economic, environmental and political factors.

The most critical factors will be used together with trends, in chapter *6. Scenario Planning*, to create scenarios and describe scenario logics. The factors are plotted in Figure 18, with different figures depending on their belonging in STEEP. The figure shows that none of the STEEP-categories stand out and all of them are present in both trends and critical factors. Therefore, a conclusion can be drawn that the participants of the workshops found factors within all categories of STEEP.

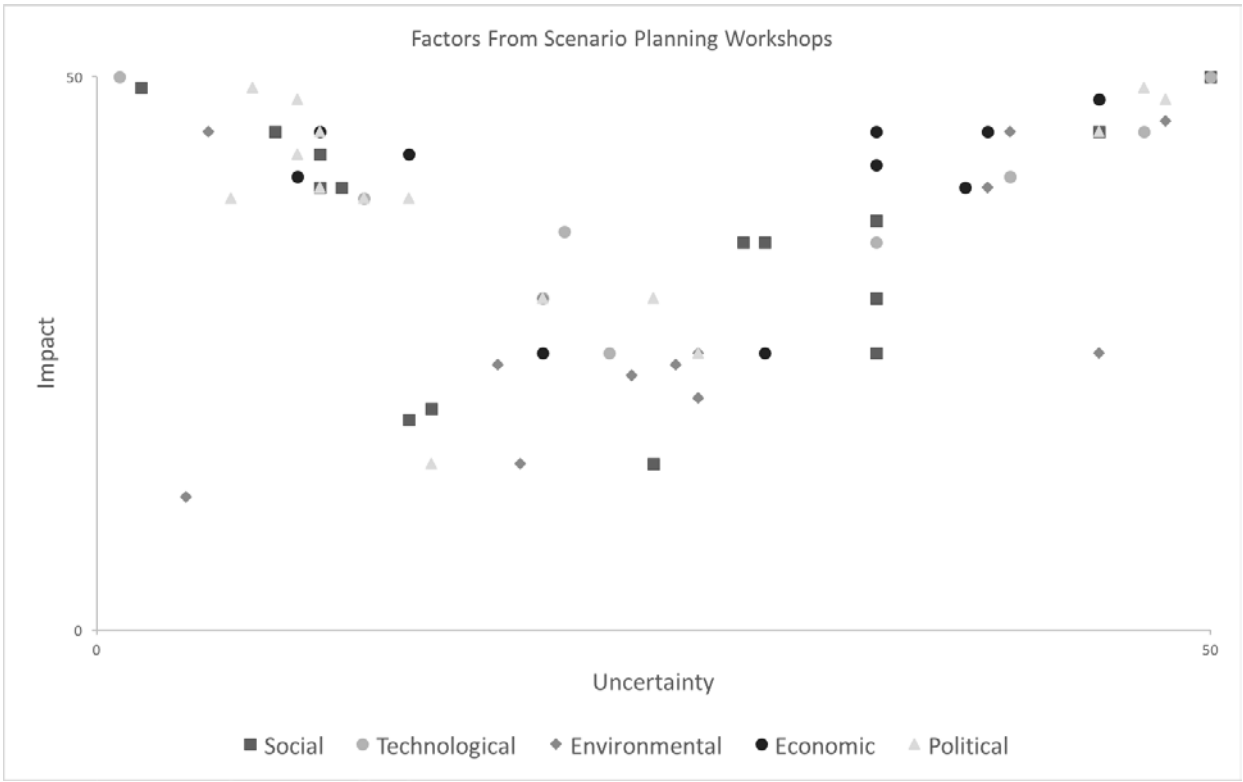


Figure 18. Factors from scenario planning workshops

5. Discussion

In this chapter, findings from interviews and workshops are to be discussed in accordance with presented theory and findings from industry reports. The aim for this discussion is to find similarities, gaps and identify other interesting views about the future of the cluster.

According to the researcher's own definition of clusters; *"A cluster refers to geographically co-located businesses and institutions, collaborating and sharing technological knowledge within related industries"*, it can be concluded from interviews that companies and institutions within the vehicle electronic and connected services industry in the region form a cluster. Actors are co-located, collaborating, and sharing technological knowledge within related industries, for example with the traditional automotive industry and telecom industry.

5.1 Triple helix

As mentioned in the theory chapter *2.1.6 Triple helix*, the triple helix consists of three components; *university, government* and *industry* (Etzkowitz & Ranga, 2013). The University of Gothenburg and Chalmers University of Technology are included in the *university* component. Local authorities such as VGR and the City of Gothenburg are referred to as the *government* and the *industry* is the vehicle electronic and connected services industry. Findings from interviews indicates that the relationship between universities and industry is the strongest one, considering several successful projects between research and industry. Moreover, the relationship between industry and government is perceived to be the weakest one due to lack of trust between these actors. For example, VGR has requested a plan from the industry for how technology should be developed, which can be read in chapter *4.2.3 Collaboration*.

In section, *Configuration in a triple helix system*, Etzkowitz and Ranga (2013) are discussing about different configurations of the triple helix system; *statist, laissez-faire* and *balanced*. Together with findings from interviews, the triple helix system in the cluster seems to have a combination between a *laissez-faire* and a *balanced configuration* but mostly towards balanced. The reason why the region could be viewed as a laissez-faire configuration is that the government to some extent seems to take the role of a regulator. Also, the government's collaboration with university and industry appears to be limited. However, Chalmers Venture, owned by Chalmers University, has taken a strong role of providing support and funding to encourage entrepreneurial ventures, which is usually an activity of the industry. This is one evidence of that the triple helix system in the cluster has a balanced configuration. However, the cluster should strive towards becoming even more balanced in its configuration. This, since a balanced configuration creates the most beneficial environment for creation of innovations. The government needs to be more involved for this to happen and one suggestion is that VGR should take the initiative to create concrete projects where all the components within the triple helix system can collaborate.

Schutz (1964 in Etzkowitz & Ranga, 2013) discusses the role of the entrepreneurial scientist in a triple helix system. This person can for example take a leading role in the formation of spin-offs. An entrepreneurial scientist is needed in the cluster since several of the interviewees state that there is a lack of culture in the region for creating start-ups or spin-offs. By having such a person in the cluster, more innovative firms can be formed.

In the theory chapter, *Activities in a triple helix system*, Etzkowitz and Ranga (2013) state that technology transfer is one of the key components in a triple helix system. In the region, such

transfer of technology is limited since many of the competing companies are afraid of breaking the law when collaborating, as can be read about in chapter *4.2.3 Collaboration*. Nevertheless, in order for universities to be involved in the technology transfer, negotiator elements need to be created such as science parks. LSP is one example of a negotiator element, that enables the university's involvement in technology transfer. It has a positive effect on for example economic growth (both on national and regional level), funding for research labs, and job creation. According to interviewees, the cluster seems strong in this area since the opportunities for the academia to test their expertise outside the universities are quite sufficient. One example is ElectriCity, which can be read in *4.2.2 Education and competence*.

Collaboration and conflict moderation is another type of interaction in the triple helix system discussed by Etzkowitz and Ranga (2013). It is important since it can convert conflicts and tension into common interest, where an innovation organizer plays a crucial role. The innovation organizer will bridge gaps between actors and find new ways for knowledge creation. According to the researchers of this study, this concept is very similar to bridge builders, cluster organizations and cluster facilitators. According to Sölvell (2015), bridge builders act as the sixth actor in the cluster. Cluster organizations can act as a bridge builder and play the role of connecting different actors of the cluster and increase the awareness of the cluster. In addition, the cluster organizations arrange meeting places for different actors of the cluster, to discuss common issues and create new projects across the gaps discussed further below. Ingstrup and Damgaard (2013) define cluster facilitators as individuals that are coordinating the cluster's development by promoting collaboration and sharing activities and resources with the actors of the cluster. Also, the interviewees discussed the importance of a cluster organization that can facilitate a smoother transition in the changes of the automotive industry. Since these types of individuals are mentioned multiple times by different researchers and interviewees, it is assumed to be an important part of the cluster's development. Therefore, an individual or an organization needs to take this role in the cluster of the vehicle electronic and connected services industry. The role of the facilitator will be further discussed in the section *Facilitator roles*.

Etzkowitz and Ranga (2013) discuss the role of networking in the triple helix system. According to the interviewees, several meeting places exist in the cluster. This leads to a lot of networking and that many of the individuals in the cluster know each other well. However, when the researchers asked the participants what projects or innovations these networking activities have resulted in, no one had a concrete example. The conclusion of this is that the meeting places need to be utilized better by discussing concrete potential projects.

In section, *Functions of a triple helix system, knowledge, innovation* and *consensus spaces* are discussed by Etzkowitz and Ranga (2013). The purpose with the *knowledge space* is to create knowledge resources or relocate existing ones in order to improve and distribute the knowledge base regionally, nationally or internationally. This goes in line with what some of the interviewees said about that it is common for employees to change jobs between companies in the region. The result of this is that the knowledge base spreads regionally. The *innovation space's* purpose is to develop local innovative companies, attract talented employees and innovative companies from elsewhere, and create a competitive advantage for the region. This is something that is crucial for the development of the cluster and one of the problems that the cluster is currently dealing with. It is important since it will make the cluster grow and help it become competitive. To achieve *consensus*, all the actors should feel like they are part of a larger whole, which is also mentioned by Porter (1998) in the section, *2.2.2 Relationships between actors*. Depending on which of the interviewees the researchers have talked to they

have received different answers. The larger companies believe that they are part of something bigger while participants from the smaller companies do not share the same opinion. However, it is important that the cluster works towards achieving more consensus by collaborating more, especially both large and small firms. Achieving consensus in the cluster includes defining a common goal for all the actors.

5.2 Actors in the cluster

In chapter *2.2.1 Actors of a cluster*, Sölvell (2015) talks about six actors inside the cluster, and two external actors. For the vehicle electronic and connected services cluster in the region, these actors have been identified. There is a variety of firms, both larger international companies as well as smaller technological companies and startups. Research organizations and laboratories, and education are also present in the cluster, for example via the universities and testing facilities for autonomous vehicles. Capital providers exist to an extent, but during the scenario planning workshop, the participants expressed a need for more and fair funding in the region. Some respondents for example said that the automotive sector does not have as high priority as other sectors in the region when it comes to funding, which could be a proof of this. The regional government is highly present through VGR, as well as some located bridge builders. For example, LSP view itself as a cluster organization. Nevertheless, interviewees have expressed the need for more interaction with other markets and other clusters, which can be a proof of lack in these areas. In other words, actors in the cluster have a great potential to improve its use of both strong and weak ties in its networks.

As McEvily and Zaheer (1999) explain, a network of ties to external actors and institutions can expose the company to new ideas and opportunities that can lead to competitive advantage. Therefore, the same should be true for a cluster, that a network of ties to external actors and institutions can expose *the cluster* to new ideas and opportunities, leading to competitive advantage. However, as can be seen in section *2.6 The concept of strong and weak ties*, there is evidence that both strong and weak ties can be used for these purposes. Strong ties are evident in the cluster since people are, according to interviews, moving between firms and meeting each other at various events. These ties can therefore be seen as links between companies and institutions within in the cluster. Furthermore, weak ties toward other clusters must be used to a greater extent for the cluster to be competitive. This is crucial since the industry is changing in a rapid way, which means that new ideas and innovations are even more important. Examples of how the cluster can take advantage of weak ties to other clusters are for example by inviting representatives to events and conferences and then use the strong ties within the cluster to spread the new knowledge within the cluster.

Many of the respondents were not able to distinguish between the traditional automotive cluster in the region and the new cluster within the vehicle electronic and connected services industry. A reason for this could be that the two are very similar and interlinked, with no clear borders in between. With findings from interviews as a base, it can be stated that the traditional automotive sector in the region is undergoing some major changes, which pushes it to evolve into becoming the vehicle electronic and connected services industry. This thinking is supported by findings in industry reports and in interviews since they both state that the automotive industry in general is changing rapidly. Consequently, it can be noted that companies and institutions in the cluster do not fully understand the sudden changes. This will be further discussed in the discussion about the industry and cluster life cycle, *5.3 Life cycles*.

5.2.1 Collaboration in the cluster

As Porter (1998) concludes, social interaction between members binds the cluster together. Several of the respondents have asked who else were interviewed in this study, and then it became evident that many of the them knew each other from having worked together or have met each other at events. However, it could be argued that since almost all interviewees were selected based on recommendations they might be part of the same networks in the region. This is however not true for all actors of the cluster, and it is impossible to know the opinions of people that has not participated in this study. Nevertheless, all the interviewees said that personal contact is an important factor when collaborations shall be established. Sölvell (2015) discusses that lack of trust and knowledge make it difficult to start collaborations. In addition, it creates gaps instead of links and this has a large effect on the innovativeness and competitiveness of the cluster. It is important for the cluster to continue to increase the level of trust among the members since Karaev et al. (2007) mention that trust can lower transition costs, decrease legal disputes and administrative procedures.

As mentioned in findings from the interviews, only one of the participants said that meeting face-to-face and not let all communication happen virtually is important for the innovation rate. This corresponds to what Porter (1998) says about personal relationships and face-to-face interaction in the cluster. But, the researchers of this study are a bit sceptical to this way of thinking. Porter talked about this in 1998 when internet was not yet as highly developed as it is now. Since then, the ability and ease of communicating with people in other geographical areas are becoming more and more sophisticated. Also, many of the new technologies and innovations emerging in this specific industry, discussed both in industry reports and in interviews, are to a great extent developed with help of computer science and software. Therefore, the innovations developed in the cluster might not depend on these social interactions to such a great extent as it would have done 20 years ago. Also, meeting face to face was often mentioned as something time consuming in the interviews. Therefore, communication via the internet for example via conference calls, could be a complement to meeting face-to-face. However, as also mentioned many times in interviews, companies and institutions in the cluster must find other areas of collaboration that is not focusing on products or competitive areas. Maybe it could still be a fact, in line with Porter's thoughts, that the pre-competitive collaboration projects must be found and developed through personal communications, exchanging information between members and finding a shared strategy. One example of a possible pre-competitive project is mentioned by one respondent and concerns that it is a common challenge for all companies in the cluster to attract young people to engineering educations.

In interviews, it became evident that people have changed positions in companies, and that when companies have had trouble keeping some of its personnel, they have been offered positions in other companies. This corresponds to what Sölvell (2015) says when he talks about that resources, individuals, technologies etc. can be reshuffled and transferred across organizations in clusters. It proves that actors in the cluster are aware of each other and approximately what competencies can be found in various organizations.

5.2.2 Gaps in the cluster

When analyzing findings from interviews and what has been said in the scenario planning workshops, some gaps can be found. Here, the gaps discussed by Sölvell (2015) in section *2.2.3 Gaps and bridges*, have been used.

First, there is evidence of present *firm-to-firm gaps* between some of the actors in the cluster, for example a lack of collaboration between larger and smaller firms at the moment. In this case, the reason for this gap is pointed out to be the larger firms' bureaucracy and demand for a certain level of security around collaborations, as well as their dependence on legal bonds. Since one respondent even said that project-times sometimes run out before all legal papers are in place, this shows just how severe this problem is in the cluster. This corresponds to what Sölvell (2015) talks about in *2.2.2 Relationships between actors*, about how large companies usually search for large suppliers.

The *firm-to-research* gap that Sölvell (2015) talks about appears not to be present in this cluster. Instead, firms are collaborating with research institutes and the research departments at universities. In the interviews, many examples have been mentioned of successful projects where firms have collaborated with research parties. This is a positive factor for the cluster, since it reduces the risk of large companies to move their facilities elsewhere where the research can be done in better ways. Nevertheless, *the firm to education gap* is more evident in the cluster. This, since there seems to be a limited contact between companies and education. As one respondent mentioned, one of the larger companies have not been a part of CHARM, in the last years. A gap between the *firms and the capital providers* is easy to identify. As stated in findings from interviews, the need for paperwork and bureaucracy when applying for certain funding of projects can be a threat for startups and smaller companies since they do not have the time or competence for those procedures. Furthermore, there is a lack of business angels and capital investors in the region.

It is evident from interviews that there is a quite large *gap between the industry and the local authorities*. The feeling of being mistreated in the industry can be found not least in the quote *"It is ironic that Gothenburg is one of the most hostile cities against cars when the city is dependent on the car industry."* This thought also contains much information about the relationship between the industry and local government, and shows a lack of trust between these actors. VGR itself also implied that their relationship to the industry is not functioning in a desirable way, and expressed the need for a plan from industry of how their strategy for how and what technologies should be developed. This should help VGR to collaborate more with the industry and better understand their needs. This is a great way to achieve the consensus space that Etzkowitz and Ranga (2013) are talking about. It is also mentioned by Porter (1998) in section *2.2.2 Relationships between actors*, when he talks about formulating common strategic objectives and agreeing on a joint developing strategy for building an efficient cluster.

The two last gaps, *firm to cluster* and *firm to global market gaps*, are harder to identify when analysing interviews. The reason is a lack of data in these areas. However, one respondent asked for more collaboration and contact with a cluster in Stockholm. Also, some of the OEMs in the region are owned by a Chinese company. Therefore, there are natural contacts towards global markets but it is unsure to what extent this is used to improve the cluster in the region. Anyhow, if these two gaps are evident in the cluster, the researchers of this study recommend to utilize strong and weak ties to overcome them, as previously discussed.

5.3 Development of the automotive industry in the Gothenburg area

In chapter *2.3 Industry and cluster life cycle*, various types of industry and cluster life cycles are presented. These will be analysed together with findings from interviews and industry reports to see where in the life cycle the vehicle electronics and connected services industry is

right now. First, the life cycle proposed by Sölvell (2015) will be analysed together with theory about the shipbuilding industry in Europe to also show some history of the Gothenburg area. Secondly, the lifecycle by Menzel and Fornhal (2009) will be discussed. At last, the development stages in clusters by Enright (2003) and facilitator roles by Ingstrup and Damgaard (2013) will be used to see how facilitators must work in this specific cluster to help it develop even further.

Since the traditional automotive industry in the region is rapidly changing, parallels can be drawn towards the shipbuilding transformation in Europe, presented in the theoretical framework. The shipbuilding industry in Europe is currently working with a process to physically and conceptually transform itself, and facing some major changes in the competition and revenue sources (Giovacchini & Sersic, 2012). This work is being done in a similar way of how the automotive industry is changing the region.

Figure 8 by Giovacchini and Sersic (2012) presented in the theoretical framework shows the various ways of how the shipbuilding industry has changed. But, there is some questions about this model. First, some of the trends might have been placed in the wrong order on the "connection with original industry" -axis. For example, when talking about the trend *industry shift* the authors mention that *"a completely new industry takes over the old shipbuilding activities"*. But at the same time, they place industry shift with high connection with the original industry in the graph. This does not seem to be correct, and therefore the model should be used with some caution. Instead the industry shift trend should be placed as can be seen in Figure 19. Nevertheless, the various trends mentioned by Giovacchini and Sersic (2012) can still be used to understand how the traditional automotive industry is changing in the region.

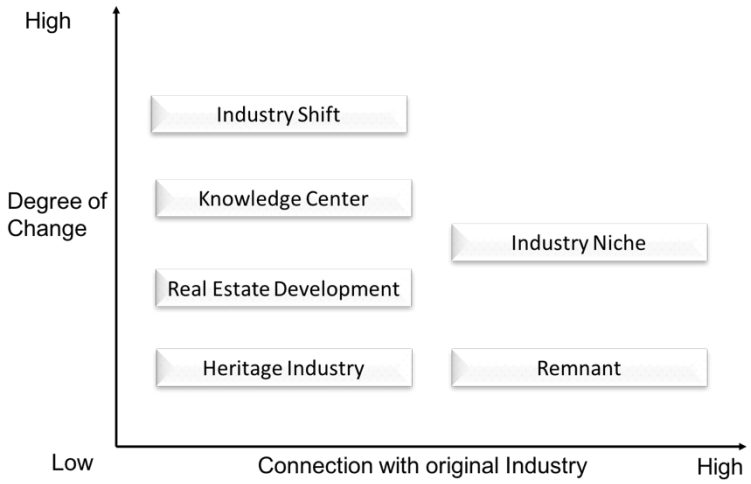


Figure 19. Modified industry transformation matrix (modification of the figure by Giovacchini & Sersic, 2012, p. 13)

Industry niche or Remnant shift are the two most suitable trends to describe the change in the automotive sector in the region. It could be viewed as an industry niche, since the interviewees many times have mentioned the need for the cluster to work with specific technologies to be world leading. The connection with the original industry would still be high but at the same time, the degree of change would be on a medium level. If the automotive sector should be viewed as undergoing a remnant shift, links can be drawn to that the cluster can use already existing infrastructure and developed technology. One example of how the cluster can use the remnant shift to give them competitive advantage is to focus on testing and development of autonomous vehicles, since the region already contains these kinds of infrastructure and

competencies. In the remnant shift, the connection to the original industry would be high but the degree of change would be lower than for the industry niche.

As Giovacchini and Sersic (2012) talk about, the Gothenburg area have previously been dependent on the shipbuilding industry. But, it declined and later new industries emerged in the area. This is one example of how the life cycle proposed by Sölvell (2015) can be applied to the Gothenburg area. First, the shipbuilding industry was of great importance for the city but it went into the "museum" stage. Later, other industries have emerged in the area, where the traditional automotive industry have taken an important role of providing jobs in the region. When compared to what the interviewees have said, and considering that the traditional automotive industry is rapidly changing now, one could argue that the traditional automotive industry is now in the "renaissance stage". It means that the industry is not declining, but rather that it is transforming into a new industry within vehicle electronics and connected services industry. It also means that there is now room for the cluster around the traditional automotive industry to jump into a new life cycle.

According to Sölvell (2015), the new cluster life cycle can occur thanks to new technologies emerging and new firms entering the cluster, and changes in the ways of making businesses. This is precisely what is happening in the cluster right now. There are new companies and firms entering the region, for example there are high expectations around the newly created joint venture, that will work with developing the technologies for a platform for future vehicles.

To give a better understanding of the above-mentioned changes in the history of the Gothenburg area, see Figure 20 and 21. Here, the three different industries can be seen on a time scale. Figure 20 shows the emergence and decline in the shipbuilding industry. Figure 21 first shows the emergence of the traditional automotive industry Now, the automotive industry is in the renaissance stage, giving place for the vehicle electronics and connected services industry. This line is made dotted, since it is just starting and therefore it is unsure what direction it will take in the future. These figures aim at showing the various industries in the Gothenburg area and how these have developed over time.

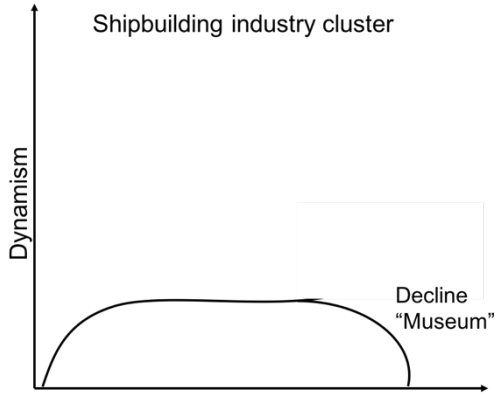


Figure 20. The life cycle of the shipbuilding industry cluster (adaption of the figure by Sölvell, 2015, p. 74)

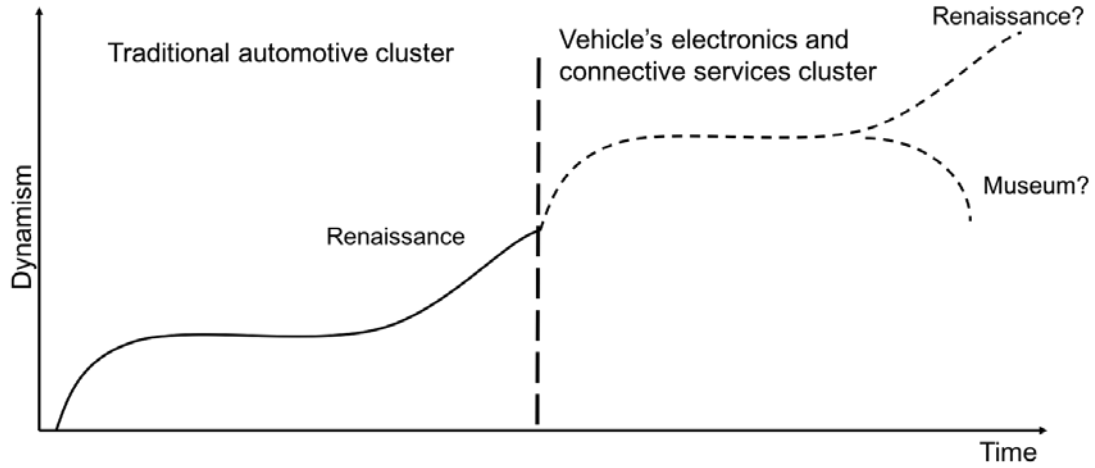


Figure 21. The life cycle of the traditional automotive cluster and the vehicle electronics and connected services cluster (adaptation of the figure by Sölvell, 2015, p. 74)

There is much evidence in interviews and industry reports that the traditional automotive industry has started to change and instead becoming the vehicle electronics and connected services industry as previously explained in Figure 21. Another way of reviewing the shift of industry is by applying the theory from Menzel and Fornhal (2009). As the authors explain, the traditional automotive cluster has now the possibility to adopt new technology and integrate new knowledge to move back in the cluster life cycle and enter new growth phases. For this new cluster life cycle, the focal industry will instead be the vehicle electronics and connected services industry, which of course contains parts of the traditional automotive industry.

In the Figure 6, Menzel and Fornhal (2009) explain the various steps in the cluster life cycle; Emergence, Growth, Sustainment and Decline. Based on the interviews, the researchers of this study are confident that the cluster is undergoing a transformation, going from a sustainment stage in the traditional automotive industry towards the emergence state of the life cycle in vehicle electronics and connected services industry. Figure 6 by Menzel and Fornhal (2009), has been adopted to clearly show the current state of the cluster life cycle of the traditional automotive industry, see Figure 22.

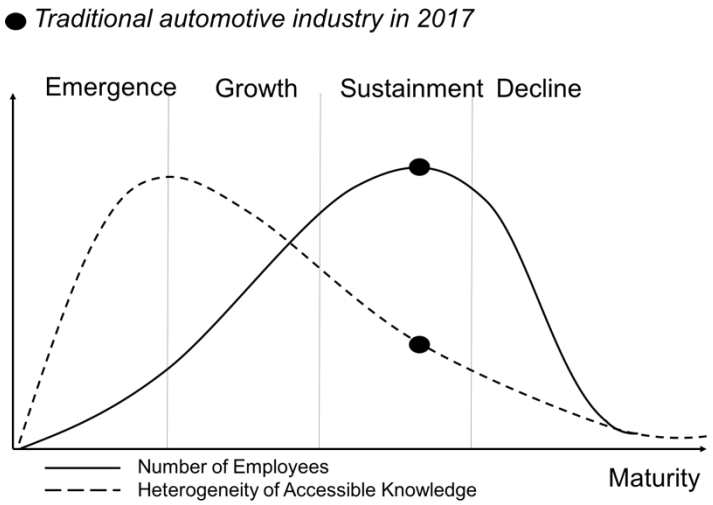


Figure 22. In a sustainment phase in the traditional automotive industry (adaptation of the figure by Menzel and Fornhal, 2009, p. 218)

As can be seen in the Figure 22, the traditional automotive industry is currently in the sustainment phase, and through transformation the industry has changed into becoming the vehicle electronics and connected services industry, and the cluster has moved to the emergence phase as can be seen in Figure 23.

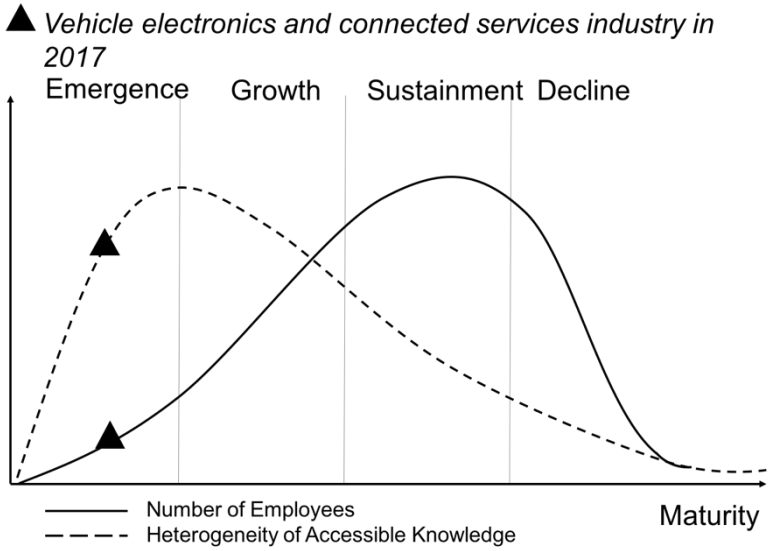


Figure 23. In the emergence phase in the vehicle electronics and connected services industry (adaptation of the figure by Menzel and Fornhal, 2009, p. 218)

What must be further explained is that the shift of industries does not mean that the whole traditional automotive industry in the region is disappearing completely. Instead it means that this industry changes from its traditional roles and business models, into a new industry with new entrants, new competitors and new technologies. Nevertheless, on a timescale from five to ten years ahead from now, it can be argued that the traditional automotive industry might decline heavily in produced units. Especially if the quote *"We will not own our own car, and it will only need to exist 1/10th of cars compared with today, and we must deliver mobility services"* happens to be true.

According to Enright, there are some stages of development of a cluster. As has already been argued for, the cluster in the vehicle electronics and connected services industry is somewhere in the beginning of its lifecycle, but at the same time it benefits from the previously traditional automotive industry in the region. There are already many companies in the automotive sector in the region and therefore it would not be possible to identify it as a potential cluster with low level of development, as one of the stages presented by Enright (2003). It is evident from the interviews that people in different companies already have contact and can meet in different forms of meeting activities and networking events. Also, companies have started to understand the importance of taking active roles in the rapidly changing industry, for example by creating joint ventures.

With the above argumentation as a base, it could be argued that the vehicle electronics and connected services industry is a latent cluster, which is a central finding in this study. Enright (2003) defines it as having high level of development and that companies are benefiting from clustering. This is true in this specific case since many new technologies are produced and tested in the cluster. Also, companies have started to run some projects together, as described

in the findings from interviews. Furthermore, Enright (2003) says that latent clusters lack sufficient levels of interaction to truly benefit from co-location. He mentions lack of knowledge about firms in the cluster, lack of interaction between actors, and lack of trust to build strong relationships. This is in accordance with what interviewees have described; a region where larger and smaller companies have trouble collaborating and where it can be hard to find the right competence. Also, interviewees said that there is sometimes a fear of sharing technological knowledge between firms.

The question is how the cluster can move from being latent to working. This will be discussed in the next section.

5.3.1 Facilitator role in the life cycle

As Ingstrup and Damgaard (2013) describe there are many various ways in which a cluster facilitator can act in a latent cluster, for it to move towards a working cluster. The role of the facilitator in the vehicle electronics and connected services industry should be of an entrepreneurial type and it should also have the role of a relationships builder. This will be of great importance in the cluster, since it is evident from the interviews that there is a lack of relationships. Not only between large and small firms in the cluster but also for example between firms and local authorities. These relationships must be improved for the cluster to be more successful. The facilitators can help the relationships between actors in the cluster with creating bonds between actors and expand the trust between them. Also, help focus the work in finding cooperation and defining the needs of the actors. For this work, Ingstrup and Damgaard (2013) say that the facilitator must have competence in the areas of for example analysis, communication, networks and problem solving. Some example of tangible tasks for the facilitator to perform are branding and marketing of the cluster which is a need often expressed during interviews. Marketing is especially important since interviewees pointed out that Business Sweden lacks in this area. Moreover, a logo and name for the cluster could be developed as additional branding. It is also to create networking events, seminars, and business idea workshops so that actors in the cluster can meet and share ideas. These types of meeting points were also expressed as very important to respondents in the interviews and were also discussed as factors during the scenario planning workshops.

5.4 Future of the industry

Figure 17 explains the value pyramid in the automotive sector, and how it will change the future of the industry. Traditional OEMs and Tier1s will move down in the value pyramid, giving place for new entrants that create operating systems and services. It also means that these new entrants will be closer to the customers in the value pyramid, and that the OEMs and Tier1s might lose important information and feedback from customers. With interviews as a base, it becomes evident that the larger companies within the cluster have begun to understand that this value pyramid is changing.

The researchers of this study are thus confident that operating systems and services will provide new value into the sector, which means more value than what OEM’s have previously gained. Nevertheless, it is difficult to estimate the exact increase of value in the sector. The thought is visualised in Figure 24 where it becomes evident that the value pyramid of the future is much larger than previously. In the operating system part of the pyramid, the new joint venture in the cluster is placed since they are attempting to create operating systems and compete with new technology entrants. In other words, that this joint venture is an attempt by one OEM and one Tier1 to keep their position in the value pyramid.

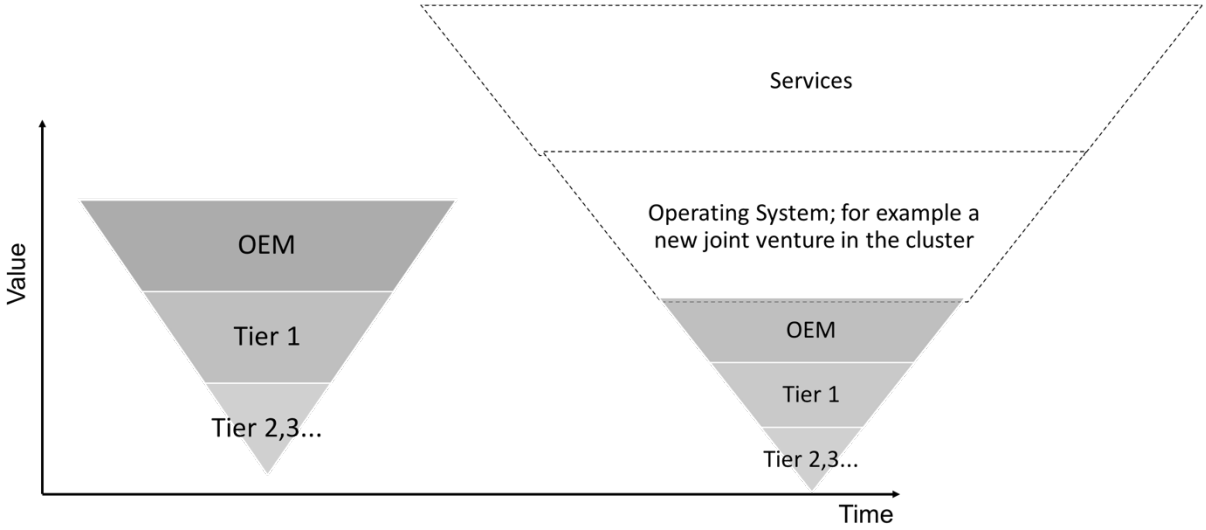


Figure 24. The current and future value pyramid of the vehicle electronics and connected services industry

The question is still if the traditional automotive companies can compete with new technology entrants, for example Google and Uber. They might benefit from excellence when it comes to the development of operating systems and services, but still they might lack valuable knowledge about the automotive sector and what preferences vehicle customers have. For companies within the cluster to be able to compete with these new entrants, it means that they must come together within the cluster, helping each other to develop new ideas and innovations in a fast rate. Also, the need for engineers with knowledge about software development will be of great importance. But, as mentioned several times, there is already a lack of such competence in the region. The question for the future of the cluster will be if companies understand the value pyramid and what challenges lies ahead, and if they can together find innovations and ideas that enable the cluster to compete on a global scale. If not, the cluster might have to focus on assembly of vehicles, which means greater focus on hardware. It means fewer jobs since then larger companies might move elsewhere if they are not able to develop operating systems and services in the region.

5.4.1 Limited awareness

Accenture (2014) states that one of the future challenges for OEMs is the ability to merge different technologies together. Here, the cluster in the region has an advantage since most of the respondents believe that one of the cluster strength is to integrate systems.

It is an interesting thought that all the respondents in general were very positive towards the new technologies, that the vehicles will become autonomous in the future and that there will come new mobility services because of these changes. But, it did not seem like the respondents were as highly conscious about how these changes would affect this specific cluster and the structure of their own companies, and how relationships between actors in the cluster could change as an effect of new technologies and emerging business models. Respondents often talked about new mobility services, new business models and changes in how suppliers deliver products that will happen in the future. But they never pointed to *exactly what* types of new business models would emerge, or *how* suppliers must work in the future. There was consensus about that *something* is happening to the industry, and it is happening very fast, but no one could point to how changes would affect them. For example, representatives from larger

companies did not in their answers show that they understood that they must change and reduce much of their bureaucracy to be able to cope with changes, for example with working more with smaller businesses and startups. Nevertheless, they all agree that collaborating and sharing technological knowledge will be of high importance if the industry in the region, in other words the cluster, wants to maintain is position in the market.

Several of the interviewees have talked about how business models will change in the future. This goes in line with Weinelt's (2016) discussion, in section *4.1.2 Challenges for the automotive sector*. He thinks that the upcoming shifts in the industry will affect business models and the existing players need to re-evaluate areas such as company structures and partnerships inside and outside the ecosystem. This can relate to the findings from the interviews since one of the participants thinks that more collaborations and joint ventures will occur. Weinelt (2016) also says that the digital transformation is allowing non-traditional, technology-based companies in the industry. These companies could have an advantage since they do not have a car manufacturing to protect. Therefore, they can take higher risks compared to the traditional carmakers, which can result in a faster development.

5.5 Reflection on findings

Many of the findings from the industry reports about the future trends of the industry have also been discussed by the participants in the interviews. However, the researchers question if this depends on that authors of industry reports and interviewees are influenced by the industry and each other. One reason could be that many of the employees in the industry read this type of reports. Another reason could be that the industry reports are angled so they will fulfil the needs of their customers. With other words, the industry reports write what the companies in the industry want to hear. Both the industry reports and interviewees are very optimistic to the future of the industry and no one barely state anything negative. The researchers of this study are a bit sceptical to this and wonder how everyone can be so sure that for example autonomous vehicles will be a success. Moreover, all the interviewees except one are convinced that autonomous vehicles will happen in the future but the researchers are not sure that it will be socially accepted. Only two of the respondents brought up the importance of social acceptance of autonomous vehicles.

6. Developed Scenarios

Common for all scenarios, and acting as a base, will be trends identified in scenario planning workshops and presented in Appendix C. Since trends are factors that have high impact but low uncertainty, it is important to first discuss them before talking about how the critical factors will impact the scenarios. This, since trends will have the same impact in all scenarios. As in the case of critical factors, trends were also mentioned several times and with similar meanings. Therefore, the researchers have grouped them together and chosen the most important ones to give a more holistic view.

The first trend is *create meeting points for collaboration*, and it includes; create prerequisites for diversity through meeting points, collaboration/platforms/meeting points, and initiatives for collaboration. The second trend is *an increasing lack of competence* which includes available competence/education, and difficult to find competence. The third trend is *digitalization*, which only contains itself but was chosen since it has very high impact. The fourth trend is *the emergence of new business models*, which contains news actors within mobility, business models, and new business models for mobility. Last but not least is the fifth trend, *hinders for development due to local authorities*, which includes hinders for development due to politicians, and local authorities/politicians' objection towards cars and always striving for the "best" projects, which in turn leads to the enemy of the good.

6.1 Scenario dimensions

Below will be an explanation of the chosen scenario dimensions with their positive and negative development. The first scenario dimension regards the attractiveness of the region and the second concerns the allowance of autonomous vehicles. How these dimensions were selected can be read about in chapter *3.2.2 Scenario planning*.

6.1.1 Attractive region

Scenario dimension 1 with a positive development is attractive region. The definition of an attractive region is available housing for residents and people moving to the region, and a balance between work and spare time. There must also exist family services, such as day care for children and high quality education. Building housing according to the demand, buildings, schools with good international results, and that the region receives positive attention in media are all signs that the region is becoming attractive. The result of an attractive region is increased chances of attracting both companies and competence to the region.

6.1.2 Unattractive region

Scenario dimension 1 with a negative development is unattractive region. This is the opposite to an attractive region and therefore the definition of it is less available housing and not enough family services. One example that will make the region unattractive is regulations for international working force. Signs that the region is becoming unattractive is that housing problems are increasing because the plan for housing was not enough, schools gaining lower degrees, and negative media attention. Consequently, it will be more difficult to attract working force and companies to the region.

6.1.3 Testing, Development, and social acceptance of autonomous vehicles

Scenario dimension 2 with a positive development is Testing, Development, and social acceptance of autonomous vehicles. The definition is that the region will be allowed to test and develop autonomous vehicles. In addition, the society accepts autonomous vehicles and are willing to buy/use them. Signs indicating that this will happen are highly developed testing labs and facilities existing in the region that can be used by cluster members and other clusters, together with positive feedback about autonomous cars from society.

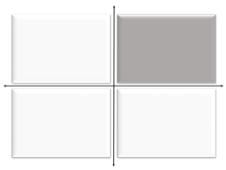
6.1.4 No Testing, No Development and no social acceptance of autonomous vehicles

Scenario dimension 2 with a negative development is no testing, no development and no social acceptance of autonomous vehicles and can be explained as testing and development of autonomous vehicles are prohibited. Moreover, there is no social acceptance of the autonomous vehicles and the society does not want to buy or use the product. Laws and regulations that prohibit use and test of autonomous vehicles can be an indicator for this, and will lead to that no testing facilities or labs will exist in the region.

6.2 Scenarios

In Figure 25, the scenarios can be viewed with negative and positive developments in the two chosen dimensions.

Figure 25. The four different scenarios with the chosen critical factors



6.2.1 Autonomous City in the year of 2030

Autonomous City can be found in the upper right corner of Figure 25. In the autonomous city, the region is attractive and there is testing, development and social acceptance of autonomous vehicles.

Thanks to the attractiveness of the region, a production facility of batteries was located in the region in the year of 2018. There were many other options for the factory to place its facility, but it chose the region thanks to housing opportunities, family services and high quality education for employees. Another important reason for placing the factory in the region is the buzz created around the cluster and that the factory could then benefit from the cluster. The battery production facility meant an increase with 3000 to the total number of jobs in the cluster when it opened for production in 2020.

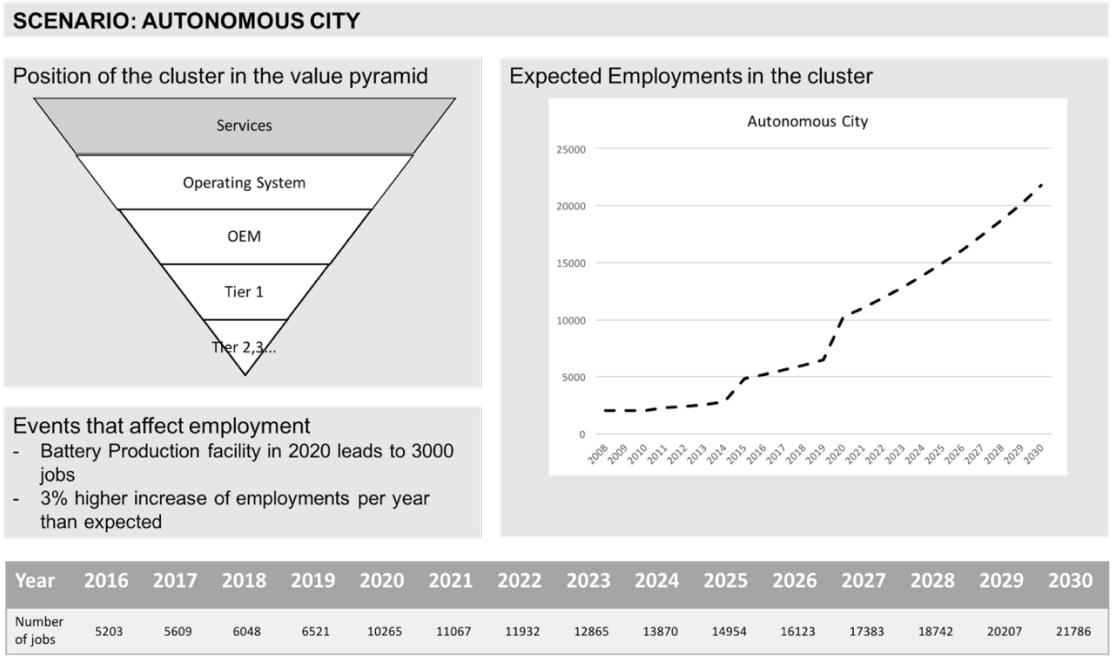
The vehicle electronics and connected services industry in the Gothenburg area is now famous in the whole world thanks to its world class testing facilities. Thanks to successful testing in the city of Gothenburg area, for example the DriveMe-project, VGR understood the potential of the autonomous vehicle as well as how it could affect employment in the cluster. Therefore, they took the decision to invest further in testing facilities such as Asta Zero in the year of 2019. To these facilities, companies from all over the world are coming to the region to test and develop their autonomous vehicles. When Google first came to the region to test their self-driven cars, with focus on utilizing the unpredictable weather in the region, it created a lot of buzz in the media, which attracted even more players to use the testing facilities.

From the start of the DriveMe project several years ago, the importance of autonomous vehicles for the cluster have therefore grown rapidly each year. Companies in the region have succeeded in keeping their position in the value pyramid close to their customers, thanks to services and operating systems that are developed by highly competent engineers. One of the most important aspects of how the cluster could attract such competence despite the low availability of engineers, was that local authorities decided in 2021 to build more housing than the original plan. Plans from 2016 were proven to be insufficient and therefore they were increased.

The inhabitants of the region are very positive towards the autonomous vehicles. Therefore the share of sold items of autonomous vehicles increases every year, compared to lower amount of sold units of vehicles with combustion engines. Nevertheless, since new business models have emerged which enables new forms of shared mobility, the actual number of cars and vehicles, especially in the city of Gothenburg, have decreased each year since 2016. Also, VGR took the decision in 2020 to include autonomous buses in the public transports of the city, which was started to be implemented in the year of 2028. These two events led the city of Gothenburg to win an award as the most environmentally friendly city in Sweden in the year of 2028. The local authorities were very pleased with this award, and their perception of the automotive industry in the region changed in a positive direction. They understood that working together with the industry does not have to mean more cars on streets, but instead new and better mobility services with positive effects on environment.

The hype and buzz created in social media and in highly recognized papers about the cluster increased the number of events that cluster representatives were invited to. Other clusters within the automotive sector invited them to conferences, meetings, and innovation days etc. Thanks to these types of meetings and sharing knowledge with other clusters, new ideas have helped the innovation rate to grow within the cluster.

The employment in the region increased with 3% higher numbers per year between 2016 and 2030 than was first predicted. The reason for this was the success of autonomous vehicles and testing of them, the collaboration between VGR and the industry, and the attractiveness of the region. A fact sheet of scenario Autonomous City can be seen in Figure 26.



Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of jobs	5203	5609	6048	6521	10265	11067	11932	12865	13870	14954	16123	17383	18742	20207	21786

Figure 26. Fact sheet Autonomous City scenario

6.2.2 Homeless Town in the year of 2030

Homeless town scenario is the quadrant in the lower right corner, see Figure 25, with an unattractive region but still with testing, development, and social acceptance of autonomous vehicles.

The cluster in the region has the last couple of years struggled to find competence. The lack of engineers and other important professions for the development of the cluster has not been able to overcome, and the primary reason has been the unattractive region. Vacancies in the cluster are empty for long periods of time and to attract competence, companies in the cluster have had to offer high salaries and thus costs in the cluster are rising. One large problem has been that students graduating from Chalmers and other universities lose their student apartments and have trouble finding new ones, and therefore must move to other regions. Local authorities struggle due to the high demand but low availability of housing, even though building plans from 2016 have been realized. Results have been that when apartments and houses hit the market, prices go up fast making it almost impossible for students and many other groups in the society to purchase them.

In the year of 2018, a company with battery production was just about to decide of where to place its new production facility. It had several options on the list, where placement in the region was one of them. But, due to the housing situation and that it was so hard to find

competence, they chose another location for the factory. It was a major disappointment not only for the cluster but also for VGR. This, since the region now lost a potential of 3000 jobs. Tensions between local authorities and the industry grew since the industry blamed VGR for not having sufficient housing plans for the region.

Even though the cluster has big troubles to find and attract competence, the cluster is successful when it comes to development and testing of autonomous vehicles. Amongst the citizens of Gothenburg and surrounding cities in the region there is social acceptance of autonomous vehicles. Testing facilities in the region are attracting some major players in the field, and of course companies in the cluster are testing their technologies. Thanks to successful testing of autonomous vehicles, VGR took the decision in 2020 to include autonomous buses in the public transportation system. It was supposed to be implemented eight years later in 2028, but was delayed due to that companies in the cluster were not able to deliver on time. It further intensified tensions between the industry and VGR.

The innovation rate and international success of the cluster have been hampered by the difficulty to find and attract competence, as well by the inability of collaboration and understanding between industry and VGR. Some key individuals from companies in the region that were of great importance for the clusters development have unfortunately been offered positions in other more attractive places. This also one reason for why the cluster is not as successful internationally as could have been. The vehicle electronics and connected services industry cluster in the region, has been able to move one step up in the value pyramid when compared to the traditional automotive industry. They are able to produce operating systems, for example within autonomous driving. Nevertheless, the lack of competence has hindered the development of services and therefore this step could not be reached. It meant that the cluster in the region was outrun by other clusters in the same industry where both operating systems and services are produced thanks to the ability to attract competence. They have a closer relationship to customers and thus can enjoy higher margins.

Due to problems in finding the right competence, nothing unexpected has happened with the employment rate in the cluster, and therefore the number of jobs have been increasing according to forecasts. A fact sheet of scenario Homeless Town can be seen in Figure 27.

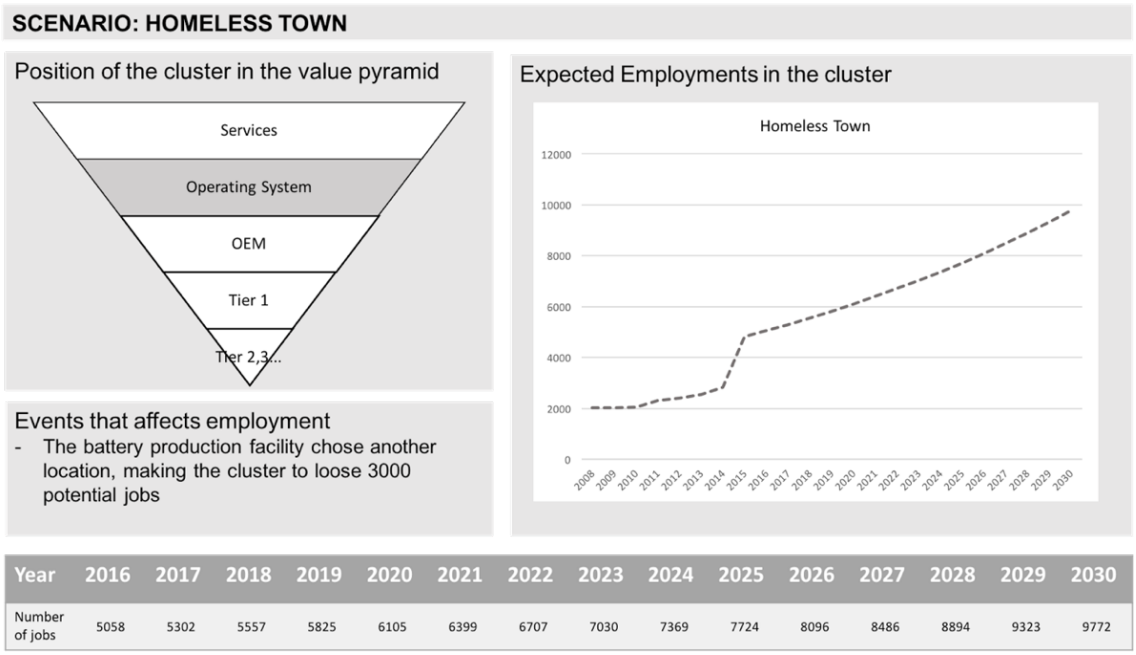
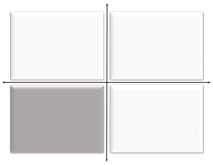


Figure 27. Fact sheet Homeless Town scenario



6.2.3 Apocalypse in the year of 2030

Scenario number three, Apocalypse, can be found in the lower left quadrant of Figure 25. Here, the region is unattractive and there is no development, no testing and no social acceptance of autonomous vehicles.

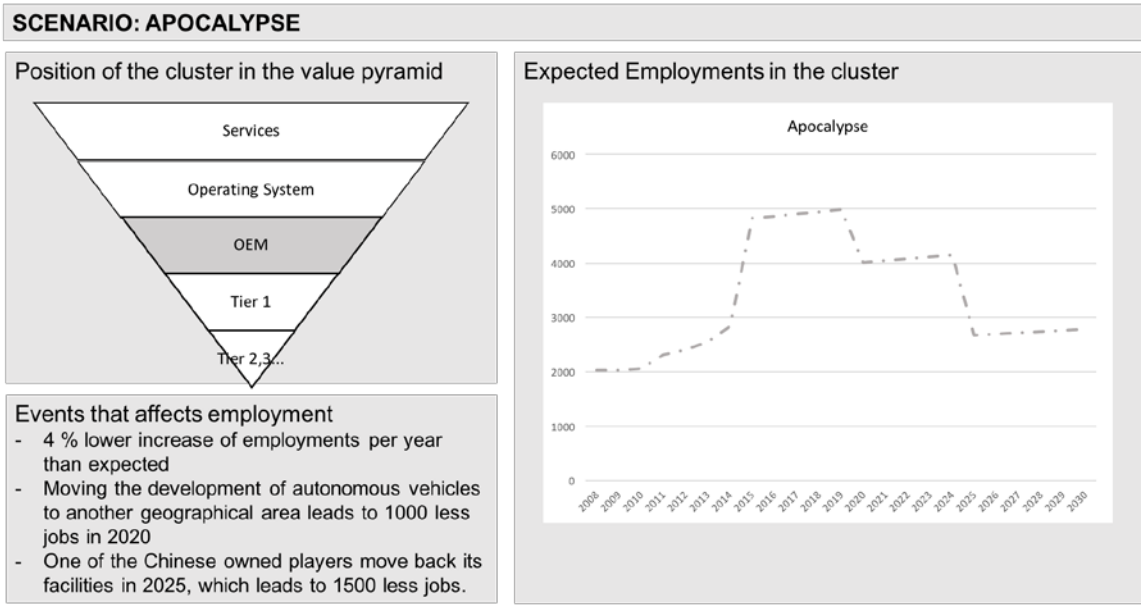
In 2018, a major accident happened in Gothenburg while testing autonomous vehicles. It was a couple and their two children on their way to work and kindergarten that was hit by a truck when their autonomous car did not stop at a red light. The hit unfortunately led to the death of the two children. The accident led to a political decision that resulted in a prohibition to test or drive autonomous vehicles. However, it is still possible to test autonomous vehicles in other countries outside of Sweden, which means that one of the players in the cluster moved its development to another geographical area. The result of this move was 1000 less jobs in the region. At the same time, society became abrasive against autonomous vehicles and they were never socially accepted. In addition, other cities and countries where autonomous vehicles are allowed, the integration of traffic systems and self-driven vehicles are well developed compared to the region. The development in the region has moved very slow and not much has happened since 2017.

Housing has been a huge problem the last 15 years since the plan in the region for building housing have not satisfied the demand. This has resulted in high competition on the housing market and the prices have increased drastically. Therefore, many groups of the society are not able to find somewhere to live. This have especially been shown at the local universities since the applications have decreased the last couple of years. Students rather move to other regions where they easier find housing. In addition, when graduates lose their student accommodations they try to find a job elsewhere due to the housing issue in the region. All these problems have made it even more difficult for companies in the cluster to find the right competence. The costs

for the companies have increased since they wanted to keep their employees and therefore they had to raise their salaries. These problems became so severe that one of the Chinese owned companies moved its facilities back to China in 2025, which resulted in 1500 less jobs.

Since the cluster was prohibited to test autonomous vehicles, it was forced to elaborate upon other technologies. In 2017, there were two large trends except from the autonomous vehicles; connectivity and electrification. The problem of finding the right competence together with the housing issue have resulted in an unattractive region and national and international companies do not want to establish in the region. One company, who is developing batteries, considered to locate its facilities in region, but due to the competence and housing issues they chose not to. Therefore, the development of electrification has been inhibited. When it comes to the connectivity, one of the distinguish companies in the region within this area moved its facilities to China, which hindered the development. In addition, the "leftover" resources are too many for the cluster to reshuffle them. These drawbacks have made the cluster move down in the value pyramid, see Figure 28. Thus, the vehicle electronic and connected service industry cluster's life cycle is moving toward "decline".

In addition to the 2500 less jobs due to movement of facilities, the employment has decreased with 4 % yearly compared to the forecast between 2016-2030. This means that the cluster has approximately the same size, when it comes to employees, as it had 2014. The reasons for this decline is the unattractive region and the regulations against development and testing of autonomous vehicles.



Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of jobs	4865	4905	4945	4985	4018	4050	4083	4117	4150	2672	2694	2716	2738	2760	2783

Figure 28. Fact sheet Apocalypse scenario

6.2.4 The Driver's Choice in 2030

The scenario The driver's choice can be found in the upper left quadrant of Figure 25. This scenario has an attractive region but there is no development, testing or social acceptance of autonomous vehicles.

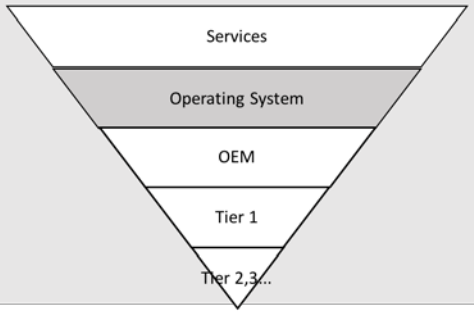
In 2018, a major accident happened in Gothenburg while testing autonomous vehicles. It was a couple and their two children on their way to work and kindergarten that was hit by a truck when their autonomous car did not stop at a red light. The hit unfortunately led to the death of the two children. The accident led to a political decision that it is prohibited to test or drive autonomous vehicles. However, it is still possible to test autonomous vehicles in other countries outside of Sweden, which means that one of the players in the cluster moved its development to another geographical area. The result of this move was 1000 less jobs in the region. At the same time, society became abrasive against autonomous vehicles and they were never socially accepted. In addition, other cities and countries where autonomous vehicles are allowed, the integration of traffic systems and self-driven vehicles are well developed compared to the region. The development in the region has therefore moved very slow and not so much has happened since 2017.

However, when laws against autonomous vehicles prohibited the cluster to continue its testing and development of autonomous cars, other technologies have been developed instead. Thanks to the attractiveness of the city and the possibility to attract competence, the cluster has still been able to innovate and find ways of how to develop operating systems in vehicles. Therefore, the cluster has managed to place itself in the Operating System stage of the value pyramid, see Figure 29.

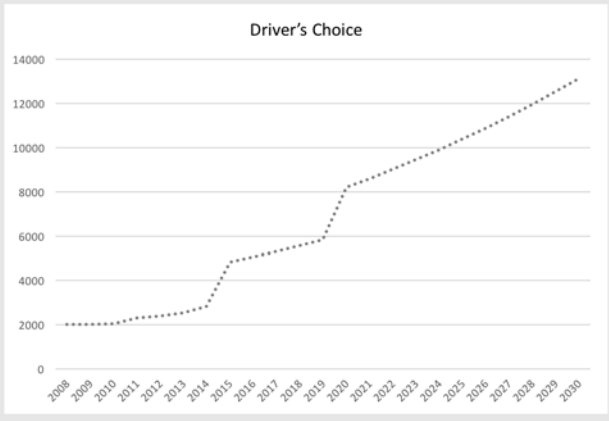
Thanks to the attractiveness of the region, a production facility of batteries was decided to be located in the region in the year of 2018. There were many other options for the factory to place its facility, but it chose the region thanks to housing opportunities, family services and high quality education for employees. The battery production facility meant an increase with 3000 to the total number of jobs in the cluster in the year of 2020. Moreover, the employment has increased according to forecasts.

SCENARIO: DRIVER'S CHOICE

Position of the cluster in the value pyramid



Expected Employments in the cluster



Events that affects employment

- Battery Production facility in 2020 leads to 3000 jobs
- Moving the development of autonomous vehicles to another geographical area leads to 1000 less jobs in 2020

Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of jobs	5058	5302	5557	5825	8201	8596	9010	9444	9899	10376	10876	11399	11948	12524	13127

Figure 29. Fact sheet Driver's Choice scenario

6.3 Scenario discussion

When scenarios are developed the next step is, as described in the chapter *3.2.4 Scenario Planning*, to develop a robust strategy for the cluster, that prepares the cluster for all possible outcomes of the future. This strategy must be determined by the members of the cluster, and therefore the major issues that needs to be considered will be discussed below.

First of all, the scenarios should first be used to start a discussion between members of the cluster. They should come together, take part in the results of this study and achieve consensus when it comes to what needs to be in place when developing the strategy.

It is evident from the developed scenarios that the attractiveness of the region has a greater impact on employment in the cluster than the developed technology has. In both the Homeless Town scenario and Apocalypse scenario, the employment was highly influenced by the unattractiveness of the region. The unattractive region even hampered the development of autonomous vehicles in the Homeless Town scenario, even though there were no laws or regulations against it. This implies that even when there are prerequisites for developing a specific technology, developments will be hampered by an unattractive region. Because of the importance of an attractive region, the strategy must consider how the region can become more attractive and what can be done to attract competence.

It could be noticed that an unattractive region will not only affect the vehicle electronics and connected services industry cluster, but also other industries in the region. The effect of an unattractive region on the total employment is thus not presented here, and could therefore be a potential possibility for future study. It would be of importance for the cluster to have contact with other industries to estimate how the attractiveness of the region would affect the total employment.

Nevertheless, outcomes from the scenario planning also showed that the developed technology has a great impact on employment in the cluster. Even though the Driver's Choice scenario suffered from prohibitions regarding autonomous vehicles, it could still attract competence thanks to an attractive region. The result was that the cluster could focus on other technologies instead, and therefore was able to secure more jobs than in the Apocalypse scenario where autonomous vehicles were also prohibited. The Driver's Choice scenario shows that it is vital for the region to spread out risks and not only depend on developing autonomous vehicles. What needs to be understood is that by first focusing on the attractiveness of the region, competence can be secured and thus there will be potential to develop other technologies as well. Therefore, the strategy developed by the actors of the cluster must contain a risk calculation of what it means to only develop one technology. The strategy must also define other possible technologies to develop so that the cluster can spread out the risks if any of the chosen technologies become prohibited.

Note
Even though all scenarios have high uncertainty due to that they are built on critical factors and assumptions, some indicators have been identified during the course of this study.

Previously the Swedish law has not clearly defined any regulations for testing of autonomous vehicles (Wendle, 2017). Nevertheless, as recently reported, the Swedish government has decided upon laws and regulations that allows testing of autonomous vehicles on public roads, which will be implemented the first of July in 2017. Although, this implies that prohibition of autonomous vehicles might not happen any time soon, a potential accident might still occur and change the circumstances drastically.

How the housing situation will unfold in the future is also very uncertain. The lack of housing in Sweden is hitting new records and 88 % of the municipalities state that they have a problem in this area (hurvibor.se, 2017). Therefore, it might come true that the region will be unattractive due to housing issues.

These two indicators point towards a Homeless Town scenario. Nevertheless, the factors are uncertain and might change.

7. Recommendations

Evident in the cluster is that several gaps are apparent. In the discussion chapter, gaps were identified between firm to firm, firm to education, firm to capital, and firm to local authorities. To overcome these gaps, some recommendations have been developed.

7.1 Cluster organization and facilitator to bridge gaps

As mentioned in the discussion chapter, innovation organizer, bridge builders, cluster organisations, and cluster facilitators are all concepts of similar character. For the cluster to overcome gaps between actors, a function must be developed with the responsibility to connect different actors of the cluster and increase the awareness of the cluster, i.e. marketing. The cluster organization can therefore also be responsible to employ one or several cluster facilitators. The definition of cluster facilitators is individuals that are coordinating the cluster's development by promoting collaboration and sharing activities and resources with the actors of the cluster. At the same time, interviewees point out that there is a need for a key individual in the cluster in order to promote it more and create a "buzz" around it. This person needs to have personal character, be inspiring and have a clearly defined vision for the cluster which she/he is dedicated to follow. Therefore, the cluster must attract a key individual, hire it in a cluster organization that is shared by the members, for example LSP or VICTA which is already present in the cluster. In addition, the cluster organization should arrange meeting places for different actors, to discuss common issues and create new projects across the gaps identified in the discussion chapter. The cluster organisation must have competence in the areas of for example analysis, communication, networks and problem solving. Some example of tangible tasks for the facilitator and other personnel in the cluster organization is to conduct branding of the cluster which is a need often expressed during interviews. Moreover, a logo and name for the cluster could be developed as additional branding. It is also to create networking events, seminars, and business idea workshops so that actors in the cluster can meet and share ideas. These types of meeting points were also expressed as very important to respondents in the interviews and were also discussed as factors during the scenario planning workshops.

7.2 Define a shared goal with all actors in the cluster

To increase consensus space and overcome several of the gaps identified in the cluster, all actors in the cluster must come together and developed a shared goal for the cluster. It could be for example "By the year of 2025, we will be world leading when it comes to…". Without a shared goal, companies in the cluster might work in different directions and not taking advantage of benefits that a cluster should give, such as synergies.

7.3 Define a shared strategy to reach the goal

When a goal has been set, the next step is to jointly develop a strategy for how technologies should be developed during the next years. This was mentioned many times in the discussion chapter, but then it more implied a plan between VGR and the industry. Nevertheless, this strategy should include all actors in the cluster for the consensus space between actors to grow stronger since it creates a shared view of the future. The strategy must include a plan of what technologies to develop since, as shown in the chapter *6. Developed Scenarios*, if one technology becomes prohibited it can have devastating consequences. However, if collaboration between industry and local authorities improves, the risk of new laws and

regulations against certain technologies that can be of importance for the cluster decreases. Moreover, the strategy should include goals for each technology, and how to secure a growing employment in the cluster. The strategy must also contain a plan for how to develop the region so that it becomes attractive. For example, it should prepare for and secure the region with sufficient housing, education and family services.

Thanks to this strategy, the researchers hope to see an improvement in the relationship between actors, especially bridging the gap between firms and local authorities. In addition, the trust between actors will increase since they have agreed on this strategy and will receive a better understanding of what challenges and opportunities the other actors are facing.

7.4 Pre-competitive collaboration projects

For all actors in the cluster to grow and be innovative, it is important that especially the large companies, understand the need of pre-competitive collaboration projects. Even though these projects do not lead to a specific product and therefore does not help the company to improve its selling numbers, it will instead benefit the company indirectly. One example mentioned in the discussion chapter was to collaborate around the fact that it is a common challenge for all companies in the cluster to attract young people to engineering educations. By doing so, companies in the cluster can secure supply of competence in the future, and at the same time collaborate with other companies and institutions in the cluster; thus benefit the cluster itself and help to overcome gaps.

7.5 Help to apply for funding

As mentioned in the discussion chapter, some companies have stated the ineffective and bureaucratic way of applying for funding. This was true especially for startups since they lack time and resources to do this procedure themselves. Therefore, one recommendation is to implement an opportunity for receiving help with these applications. Responsible for this service could be the cluster organization, or other institutions that have knowledge in the area. This service should be directed towards smaller companies and startups, and not the larger players whom already have the knowledge and resources to accomplish this. Consequently, this will overcome the gap between firms and capital providers.

8. Concluding Discussion

In this chapter concluding remarks on answers of the research questions are presented. Also, suggestions of future research in the area are discussed.

8.1 What learnings can be found from theory about how clusters can evolve over time?

In this study, it was concluded that the vehicle electronics and connected services in the region forms a cluster, according to the definition of cluster by the researchers. It means that actors are co-located, collaborating, and sharing technological knowledge within related industries, for example with the traditional automotive industry and telecom industry.

Since the traditional automotive industry in the region is rapidly changing, parallels can be drawn towards the shipbuilding transformation in Europe, presented in the theoretical framework. The shipbuilding industry in Europe is currently working with a process to physically and conceptually transform itself, in a similar way of how the automotive industry is changing the region. Industry niche or Remnant shift are the two most suitable trends to describe the change in the automotive sector in the region. It could be viewed as an industry niche, since the interviewees many times have mentioned the need for the cluster to work with specific technologies in order to be world leading. The connection with the original industry would still be high but at the same time, the degree of change would be on a medium level. If the automotive sector should be viewed as undergoing a remnant shift, links can be drawn to that the cluster can use already existing infrastructure and developed technology. In the remnant shift, the connection to the original industry would be high but the degree of change would be lower than for the industry niche.

One way of reviewing the shift of technology in the traditional automotive industry is by applying the theory from Menzel and Fornhal (2009). According to them, heterogenity of accessible knowledge is driver for the cluster development. When heterogeneity declines, the cluster goes into the decline stage. But, when heterogeneity grows, the cluster will move back to the growing stage of the life cycle. Heterogeneity can be increased by, for example, integrating knowledge in the cluster about new technologies. By keeping a level of heterogenity of knowledge, in other words integrating new knowledge into the cluster, the cluster itself can adapt to a changing environment (Menzel & Fornahl, 2009). Therefore, it can be argued that the traditional automotive cluster has now the possibility to adopt new technology and integrate new knowledge to move back in the cluster life cycle and enter new growth phases.

According to Sölvell (2015), a new cluster life cycle can start thanks to new technologies emerging and new firms entering the cluster, and changes in the ways of making businesses, which is happening in the cluster right now. The life cycle by Sölvell was applied to the specific region to see where in the life cycle the traditional automotive sector can be found, as well as pointing out the position of the vehicle electronics and connected services industry cluster, see Figure 21.

According to Enright (2003), there are stages of development in the cluster. As has already been argued for, the cluster in the vehicle electronics and connected services industry is somewhere in the beginning of its lifecycle, but at the same time it benefits from the already existing traditional automotive industry in the region. There are many companies in the automotive sector in the region and therefore it would not be possible to identify it as a potential cluster

with low level of development, as is one of the stages presented by the author. Instead, it could be argued that the vehicle electronics and connected services industry is a latent cluster. Enright (2003) defines it as having high level of development and that companies are benefiting from clustering. This is true in this specific case since many new technologies are produced and tested in the cluster.

As Ingstrup and Damgaard (2013) describes, there are many various ways in which a cluster facilitator can act in a latent cluster, for it to move towards a working cluster. The role of the facilitator in the vehicle electronics and connected service industry should be of an entrepreneurial type and it should also have the role of a relationships builder. The facilitators can help the relationships between actors in the cluster with creating bonds between actors and expand the trust between them. Also, focus the work in finding cooperation and defining the needs of the actors. For this work, Ingstrup and Damgaard (2013) say that the facilitator must have competence in the areas of for example analysis, communication, networks and to solve problems.

8.2 What distinct scenarios can be defined depicting how the cluster in the region could evolve in the future?

The future for the vehicle electronic and connected service industry is uncertain. However, four possible scenarios for the future have been developed based on the assumptions in chapter *6.2 Scenarios* and are presented in Figure 30.

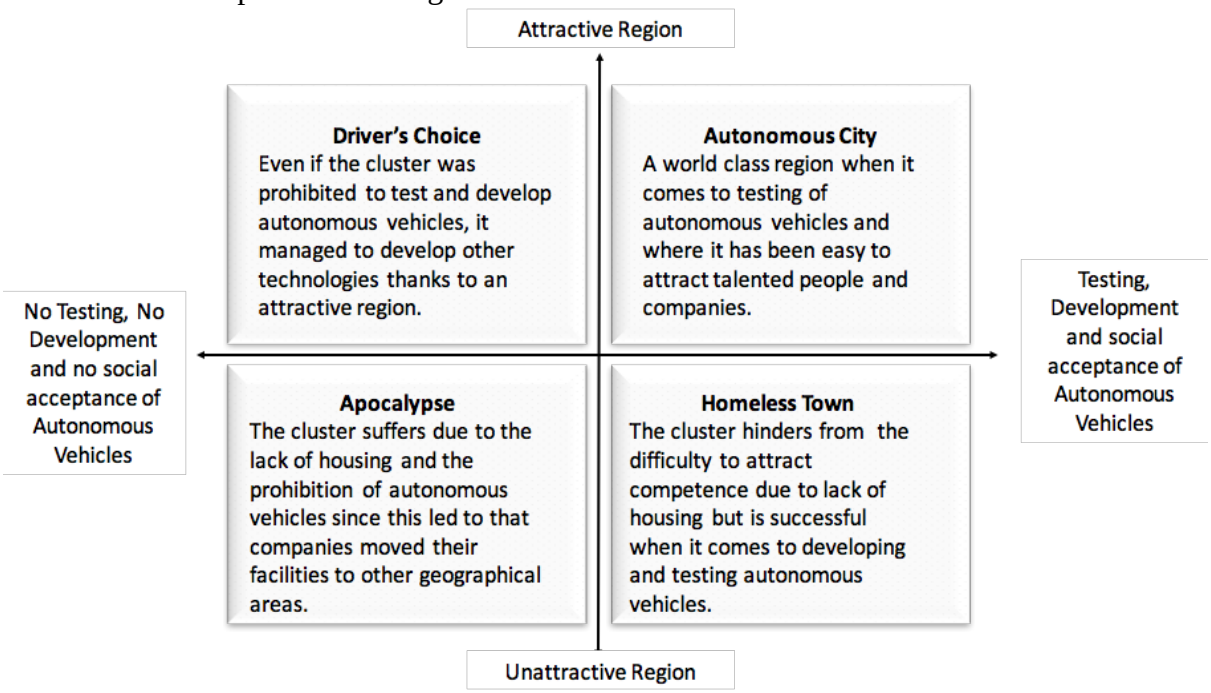


Figure 30. The four different scenarios with explanation

8.3 How will each of the scenarios affect the demand for employment in the region?

A yearly increase of 4,8 % was used as a base when calculating the employment for the different scenarios. Each scenario affect the employment in the region in different ways, see Figure 31, due to various assumptions. The following assumptions were made in each scenario.

Autonomous City
The Autonomous City scenario is the scenario that benefit the region the most when it comes to new job opportunities. This scenario is assumed to have 3% higher increase of employment per year than expected, namely 7,8% yearly increase. In addition, a battery production facility will be located in the region in 2020, which leads to 3000 new jobs.

Homeless Town
This scenario has the third highest employment and development is assumed to follow the expected increase, 4,8%, of new job opportunities. The battery production facility chose another location, making the cluster to lose 3000 potential jobs

Apocalypse
The Apocalypse scenario is the scenario that has the worst effect on the region when it comes to new job opportunities. This scenario is assumed to have a 4 % lower increase of employments per year than expected, namely 0,8% yearly increase. Moving the development of autonomous vehicles to another geographical area leads to 1000 less jobs in 2020. Moreover, one of the Chinese owned players moved back its facilities in 2025, which leads to 1500 less jobs.

Driver's Choice
This scenario has the second highest employment and development is assumed to follow the expected increase, 4.8%, of new job opportunities. A battery production facility is assumed to be located in the region in 2020 and this leads to 3000 new jobs. However, the development of autonomous vehicles will be moved to another geographical area, which leads to 1000 less jobs in 2020.

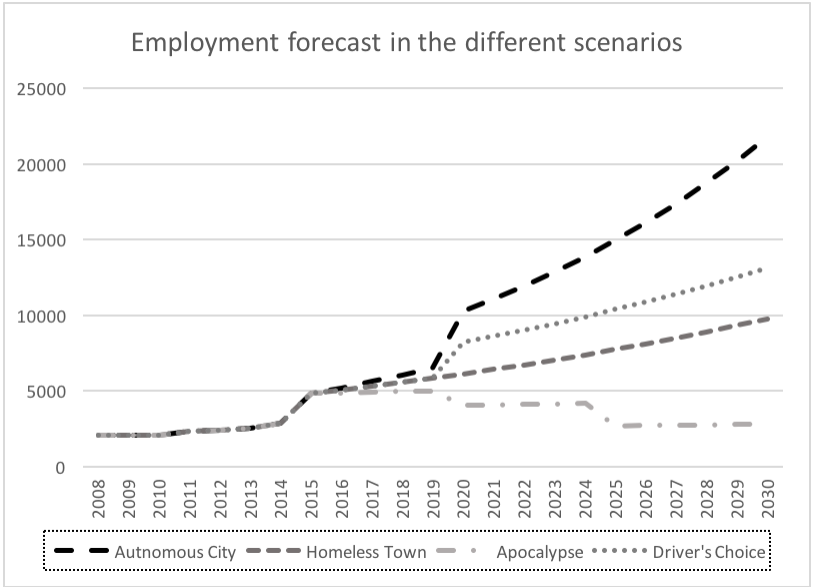


Figure 31. All scenarios and their development of employment between 2008 and 2030

The scenarios differ widely in the final year of 2030, with a maximum of 21 700[1] jobs in the Autonomous City, to the lowest number of 2700 jobs in the Apocalypse scenario. The number of jobs in the future of the vehicle electronic and connected services industry cluster varies therefore with 19 000 depending on what scenario will come true.

As shown in the figure, the scenarios with an attractive region have the highest employment. Therefore, it is assumed that availability of housing, family service and a high quality education have a crucial role when it comes to new job opportunities. This is not only applicable on the vehicle electronics and connected services industry, but other industries might also suffer from an unattractive region.

8.4 How could the vehicle electronics and connected services industry cluster be facilitated in the region?

Several recommendations have been developed based on the finding in this study. First of all, the scenarios should first be used to start a discussion between members of the cluster. They should come together, take part in the results of this study and achieve consensus when it comes to what needs to be in place when developing the strategy. Below is a short list of how the cluster can be facilitated in the region:

- For the cluster to overcome gaps between actors, a function must be developed with the responsibility to connect different actors of the cluster and increase the awareness of the cluster, i.e. marketing. The cluster organization can therefore also be responsible to employ one or several cluster facilitators.
- To increase consensus space and overcome several of the gaps identified in the cluster, all actors in the cluster must come together and develop a shared goal for the cluster.
- When a goal has been set, the next step is to jointly develop a strategy for how technologies should be developed during the next years. Moreover, the strategy must consider how the region can become more attractive and what can be done to attract competence.
- For all actors in the cluster to grow and be innovative, it is important that, mostly large companies, understand the need of pre-competitive collaboration projects. Even though these projects do not lead to a specific product and therefore does not help the company to improve it's selling numbers, it will instead benefit the company indirectly
- Create an opportunity for smaller companies and startups to receive help with applications for funding.

[1] The calculated employment only includes jobs linked directly to the vehicle electronics and connected services industry. When these jobs have been created, additional jobs can be established in other industries, such as day care and jobs within services. To calculate the jobs created in other industries, the employment within the vehicle electronics and connected services industry should be multiplied with 1,6 (Warda, 2017).

8.5 Future Research

Suggestions for future research is:

- Investigate the vehicle electronics and connected services industry cluster's relationship to other clusters and global markets since this was a gap that was not able to be identified in this study.
- More research about the importance of face-to-face communication in clusters due to digitalization.
- It could be noticed that an unattractive region will not only affect the vehicle electronics and connected services industry cluster, but also other industries in the region. The effect of an unattractive region on the total employment is thus not presented here, and could therefore be a potential possibility for future study.

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02875-6&token2=exp=1494918513~acl=%2Fstatic%2Fpdf%2F618%2Fbok%25253A978-3-658-02875-6.pdf%3ForiginUrl%3Dhttp%25

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Appendices

Appendix A

Interview template

1. Demographics
    a. Job title
    b. Years in the industry?
    c. Have you worked in another industry before?
2. Please tell us about your company's position in the vehicle electronics and connected services industry.
3. What do you think will happen to the industry in the future?
    a. What role do you think that your company will take?
4. Is there any particular knowledge that will be required of the industry for the future?
    a. If yes, how can the region attract this knowledge?
1. What is collaboration for you?
2. Does your company collaborate with other companies?
    a. How does it work? Are companies collaborating with other companies, or is it individuals who have personal networks?
    b. Why those companies? Any specific reasons?
3. How much does your company share with other companies when it comes to software development?
4. Do you believe that companies in the industry are collaborating and sharing technological knowledge within the region?
    a. If yes, to what extend?
    b. If no, do you think it is possible in the future?
    c. Do you think that they are collaborating in some other ways than sharing knowledge?
5. Do you think it is possible for competitors to collaborate when developing software?
6. What advantages do you see with collaboration between companies?
7. What disadvantages do you see with collaboration between companies?
8. What prerequisites for collaboration between companies can you see in the region? For sharing knowledge?
9. What hinders for collaboration between companies can you see in the region?
10. In order for you to collaborate more with other companies, what do you have to change in your organization?
    a. How will this affect your development?
    b. Are there any positive effects?
11. In order for you to collaborate more with other companies, what do they have to change in their organization?
12. What, in your opinion, needs to be done in the region in order for facilitating collaboration between companies?
13. In what ways, in your opinion, can the region attract national companies within software development?
14. In what ways, in your opinion, can the region attract international companies within software development?
15. What specific knowledge do you believe exists in the cluster right now, that can be developed further in the future to position the cluster in a global market?

16. What do you think needs to be done/what needs to exist in order to secure future job opportunities in the vehicle electronics and connected services industry within the Västra Götalandsregionen? Give examples!
17. Considering this industry, it is right now undergoing some major changes. Do you believe that there are any actors from other industries that we can interview in order to broaden our view?
18. Have you ever come across the term Cluster, and if so, how do you define it?
    Our definition of clusters is: *"A cluster refers to geographically co-located businesses and institutions, collaborating and sharing technological knowledge within related industries."*
    a. Do you think this is accurate?
19. Is it a cluster in the vehicle electronics and connected services industry within Västra Götalandsregionen?
20. How do you think others view the vehicle electronics and connected services industry within Västra Götalandsregionen from a global perspective?
21. How much do you believe your company will grow in the following 5-10 years when it comes to number of employees?
22. How much do you believe that the industry will grow in the following 5-10 years when it comes to number of employees?

Appendix B

The used data for calculating employment

Regards employees with the age of 16-64, within SNI 29-30 manufacturing transportations in Västra Götalands län.

SSYK 96	Profession	2008	2009	2010	2011	2012	2013
***	Osäker uppgift	62	57	41	88	95	103
1225	Driftchefer inom finansiell verksamhet, fastighetsbolag, företagstjänster m.m.	11	12	11	14	14	15
1236	IT-chefer	32	30	30	41	45	48
2131	Systemerare och programmerare	313	309	298	335	379	401
2139	Övriga dataspecialister	205	182	172	184	188	212
2143	Civilingenjörer m.fl., elkraft	75	74	71	75	83	86
2144	Civilingenjörer m.fl., elektronik och teleteknik	428	442	449	538	500	551
3113	Elingenjörer och eltekniker	181	197	214	201	216	228
3114	Ingenjörer och tekniker inom elektronik och teleteknik	137	139	150	192	219	243
Total		1444	1442	1436	1668	1739	1887

SSYK 12	Profession	2014	2015
***	Osäker uppgift	634	689
1311	IT-chefer, nivå 1	9	17
1312	IT-chefer, nivå 2	51	56
1342	Chefer inom arkitekt- och ingenjörsverksamhet, nivå 2	5	27
2143	Civilingenjörsyrken inom elektroteknik	353	2096
2511	Systemanalytiker och IT-arkitekter m.fl.	60	121
2512	Mjukvaru- och systemutvecklare m.fl.	193	190
2514	Systemtestare och testledare	12	13
3113	Ingenjörer och tekniker inom elektroteknik	461	833
Total		1778	4042

Regards employees with the age of 16-64, within SNI 62-63, computer programming, data consultancy and information services in Västra Götalands län.

SSYK 96	Profession	2008	2009	2010	2011	2012	2013
***	Osäker uppgift	740	460	666	887	915	1127
1225	Driftchefer inom finansiell verksamhet, fastighetsbolag, företagstjänster m.m.	13	16	16	30	34	32
1236	IT-chefer	184	173	175	172	161	167
1315	Chefer för mindre företag inom finansiell verksamhet, fastighetsbolag, företagstjänster m.m.	127	146	154	162	181	146
2131	Systemerare och programmerare	5476	5476	5427	5519	5729	5690
2139	Övriga dataspecialister	469	582	670	637	643	603
2144	Civilingenjörer m.fl., elektronik och teleteknik	189	189	186	187	171	202
3113	Elingenjörer och eltekniker	13	11	9	9	9	8
3114	Ingenjörer och tekniker inom elektronik och teleteknik	72	83	120	153	159	183
Total		7283	7136	7423	7756	8002	8158

SSYK 12	Profession	2014	2015
***	Osäker uppgift	1493	1816
1311	IT-chefer, nivå 1	68	135
1312	IT-chefer, nivå 2	393	320
1342	Chefer inom arkitekt- och ingenjörsverksamhet, nivå 2	29	36
2143	Civilingenjörsyrken inom elektroteknik	182	275
2511	Systemanalytiker och IT-arkitekter m.fl.	808	807
2512	Mjukvaru- och systemutvecklare m.fl.	3912	3932
2514	Systemtestare och testledare	413	377
2516	IT-säkerhetsspecialister	43	54
3113	Ingenjörer och tekniker inom elektroteknik	85	84
Total		7426	7836

Appendix C

Factors from the scenario planning workshop

Factor	Description (when needed)	Critical or trend	Uncertainty; Impact
Social Factors			
Create prerequisites for diversity through meeting points	Creating meeting points for people with different background, for example different education, heritage, company etc.	Trend	2;49
Initiatives for collaboration e.g FFI or Drive Sweden	There is a need for more initiatives in the region that foster collaboration.	Trend	8;45
Collaboration/Platforms/Meeting points	The respondent thought that collaborations between parties in the cluster, sharing platforms and creating meeting points are important factors for the clusters future.	Trend	11;40
Improving "we are Europe" thinking	The respondent saw a need for interaction and collaboration with other clusters in Europe, instead of seeing them as competitors.	Trend	10;40
Available competence / education	There is a lack of competence and the right education for securing the future of the cluster	Trend	10;43
Integration	Companies must be good at integrating people with various background for reaching higher results	Critical	45;45
Autonomous drive development and rate of acceptance.	The future of the cluster depends on how well the autonomous vehicles will be developed and if it will be accepted by the big mass of customers or not.	Critical	50;50
Acceptance of cultural diversity	Companies and institutions must develop a culture where cultural diversity is seen as something positive	Neither	25;15
Do not try to only attract the most culturally deviant people	The respondent thought that Chalmers are trying to attract students from parts of the world with very different culture from Sweden. Therefore, it is less likely that those students will stay in Sweden after they graduate, if they are not able to adapt to the cultural differences.	Neither	35;25
Supply of the competence; to attract international working force to the region.	If the right competence cannot be found within the region then the cluster must search internationally after attracting individuals who possess the competence.	Neither	29;35
Visionary leader of the cluster	It will be easier to develop the cluster if there is a visionary leader or individual who wants to achieve something complex in a fast way. Then this individual would need help from all possible parts of the cluster and thus it will thrive.	Neither	35;37
The will to change	The will to change must be a big part of the culture in companies.	Neither	35;30

Skills development and movement	People are developing their competencies and changing positions between companies.	Neither	30;35
Hierarchal thinking	Hierarchical thinking in between companies can be negative for the development of the cluster because of power distributions.	Neither	15;20
Knows-best thinking	If players in the cluster believe that they have all the knowledge internally, then it will be a problem for the collaboration rate.	Neither	14;19
Technological Factors			
Many actors that drive innovation, business climate in the region	Innovations and disruptive technologies will spur from a strong business climate in the region where many actors are working together to find the best technologies.	Neither	23;25
Taking the lead of innovation	Finding innovations that can compete on an international level.	Trend	21;36
The will to support innovation from the region/government	VRG´s willingness to support innovations through funding and collaboration initiatives.	Neither	20;30
Digitalization	The digitalization of the whole society will affect the development of the cluster.	Trend	1;50
News actors within mobility	Companies that are not traditionally a part of the automotive sector can now start to compete with traditional OEM's and suppliers.	Trend	12;39
5G, cloud, owner	It is unclear how the development of 5G-technology will evolve in the near future. Also it is unclear who will own the big amount data that is stored in the clouds.	Critical	47;45
Agile, university and city of Gothenburg.	The city of Gothenburg and Chalmers University will have to work more agile and fast. Since the industry is changing rapidly, government and universities must also be able to change and cope with these changes.	Critical	35;35
Autonomous drive development and rate of acceptance.	The future of the cluster depends on how well the autonomous vehicles will be developed and if it will be accepted by the big mass of customers or not.	Critical	50;50
Competence/Resource exchange. Example is Zenuity.	Joint ventures and collaborations between companies to exchange competence and resources.	Critical	41;41
Environmental Factors			
Region that is actively working with sustainability	Whether or not Västra Götalands Regionen will have regulations about sustainable vehicles and sustainability in general.	Neither	18;24
Natural Environment	The region is a place allowing for rich outdoor life and a clean and safe environment.	Trend	5;45
Region is an attractive place to live		Critical	40;45

Housing opportunities	Housing Opportunities in the Gothenburg area are limited but will affect the development of the cluster.	Critical	48;46
Householding and infrastructure	Housing Opportunities in the Gothenburg area are limited but will affect the development of the cluster. Public Transport and other infrastructure will also affect the clusters development.	Critical	40;40
Housing availability for people moving to the region	Housing Opportunities in the Gothenburg area are limited but will affect the development of the cluster. The respondent thought that this might be even harder for people moving from outside the region since they might not have local contacts in the housing market.	Critical	41;45
Attractive City and Region		Neither	24;23
Accommodation possibilities	Housing Opportunities in the Gothenburg area are limited but will affect the development of the cluster.	Neither	27;21
Schools and education	If the region can offer high quality schools and education for children if their parents are moving to the region to work in the cluster.	Neither	45;25
Quality of university and education	That Chalmers University of Technology and Gothenburg University offers a high level of their education and research.	Neither	20;30
Minerals, and earth metals	The availability of minerals for the research of for example battery production.	Neither	19;15
Energy storing	How the vehicles will store energy in the future.	Neither	4;12
Accommodation, services, daycare.	It should be easy for people moving to the region to bring their families, and for this purpose, many various types of services are required.	Neither	26;24
Infrastructure.	The infrastructure in Västra Götalandsregionen will affect the development of the cluster, for example Public Transport, roads etc.	Neither	27;25
Economic Factors			
Business models	The business models in the automotive industry is undergoing some major changes.	Trend	9;41
New business models for mobility	Mobility as a service is a new business model.	Trend	14;43
Difficult to find competence	The need for engineers and behaviour scientists	Trend	10;45
Availability of engineers	How easy it is to find competence will affect the development of the cluster	Critical	45;48
Better and more fair funding	The respondent thought that the region and other institutions should be better at giving more funding to the automotive sector, he/she believed that the automotive sector can sometimes be put lower down on the priority list than other industries.	Critical	40;45

Development within telecom/Ericsson goes bankrupt	The automotive industry will become more dependent of the telecom industry and therefore the cluster will be dependent of the evolvement of Ericsson in the Gothenburg area.	Critical	35;42
State of the market for the industry		Critical	35;45
Price for electricity	If batteries become the main source of energy in vehicles, then it will be greatly affected by energy prices.	Critical	39;40
Possibilities and speed in the collaboration between companies and authorities.		Neither	30;25
Investments in infrastructure.		Neither	20;25
Political Factors			
Rules and regulations, society planning and time aspects	Rules and regulations will to a high extent impact the development of the cluster, for example if society planning supports autonomous vehicles or not.	Trend	9;48
Laws and regulations	Depending on legal setups and regulations, various forms of research and development might not be able to be carried out. Since the cluster is so dependent on research, this will greatly affect the development of the cluster.	Trend	14;39
Stable society, power, water, safety	It is important that Sweden is a stable society with electricity, water and high levels of security.	Trend	10;40
Globalization	Companies and other actors in the cluster are working on a global market to a greater extent.	Trend	7;49
Hinders for development due to politicians.	Politicians will personal agendas or agendas that conflict with the industry will hamper the development of the cluster.	Trend	12;39
Local authorities politicians objection towards cars and always striving for the ”best” projects, which in turn leads to the enemy of the good.	Many times, politicians must (or chooses to) fund and support the one alternative that is “most appropriate” which means that they never take any risks. Reason for this is that it takes a lot of time to complete the technology to the high level of acceptance, so during this time, new and better technology have already arrived in the market. In other words, the politicians always choose the most developed alternative which might force them to actually miss out on better technologies (=enemy of the good).	Trend	6;39
Heterogeneity of size when it comes to companies in the automotive industry.	The bigger companies have a bargain power over smaller companies and startups.	Trend	10;45
Stabile country with low levels of corruption		Trend	9;43

Allowing for competitive research by setting the right legal set up.	Sometimes legal setups can hinder the development of technological innovations.	Critical	48;48
Testing self-driving cars	Laws and regulations that affect the ability to test self-driving cars in the region in the future.	Critical	47;49
Public Transport		Critical	45;45
Flexible regulations for international competence	Sometimes, difficult and inflexible rules and regulations for international working force can hinder companies to attract the right competence for other countries.	Neither	20;30
Transportation of goods and people quick and easy		Neither	15;15
"Hindenburg disaster" within autonomous cars	If there were to happen a serious accident when testing autonomous vehicles, this might be a risk for the cluster. "Hindenburg disaster" refers to an accident when an airship caught fire in 1937, which was the end of the airship industry.	Neither	27;25
Environmental requirements, for example requirements for clean air	Environmental requirements for clean air affects the development rate of alternatives to the combustion engine.	Neither	25;30