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Identifying misalignments in the transition to a sustainable road transportation system

A case study of Gothenburg, Sweden

Master's thesis in International Project Management &
Sustainable Energy Systems

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[Misalignment clusters in the transportation system of Gothenburg]
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Abstract

Gothenburg is increasing in density and population as well as expanding its residential and commercial spaces. Due to increasing needs of the city, the current transportation system is expected to face challenges and needs to grow into a more robust, dynamic and accessible system. The City of Gothenburg has implemented the Climate 2030 strategy to curb emissions, and address other negative effects such as particulate emissions, noise, accidents and congestion that arise from road transportation. From this perspective, a host of new technologies and business models are being tested to achieve a more sustainable transportation system in the region. Therefore, this socio-technical system is undergoing a sustainability transition that involves interactions between a complex web of actors. Due to differences in visions, interests, perceptions and belief systems conflicts between these actors exist. This thesis explores the diverging interests and conflicts between actors in public administration, industry, and niche-level companies by answering the research question: ***What are the current misalignments in the transition to a sustainable road transportation system in Gothenburg?*** Answering the research question is relevant because existence of shared visions and alignment of perspectives leads to trust, stability and coherence of strategies which ensure a quicker transition. The main purpose of this thesis is to visualise the misalignments within the system and between actors and bring out the topics around which there is a clear conflict, and where there is common ground. The secondary purpose of thesis is to inspect the misalignments and understand their effects and implications. The preliminary research began by mapping of relevant actors using the multi-level perspective to get a comprehensive understanding of the system. The actors chosen included bureaucrats, executives from the freight and passenger transport industries, entrepreneurs and researchers. The main method of the thesis were semi-structured interviews which were complemented by the Q sorts and the workshop. This triangulation approach, to compare results from different methods, was done to check for consistency while formulating misalignments. Eleven semi-structured interviews were executed, followed by interviewees performing a Q sort, during which they classified statements representing different standpoints about the future system based on the level of their agreement with them. The final phase involved a workshop with a deep-dive into the causes of misalignments with the interviewees. Results were formulated as two types of misalignments classified under five misalignment clusters: (i) *the speed and nature of transition* (ii) *roles of actors* (iii) *modes of transportation* (iv) *planning* and (v) *uncertainty in the system*. The two types of misalignments presented were defined as *strategic* (present between actors) and *systemic* (present as contradictions within the transportation system). From this point, the following questions were raised for stimulating further research: (i) How to allocate/prioritise urban space? (ii) How should the data be shared? (iii) How should MaaS be embedded with public transportation? (iv) Who owns the customer? and (v) Who should buy down the cost (of new innovations/solutions)? Further analysis of the effects and implications of misalignments revealed that, strategic misalignments are bound to exist due to market competition, while systemic misalignments merit attention from all actors involved, since they present conflicts within the system that hinder the transition.

Keywords: Traffic Strategy, Sustainable Urban Planning, Transport Policy, Q Methodology, Sustainable Transportation, Sustainability Transitions, Multi-Level Perspective, Socio-Technical Systems, Challenge Lab

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Nickhil Sharma & Ville Kilpiö

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Abbreviations

MaaS	Mobility as a Service
VGR	Region Western Sweden (Västra Götalandsregionen)
TaaS	Transportation as a Service
BEV	Battery Electric Vehicle
AV	Autonomous Vehicle
OEM	Original Equipment Manufacturer
EV	Electric Vehicle
UCC	Urban Consolidation Centre
STS	Socio-Technical System
CLab	Challenge Lab
GHG	Greenhouse Gas
ICE	Internal Combustion Engine

1. Introduction

Sustainability transitions are of global interest, as the 17 Sustainable Development Goals (SDGs), announced by United Nations, are binding countries to work together with all the dimensions of sustainable development; economic, social and environmental. Many of the sustainability challenges present both, local and global aspects.

When considering the global environmental aspect, Rockström et al. (2009) use the term 'Holocene', to describe the period of stability on Earth, in terms of temperatures, freshwater availability and biochemical flows. Human actions are however, pushing the limits of Holocene, the so called "planetary boundaries" (Rockström et al., 2009). Exceeding these boundaries is expected to have drastic and irreversible consequences. One of these boundaries is climate change, and the safety limit for this boundary has already been exceeded. To tackle this challenge, fundamental social changes are required to tackle our current unsustainable way of meeting our requirements (energy, mobility, food etc.). At a broader level these environmental concerns also effect livelihoods and cause economic and social distress, and the SDGs aim to counter all three.

As Sweden is committed to these goals, national and regional strategic plans, together with the SDGs, give environmental quality objectives especially high priority (Naturvårdsverket, 2017). The Västra Götaland Regional Council (VGR) in Sweden is committed to undertaking concrete actions directing the region towards a low-carbon transition, aiming to be fossil free by 2050. The City of Gothenburg (Göteborgs Stad) has also developed a climate program which aims to achieve an "equitable and sustainable" level of greenhouse gas emissions by 2050.

This master thesis was part of The Challenge Lab and examines the transition to a sustainable road transportation system in the region. It must be mentioned here that this thesis was carried out in two phases:

(i) **Phase 1**: Involved the participation of all students conducting research at CLab during Spring 2018. With the backcasting framework in mind, and a value-based approach, the most important leverage points were identified through workshops with stakeholders, desk research and brief interviews. Research questions were them formulated around the thematic areas of mobility, urban futures and circular economy. The CLab staff designed and offered mentorship throughout this phase. The details of this phase can be found in Appendix A.

(ii) **Phase 2**: This involved designing and executing the research methods, presenting and analysing results, concluding and answering the research question. This was where most of the time was spent. The details of this phase are presented in this report.

Below a short presentation will be given of The Challenge Lab and the background of the low-carbon transition of the road transportation system followed by the purpose, research question, scope and delimitations of this thesis.

1.1. Challenge Lab

The Challenge Lab, an initiative of the Chalmers University of Technology, takes on sustainability challenges in the Region West Sweden (Västra Götalandsregionen or VGR). The collective future of planet earth is complex as it presents the massive challenge of sustaining 10 billion people, their environment, economy and society, and in this context, the idea to begin tackling some of these challenges at a local scale was initiated by students. The CLab, thus, aims to empower master's thesis students as "change agents" who use it as a neutral arena for different instances to meet, discuss, engage and co-create.

The full potential of the CLab to be a long-term change agent in the region can be attributed to its goal to be a neutral space bringing actors from the public sector, industry and academia of the region, which in turn is realized by the students who lead the CLab process. The students work together with stakeholders and academic researchers and focus on managing sustainability transitions rather than just technological solutions. Trust building in the socio-technical system is one of the main purpose of the CLab process.

In the CLab thesis, the backcasting process (Holmberg and Robert, 2000) is used by the students deal with the regional challenges in two phases. The first phase involves engagement with stakeholders on a strategic level to get an overview and understanding of the system from various perspectives and then identifying critical leverage points. The students then formulate the research question(s) that become the theme for the second phase. A process then follows to dive deeper into the leverage points along with more specific regional actors. The results from this process are then summarized and discussed, and conclusions and recommendations presented to the stakeholders.

1.2. Thesis background

A major contributor to climate change are the greenhouse gas (GHG) emissions from fossil-based energy. Within European Union area, the transportation sector is producing 24,3%[1] of these (GHG) emissions and is the only sector where the emissions are increasing (Eurostat, 2015).

Even if at the global scale, Sweden and VGR are minor contributors to the GHG emissions (1.3% at the EU-28 level, European Commission, 2017) the negative impacts of the transportation sector concern and affect residents, as in the Region Western Sweden, CO_2 emissions from transportation sector account for 34%[2] of the total share. In addition to the pollutants, the transportation sector is facing other challenges, such as traffic congestion, road safety and limited urban space. With the plans of Gothenburg city to expand, these problems are expected to become even more critical. Therefore, there is a need for transition to a more sustainable transportation system.

[1] GHG Emissions from Transport – 2010
[2] Nationella emissionsdatabasen [1]

The transition in itself is complex due to the direct relation between the transportation sector and the regional economy and well-being - any changes made to the transportation system have to be made with deliberation. Furthermore, it involves interactions between politics, industry, and the civil society. This places it high on the list of actionable items of most planning or strategic administrative units, not just in Gothenburg but across the globe.

Gothenburg is an important economic centre as it handles 30% of Swedish foreign trade[3]. Its strategic location, presence of educational institutions, and large industries make it an important urban centre, one which is expected to experience a significant growth in population over the next few decades. Simultaneously, the new RiverCity project will change the way the city is structured, and cause densification in the city centre[4]. These rapid economic developments are expected to be complemented by an increased and robust passenger and freight transportation system. To respond to the growing economic needs of the region in a sustainable way is detrimental to its stable future and addressing challenges in this area is valuable. These were the prime reasons to explore the transition in this sector.

1.3. Purpose and research question

Building on a study by Walraven (2010) around alignments of organisational perspectives, the transition to a more sustainable road transportation system not only involves implementation of system-level innovations like the electric vehicle, but also enabling processes like developing the charging infrastructure around it, developing policies to ensure market uptake, and implementing energy system models which ensure electric grid security. For these innovations to be implemented, interactions between a complex web of actors is required. The existence of shared visions and perspectives between the actors that are involved is a basis for trust and smooth collaboration in between them. According to Walraven (2010) it is vital to ensure that the actors that are involved are aligned to co-create a robust basis for the development of coherent strategies, ideas and knowledge to implement innovations and enable the transition.

However, planning and development of road transportation system in and around Gothenburg is currently fragmented – a conclusion made after reading the goals and visions enumerated by the strategy documents of regional actors such as the urban transport administration[5] and the national transport administration[6] have different focus areas and priorities. Conflicts among actors, differences in arriving at a shared vision of the sustainable transportation system and difficulties in collaboration were also brought up by some representatives of the urban transport administration during the dialogue sessions held during the preparatory process for the CLab thesis process (see appendix A). In this context, the idea of delving into misalignments between different actors in the region was developed.

[3] Home Page of the Port of Gothenburg [2]
[4] Home page for Investors in Gothenburg [3]
[5] Gothenburg 2035*:* Transport Strategy for a Close-Knit City [4]
[6] Swedish National Transport Goals [5]

Studies indicate that many difficulties arise during the system innovations and transitions due to a lack of alignment of ideas and scopes of the different organisations that are involved in the system (Deakin, 2001). The understanding of the perspectives of the different actors in the socio-technical system along with the sources of agreement and disagreement between them is critical for innovation strategies that require collective action (Walraven, 2010).

Thus, the main purpose of this thesis is to visualise the fragmentation in planning and strategizing for the future through a web of inter-connected misalignments and through it, developing an understanding of the topics around which there are conflicts. This will be done by first employing a backcasting approach to explore the ideas and opinions of actors about the state of the future transportation system through interviews and complementing them with qualitative analysis through Q methodology and a discussion workshop. The implications of the misalignments for the system will be discussed and suggestions will also be made for future research.

The ecological and economic consequences of misalignments mentioned above, have an obvious connection to the research around sustainable transportation in this thesis. However, there are also certain connections to the social dimensions of sustainability, that might not be so obvious. The 'horizontal relations' and 'vertical relations' of social sustainability identified by the CLab participants (see appendix A) not only include communication and cooperation between different actors across sectors, hierarchies, and industries, but also transparency and trust between them. There is a strong belief throughout the thesis that better communication for recognising and discussing misalignments will lead to a more robust, less uncertain, sustainable future. Thus, the thesis also is guided by social sustainability principles.

To fulfil the purpose stated above, the following research question was formulated:

What are the current misalignments in the transition to a sustainable road transportation system in Gothenburg?

1.4. Scope and delimitations

The topic of the thesis is limited to road-based land-transportation, ruling out the waterways and rail transportation modes. Since the understanding of perspectives around the entire road-based land transportation system is rigorous, certain modes have been prioritised. The focus point of the thesis is the role of the personal vehicle in the transportation system of Gothenburg. Other aspects of road-based land-transportation such as freight and public transportation, active mobility (pedestrians and bicyclists) are also covered in the thesis.

The guiding principle for the selection of actors for exploring misalignments was the multi-level perspective (consisting of the niche, regime and landscape). Due to limited time to complete the thesis, some relevant actors might have been missed out from the study. The selection of

interviewees (as representatives of these actors) was based on contacting key persons that are in strategic roles in their organisations and would thus be able to provide a comprehensive view of the whole system and the interactions between different actors. However, these persons were encountered as individuals and therefore, their opinions cannot be considered as representative of their organisation. Limitations of the main research methods will be highlighted in chapter 6.

The reasons behind the misalignments, their implications and solutions to resolve them are beyond the scope of this thesis and will be only mentioned briefly.

1.5. Thesis outline

Chapter 2 of this thesis will present an overview of the theories and concepts employed to analyse and understand the results of the thesis (i.e. socio-technical systems, multi-level perspective, transition patterns, and disruption framework).
Chapter 3 describes the methodology and begins with an explanation of the research design, and details backcasting, semi-structured interviews, Q methodology, and workshop as techniques used for answering the research question.
Chapter 4 shifts focus to the results of the three data-collection methods. It presents and describes results from the interviews, Q methodology and workshop.
Chapter 5 consists of two parts – the first part classifies, and details different misalignments identified through an analysis of the results, while the second part compares these findings with the theories from Chapter 2.
Chapter 6 includes discussion of the results, the limitations of the findings, a critical reflection on misalignments in the system, and recommendations for future research.
Chapter 7 contains the main conclusions from the study.

2. Theoretical framework

The theoretical framework includes theories that explain systems-perspective and theories that explain system transitions. Systems-perspective is addressed by theory of socio-technical systems and multi-level perspective. System transitions are elaborated with the theory of transition patterns and disruption framework.

2.1. Socio-technical systems

Modern culture can be inspected as technological culture, because of the strong connection to technology and science. It is not possible to understand modern culture without considering the aspects of technology and science (Bijker, 2001). According to Bijker (2001), the so called 'constructivist view of science and technology' explains this connection, as it recognises the political dimension of science and technology. Where standard view of science considers it objective and value-free and technology as an autonomous force in society, the constructivist view considers politics and science/technology rather intertwined than distinguished. Because of this intertwined nature, Bijker suggests that the development of science and technology is not a linear process of interlinked decisions, rather this development should be described as a social process. In this parallel process society shapes technology as well as technology shapes society (Bijker, 2001).

Saurin & Gonzalez (2013) explain this connection between society and technology with the term socio-technical system (STS), which includes elements of human, machines and their work environment. According to them, many systems in society can be inspected as complex socio-technical systems, as they include large number of elements that are dynamically interacting, a quality that results in unpredictable behaviours. Geels & Kemp (2007), mention these different elements being technology, science, regulation, consumer behaviour, markets, culture, infrastructure, production and supply networks. Supply-side actors (companies, research institutes, universities and policy makers) and demand-side actors (users, special-interest groups and media) create, maintain and refine these elements (Geels & Kemp, 2007). According to Saurin & Gonzalez (2013) the complexity of these systems is difficult to quantify, but some common characteristics can be found. These characteristics are related to system properties and system functions. In addition to a large number of dynamically interacting elements, system properties can be defined with diversity. Saurin & Gonzalez (2013) define diversity with differentiation to categories, such as different hierarchical levels, which leads to division of tasks. The nature of these relations defines the degree of co-operation and information exchange. System functions again explain the resilience and unanticipated variability of the system. Unanticipated variability occurs because of the openness of the system and uncertainty in decision-making, whereas resilience occurs because of system sustainability – system's ability to adapt to disturbances and changes (Saurin & Gonzalez, 2013).

Unruh (2000) elaborates on the presented interaction between technological systems and governing institutions, with the use of lock-in mechanisms. An obvious example of these lock-in mechanisms is the carbon lock-in of industrial economies, dependent on fossil fuel-based energy systems. Unruh (2000) states the reason behind these lock-ins are the co-evolutionary processes of technology and

institutions. This co-evolution is driven by path-dependency, as positive feedback loops occur because of increasing returns. According to Unruh (2000), one of the most important example of increasing returns are scale economies, meaning that with the increasing volume of production, the production cost declines, as the fixed costs are divided more broadly. Other positive feedback loops, presented by Unruh (2000), are learning and network economies as well as adaptive expectations. With learning economies, specialised skills and knowledge improve the performance, and with network economies interdependence with technological systems increase. Adaptive expectations again reduce the uncertainty of the system, as adoption rate increases. These characteristics make market persistent and create policy barriers to alternative technologies or solutions (Unruh, 2000).

2.2. Multi-level perspective

Geels (2005), recognises the lock-in mechanisms in existing systems as a reason for the stable nature of the system. Adoption of new technologies is not related to purely economic reasons, also social, cultural, infrastructural and regulative reasons play a role in the process. Therefore, the socio-technical system should be considered as an entity, including different elements, such as artefacts, knowledge, markets, regulation, cultural meaning, infrastructure as well as maintenance and supply networks. To inspect this kind of system, Geels (2005) introduces the Multi-Level Perspective (MLP), emphasising the co-evolution of technology and society. MLP distinguishes three levels in the system: meso-level of socio-technical regimes, micro-level of technological niches and macro-level of the socio-technical landscape, as presented in the figure 1.

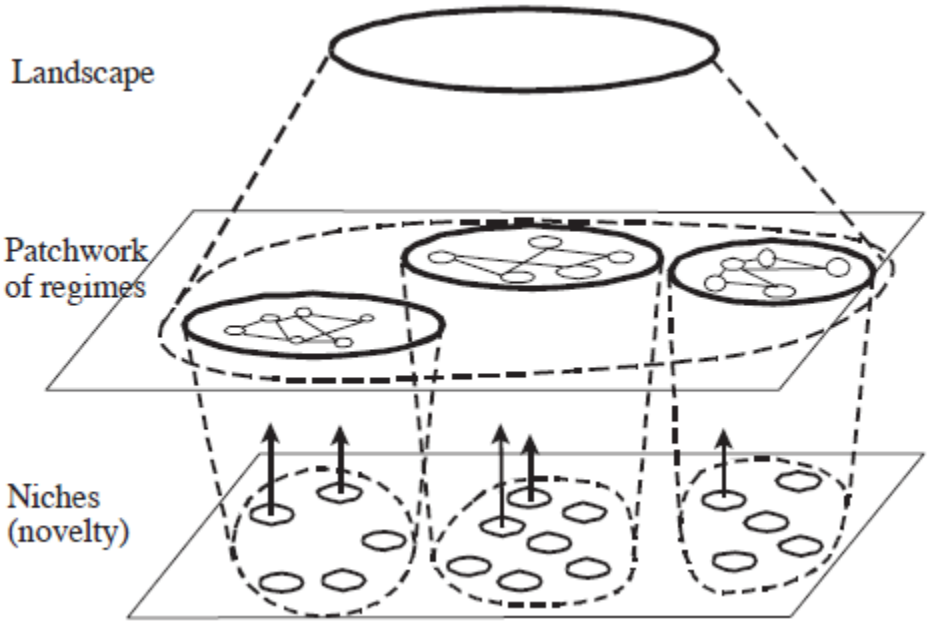

Figure 1: Multi-level perspective introducing three levels of the socio-technical system (Geels, 2005)

Socio-technical regime is described to establish the deep structure of the system, i.e. existing practices and semi-coherent set of rules, which lead to the stability of the system (Geels, 2011). The dynamics of regime are based on the meta-coordination of different sub-regimes, which interact according to established rules. These rules coordinate the activities within the sub-groups and these groups again reproduce more elements of socio-technical system. The rules themselves have dual-structure; actors of the socio-technical system utilize the rules and turn them to concrete actions, and on the other hand, rules configure the actions themselves. Examples of such rules are cognitive routines and shared beliefs, common practices, institutional arrangements and regulations as well as contracts (Geels, 2011).

Niches are described as favourable platforms for innovations to occur, for example research & development laboratories, demonstration projects or emerging innovations answering to very specific demand can provide such a platform (Geels, 2011). Actors in the niche level differ from the existing regime as niche actors tend to work with radical innovations. The aim of these actors is to include their innovations to the existing regime or even to replace it. Challenges that these actors face, are mismatches with existing infrastructure, regulations or consumer practices (Geels, 2011).

Land-scape level inspection takes a wider approach by broadening the context from the technical and material aspect to consider demographical trends, political ideologies, societal values and macro-economic patterns as well (Geels, 2011). The term 'landscape' captures the essence of the combined nature of all the factors stated earlier. Landscape influences niche and regime level dynamics as well as niche and regime levels influence the landscape. However, the impacts of latter are relatively slow (Geels, 2011).

Even if the landscape-level reacts rather slow, changes do happen, for reasons such as, globalisation, environmental issues and cultural changes (Geels, 2005). These changes on landscape-level create pressure to the regime-level. Regimes evolve also, but this development happens incrementally because of the stable trajectories in different areas, such as technology, policies and markets. Trajectories have their own dynamics, but they also interact and co-evolve with each other. It is this alignment between sub-regimes that creates stability to the regime but can also lead to tensions. Together with the pressure from landscape-level, this can destabilise the regime and create a window of opportunity for niche-level actors (Geels, 2011). In order to niche-level actors to utilize this possibility, internal momentum must be gathered. This can be done by selection of dominant design from different variations of niche-level innovations. The selection of dominant design occurs through learning processes regarding technology itself, market demand and business models. Broader user-base by extended networks with adjustment of expectations of visions also help niche-level actors to challenge the existing regime (Geels, 2011).

2.3. Transition patterns

Geels (2005), describes transition as a system innovation, a change from one socio-technical system to another. Important aspects of system innovations are the interlinkages between elements and emphasis of co-evolutionary processes (Geels, 2005). As these processes occur in multiple levels, they link up and reinforce each other. Therefore, it is not possible to distinguish one specific cause or driver to the transition (Geels, 2011). To study these transitions, the aspects of emergence of new sectoral system and the link with the previous sectoral system are highlighted. The basic principle of transition is presented in the figure 2, where the landscape creates pressure to the existing regime and opens a window of possibility to niche-level actors affect to the existing regime. Geels (2005), identifies three co-evolutionary and sociotechnical patterns related to transitions: two-transition routes, a fit-stretch pattern and patterns in breakthrough.

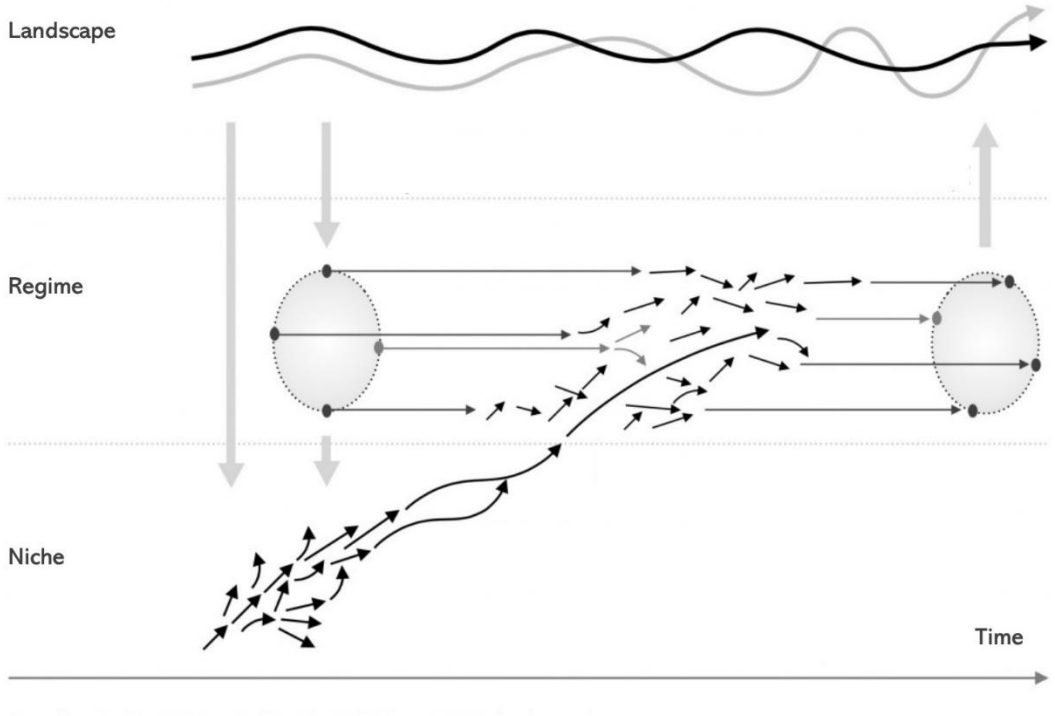

Figure 2: Transition pathway[7] (Geels, 2005)

2.3.1. Two-transition routes

Transition routes are presented with technological substitution route and wider transformation route (Geels, 2005). Technological substitution route utilizes the capability of niche-level actors to work under the radar of regime-level. Unlike the incremental development of regime-level, actors on niche-level work with radical innovations, improving the innovation and gathering momentum. Once

[7] Image (modified) source [6]

landscape-level poses enough pressure to the existing regime, a breakthrough may occur from niche-level to disrupt the existing regime. This breakthrough might surprise the actors at the existing regime and lead to destructive consequences for regime-level companies. Once the breakthrough has happened, the regime-level experience era of turbulence, before new regime establishes itself and dynamics move back to incremental change (Geels, 2005).

In addition to landscape-level changes, regime itself can face internal, persistent problems that will lead to regime to become unstable and open up for wider transformation route (Geels, 2005). In situation like this, changes happen simultaneously in multiple dimensions, for example, with policies, user preferences, technologies, infrastructure or culture. As now there are multiple different niche-level actors occurring simultaneously, the regime-level experiences fluctuation. This fluctuation is described with 'heating up', when actors experiment with multiple innovations, and 'cooling down', when options are narrowed down. Eventually, one solution can become a dominant design, leading to a creation of new regime around the chosen solution (Geels, 2005).

2.3.2. Fit-stretch pattern

A fit-stretch pattern is another way to explain the co-evolution of the technical form and social function of the innovation (Geels, 2005). In this process, technical form is the design of the innovation, whereas, social function covers the user context and functionality of the innovation. Both, the technical form and social function, fit to the existing regime at the early stage of the transition. Interpretation of the new technology through the dimensions of existing regime, leads to gradual development process. In this process, technological development leads to new technical forms and user experiences lead to new functionalities. Added functionalities and new ways to use the product stretch the original purpose of the innovation, which leads to wider diffusion. Once the diffusion leads to adaption, new socio-technical regime is established around the innovation and again, form and function of the innovation, fit to the new regime (Geels, 2005).

2.3.3. Patterns in breakthrough

According to Geels (2005), the crucial point for patterns in breakthrough, is when niche innovations enter to mainstream market. At this point they are exposed to the competition with existing technologies and wider changes in regime are possible. In addition, to connections with ongoing processes at regime and landscape level, internal drivers are important for wider diffusion to happen. These drivers can be economic, such as price-performance related, as well as socio-technical or social drivers. Geels (2005), introduces three different socio-technical patterns in breakthrough: niche accumulation, co-evolution of technologies and actor-related patterns.

Niche accumulation occurs, when the diffusion of innovation from specific technological or market niche is further used in subsequent application domains. This trajectory of niche accumulation creates new niche markets, where the new innovations are being used (Geels, 2005).

Co-evolution of technologies is explained with different forms of connections between multiple technologies. Interlocking of technologies occur, when new technology is facing problems or constraints, that another technology can solve. Technologies are separate but dependent on each other. Technical add-ons and hybridization occurs, when technologies are co-existing, old and new technology form a symbiosis instead of competition at the beginning of transition. Sequential accumulation occurs in situation, where the first new technology acts as a catalyst and provides a platform to later technologies to build on (Geels, 2005).

Actor-related patterns take a process approach to MLP, as in this case the emergence of new regimes is explained with multiple developments gradually linking up and reinforcing each other. Actors have important role in the process, as they are the ones making the linkages between different developments. These actors can be related to companies, policies or users and cultures. As the actors have their perceptions and strategic interactions, the process becomes non-linear with accelerations and slowing downs, depending on the actions of different actors (Geels, 2005).

2.4. Disruption framework

Seba (2016), describes a product or service, that is creating a new market, while considerably weakening, transforming or even destroying the established market segment, as disruptive. The disruption framework of Seba (2016), is based on convergence of technologies, which enables exponential adaptation of new innovations. Technologies develop at different speed, but once they converge at a certain point, they allow new disruptive products or services to enter the market. Innovative products or services require different technologies to be mature enough, for example smart phones required digital imaging, touchscreens and different sensors to be developed enough, in order to manufacture the smart phone itself. Seba (2016), implies that disruptive technologies have potential for systemic disruption. This means that, disruptions can have effects, that are greater than single market category. Such a disruption can impact the whole economic sector with revolutionary consequences. An example, that is given by Seba (2016), is Transportation as a Service (TaaS) and its potential to impact on parking policies, insurance business and road infrastructure.

Seba (2016) introduces four models for disruption to emerge; disruption from above, architectural disruption, disruption from below and big bang disruption. These models differ, for example by their level of performance and price, compared to established products. In disruption above -model, the disruptive product is superior by its performance but more expensive than products in established markets. The price is however decreasing because of technological cost curves to the point it becomes less expensive than the competing products. This is the point, when disruption happened, and it can be predicted by interpreting technological cost curves. The extent of disruption can be hard to realize, as usually these disruptive products are not just direct substitutes, but they offer additional value with new features or purposes to use (Seba, 2016).

According to Seba (2016), architectural disruption happens, when disruptive technology impacts to the system in the extent how products or services are produced, managed and delivered. An example

of such a disruption is the role of solar panels and high-capacity batteries in decentralizing energy production and by doing so disrupting the whole sector of conventional energy production.

Seba (2016), introduces the model of Christensen, when describing the disruption from below. Unlike in the disruption above -model, the innovative product or service is inferior at the point when introduced to markets from niche-level. However, this niche-level technology improves the performance and decreases the cost faster than products in established markets and therefore, disrupts the market segment.

The fourth disruptive model that Seba (2016), introduces, is the big bang -disruption by Downes and Nunes. In this model, the disruptive product or service is superior by all measures; cost, performance, etc. Products in established markets don't have time to react for such a situation, and the market dynamics are quickly disrupted.

Convergence of technologies is making the disruption possible, and Seba (2016), explains the convergence with technology cost curves, business model innovation and product innovation. *Technology cost curves* explain how much the technology is improving economic-wise over time, for example the cost per kilowatt, when analysing lithium-ion batteries ($/kW). The improvement happens, because of multiple factors; increasing manufacturing and investments, research and development, standardisation, market segment growth and increased knowledge. Important thing about these cost curves is their exponential nature, which Seba (2016), explains with Moore's Law and compares different technologies with it – how long it takes for technology to double its performance. However, cost curve improvement is not static, there can be fluctuation with the speed of development decreasing and accelerating, which makes the prediction of the disruption harder.
Business model innovation is explained by Seba (2016), to explore new possibilities of value creation in the value network, i.e. exploring possibilities of capturing value in new ways, that are made possible by the technology converge. Business models don't need to be completely new, existing business models can be utilized in new markets as well. Seba (2016), gives example how ride-hailing services, that were made possible by converge of smart phones and cloud service, renewed the old brokerage business model by taking a share from each transaction made by the customers. Seba (2016) states that, as the business models are renewed, also new set of metrics are created. Seba raises an example from music industry, where business model of music streaming created new indicators of success, number of plays instead of albums sold.

Product innovation elaborates on the earlier statement, that new disruptive products are not one-to-one substitutes. Instead, these new products can solve problems or create value in completely new ways. These new ways can make the competition for established market products impossible. Seba (2016), gives an example of such a product with NEST learning thermostat, that is instead of just keeping the selected temperature, creating more value by monitoring the occupancy of rooms and electricity prices and adjusting itself accordingly.

Seba (2016), introduces disruption accelerators, that can increase the disruptive potential of technologies. Open access to technology and capital can lower the costs of development and therefore, increase the speed of development as well as lower the barriers to entry for new actors. Other favourable effects of open access technologies are the increased speed of developing knowledge, skills, data and invention. In addition to favouring new innovation development, open access technologies also reduce the power of established companies to defend market positions and prising power. Seba (2016) points out that, open access technologies reduce the need for in-house building and advantage of scale. This creates a situation, where the number of potential disruptive competitors rises dramatically, as barriers to enter lower. Another addition to disruption accelerators are conceptual innovations. According to Seba (2016), these can be concepts, methods or models that are revolutionising the market segment. Seba (2016), gives an example of conceptual innovation with blockchain technology, that decentralizes the monetary transactions between the actors, bypassing banks and governments.

According to Seba (2016), the impact to market and system dynamics is exponential growth, rather than linear growth. The technology adoption lifecycle S-curve occurs because of economies of scale, network effects and increasing returns. In this context, demand side economies of scale are relevant. It is based on the number of users, rather than number of unit production, a feature that is common in information economics. Seba (2016) states that, another important feature is the inter-connectedness of users, because each joining user adds the value of the network. The value of network increases exponentially as the number of possible connections multiply with each joining user. Increasing number of users leads to increasing returns, since as the product or company acquires more users, the more value it creates, which again attracts more users (Seba, 2016).

3. Methodology

In order to understand the land-based road-transportation at system level, it is important to consider the societal functions of the system. Therefore, transportation system is treated as a socio- technical system in this study, including elements of technology, science, regulation, consumer behaviour, markets, culture, infrastructure, production and supply networks. As transportation system builds on the interaction of multiple actors, the multi-level perspective (MLP) from Geels (2005) is utilised in this research. This model places actors at different levels, depending upon position in the system. The model is utilised in the interviewee selection, as mentioned in the section 3.2., to ensure that the data is collected from all the levels of transportation system.

As shown in figure 3, the data-collection process was divided into different stages, where different methods were utilised. These methods were: semi-structured interviews (where backcasting framework was used as a structure for the interviews), Q methodology as well as workshop and they are elaborated further in the following chapters.

Pre-interview phase included stages of desk research, formulation of sample statements for Q methodology and interview design. This was followed by interviews, that included transcriptions and Q sort recording. In the results phase, the results were compiled (from the transcripts), disassembled (coding) and then reassembled (themes). Parallelly, the Q methodology results were compiled and elaborated in the workshop.

After this, the results from the three methods were triangulated and the misalignments defined. The main patterns of transition that emerged were compared with theories in chapter 2. Finally, limitations of the study were discussed and the scope for future research described.

Figure 3: Process Timeline

3.1. Backcasting

In this study, backcasting was used to decide a semi-formal structure for the interviews. The research question investigates the misalignments in planning for a future, and it was decided that the backcasting approach would offer a holistic picture of the system. This is because it not just captures the future vision, but also offers an opportunity for the interviewees to reflect upon the current state in relation to that desired future and challenges/solutions they envision. The theory behind backcasting as applied at the CLab will be explained here.

Backcasting is a research method that starts by defining a very specific future, and then moving backwards in time to the present and defines what is needed to be done now, in the current system, in order to achieve that future step-by-step. It can be a very effective tool for conducting research that involves complex societal problems (Dreborg, 1996). The process of defining future values in the CLab is done through value-based self-leadership exercises, as well as through careful deliberation and thought experiments of evaluating the consequences of having different future scenarios. The steps involved for backcasting follow a systematic pattern of thinking and aim to provide a holistic picture of the entire system, and such a systems-level perspective is fundamental to problem solving for sustainability.

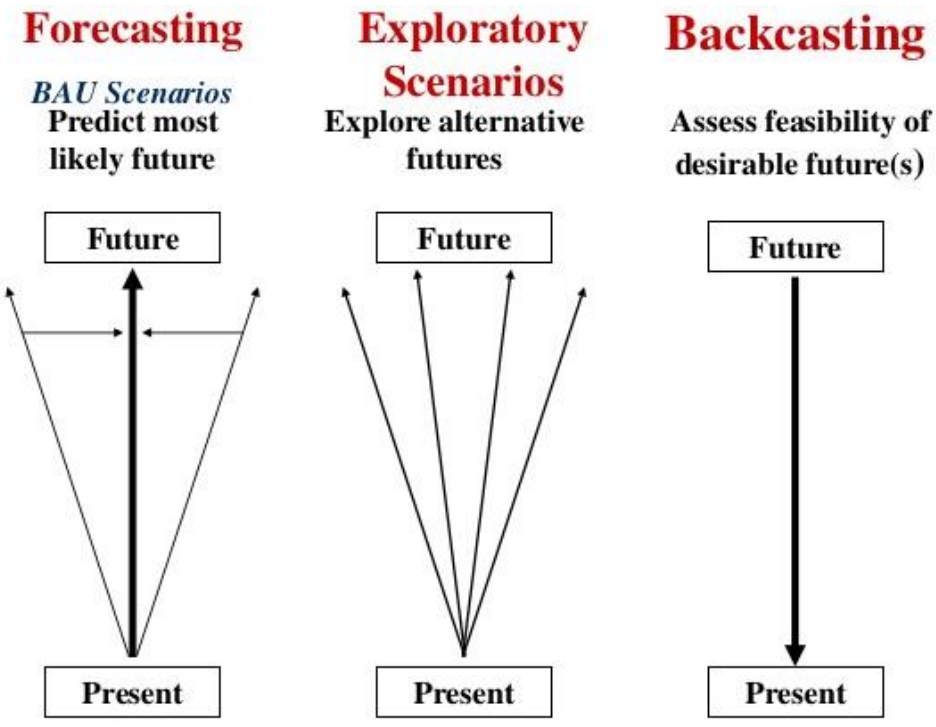

Figure 4: Distinctive features of backcasting from forecasting as depicted by Robinson (2011)[8]

[8] Image source [7]

Backcasting is the opposite of forecasting, (see figure 5) a tool widely used in various domains, since the point of origin is not the current state, but rather the desired future state (Robinson, 2011). Forecasting simply extrapolates the current system into the future, making predictions based on historical trends, which may lead to an undesirable future state. The strength of backcasting lies in defining criteria for the future, which are desirable by the set of individuals doing the research, and it avoids the assumptions that forecasting makes while being less prone to errors arising from uncertainty that affect forecasting. Below, the steps involved in backcasting as followed at the CLab and developed by Holmberg and Robert (2000) are presented.

Step 1: Defining a framework for sustainability
This step involves specifying quite concretely a value-based framework. The framework consists of certain principles that need to be adhered to in order to achieve the desired sustainable future. The principles themselves are defined based on a number of criteria laid out by previous studies (Larsson and Holmberg, 2017). The exact process followed will be described in the next section.

Step 2: Examining the current situation
This involves in exploring and understanding the complexities of the current system. The situation is first understood through dialogues with different stakeholders, short interviews, and literature reviews. Questions researched through this process include but are not limited to: 'What are the current competencies of the system? What competencies are missing? Are some stakeholders missing from the picture? What activities and initiatives for sustainability are currently existing?' This gives a holistic picture of the system, and when compared with the framework defined in step 1, can present some leverage points in the system which require special focus.

Step 3: Visualising future scenario
By knowing what is desirable in the future (step 1) and knowing what the current system looks like (step 2), the third step focuses on envisaging possible components of the future. The vision can be broad and/or from a bird's eye perspective but must be within the framework defined in step 1. Understanding the current competencies, and the complexities of the network of different stakeholders in the step 3 helps in ensuring that the future scenarios described in this step are realistic and pragmatic.

Step 4: Determining strategies to transition to the future scenario(s)
The ultimate step involves finding strategies to fill the gap that exists between the current state (step 2) and the desired future scenario (step 3). It is very important that while finding these strategies, the framework defined in step 1 is considered very carefully because, it ensures that the strategies don't create new problems while trying to solve existing ones. Strategies can be complete quick-fixes to the current system which solve small, relevant problems in an efficient manner, or could also be a small first step in attempting to solve a more complex problem.

3.2. Semi-structured interviews

According to Yin (2013), one of the most common techniques of qualitative research are the semi-structured interviews. The process suggested by Yin (2013) for semi-structured interviews was adapted and used to understand, evaluate, and compare the insights, ideas, opinions, values and beliefs of different stakeholders around the future road transportation system in Gothenburg. While a lot of this subjectivity can be deciphered from their goal/strategy documents, it was considered important to explore them in more detail and understand the reasons for these organisations to have such strategies. The same questions were asked to all interviewees, with additional questions to each interviewee based on their specific area of work, interest or expertise. This provided multiple sources of evidence for opinions around similar topics (Yin, 2013).

In order to understand misalignments, it was decided to have a broad approach of trying to understand the entire system and its interactions. So, even though a question about misalignments was asked to all interviewees, a lot of other questions about the transportation system were asked. The responses were then further analysed for misalignments. Thus, both perceived misalignments and actual (the ones that emerged after analysis) will be presented in subsequent chapters.

Interviewee selection and interview design

The participants for the interviews were selected based on the MLP theory (Geels, 2005) and stakeholders from the regime, landscape and niche-level were chosen (see figure 5 below). The reasoning for this selection was that the MLP theory facilitates visualizing the complex interactions between various actors in a socio-technical system. The interviewees held administrative positions in their respective organisations and/or had knowledge about their sustainability strategies (see Table 1 list of organisations). In the table, the organisations have been placed in one (or more) levels of the MLP (Geels 2005). The limitations of the arguments provided in the table for the placement will be explained in chapter 6. The figures in green indicate that the representative(s) was also present in the workshop. The questionnaire for the interviews were designed based on the overarching concept of the backcasting principles (see section 3.1) and thus captured the future state (desired) of the transportation system, the current state, and the challenges in achieving the transition from now to that future. Strategies and solutions to do so were also covered (see appendix B for questionnaire).

Name of the Organisation	MLP Level	Number of representatives from the organisation	Description
National transport administration (Trafikverket – 'TV')	Landscape	1	The actors that influence both region and nice dynamics, and include structures, institutions, political ideologies, societal values, beliefs and concerns etc., were placed in this level (Geels, 2005). Typically, the landscape is a "metaphorical space" where dynamics of the socio-technical universe play out (Geels, 2005).
Urban transport administration (Trafikkontoret – 'TK')		2	

Regional development authority (Västra Götalandsregionen – 'VGR')	Regime	1	The actors placed at this level benefit from well-developed systems around them. They enjoy stability in the socio-technical landscape since they have existing technologies, regulations, user patterns, infrastructures, and cultural discourses that favour them (Geels, 2005). Innovation is incremental and slow in these organisations because of path dependence and lock-in.
Car manufacturer (Volvo Cars – 'VC')		1	
Truck manufacturer (Volvo Trucks – 'VT')		1	
Logistics provider (DB Schenker – 'DBS')		1	
Infrastructure consultant (Sweco – 'SW')		2 + **1** (only in the workshop)	
Mobility collaboration platform (Drive Sweden – 'DS")	Regime/Niche	1	This organisation was placed in between the regime and niche level because it doesn't fit the standard definitions of any of the levels described in the MLP perspective. It is a platform for actors to collaborate with each other in a cross-functional way and together determine the future of sustainable mobility in the region. Thus, even though it is a novel idea (placing it in the niche), it consists of actors from the regime interacting around projects and was hence placed in between the two levels.
MaaS provider (UbiGo – 'U')	Niche	1 + **1** (only in the workshop)	The actors that present novel ideas and aim to compete with the regime were placed on this level. Described by Geels (2005) as the "seeds of systemic change", these niche-actors are aiming to demonstrate the disruptive potential of their respective solutions in specialized markets or in scalable-pilot applications. They are characterized by rapid innovations.
Logistics provider (Einride – 'E')		**1**	

Table 1: List of organisations that were part of the research process through representatives.

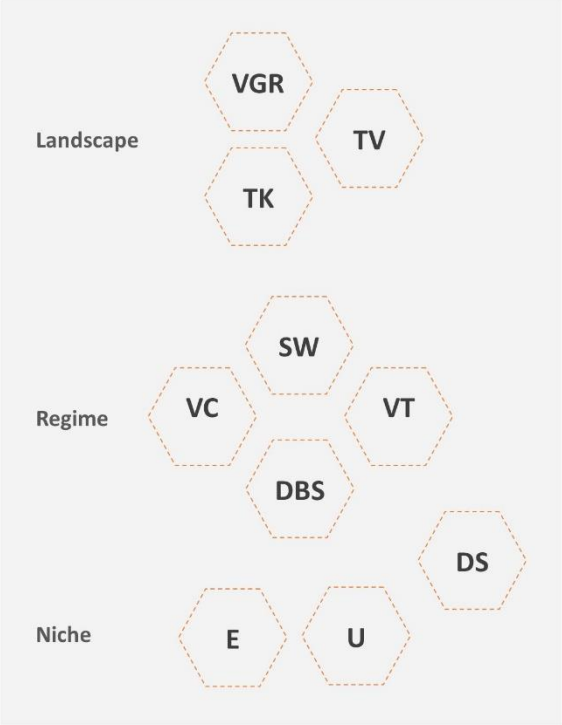

Figure 5: List of organisations that participated in the study through representatives with MLP levels (Geels 2005) assigned. The codes for each organisation have been assigned in Table 1.

Interview execution

The interviews followed a conversational mode presenting the opportunity for two-way interactions. In total, 11 interviews with a duration from around 45 to 90 minutes were conducted in-person. Apart from the interviewee(s), there was a main interviewer and an observer, with the latter stepping in if required. The questions were asked in the general format (presented in appendix B), but the sequence varied depending upon the topics brought up by different interviewees. The questions were designed to be open-ended, allowing for a broad answer where the interviewee used their own words to express their thoughts on the issue, without using words and expressions fed by the researchers (Yin, 2013). Any specifics/or significant replies that emerged from within the answers were clarified further. The interviews were audio recorded after seeking permission from the interviewees and transcribed verbatim[9]. Further, notes were taken during the interviews by both the interviewer and the observer, capturing the most significant findings related to the research question. They were later compiled after a post-interview comparison and discussion.

Interview results

The extraction of interview results was carried out in three phases suggested by Yin (2013): the first analytic phase, consisted of compiling data into a formal database with a semi-formal coding

[9] The transcripts are not included in this report but can be made available on request.

procedure. Statements from each interview transcript were chosen separately by each researcher and assigned a code/codes representing the topics (see list of topics, appendix B) already covered during the interviews. After each interview there was a discussion where the individual categorization by each researcher was discussed, and the statements that both researchers agreed upon were compiled into the final database. The second phase involved disassembling the data in the database and grouping the most important statements within a topic together to visualise themes. The themes that were used are: logistics, MaaS, public transportation, electromobility, connected vehicles, shared mobility, autonomous transportation, urban planning, transport efficiency, collaboration, and take-aways. The third phase, reassembling, involved using existing knowledge and insights to bind the different statements together. It also involved visualising and presenting emerging themes within each topic.

The results of the interviews are presented in section 4.1.

3.3. Q Methodology

The study uses Q methodology which was developed in social psychology as a tool to study human subjectivity (Watts and Stenner, 2011). It sets a quantitative basis for exploring contradictions and conflicts surrounding an issue without necessarily predefining themes or patterns of thinking. Q methodology has been used for exploratory analysis of differences in opinion in transformation landscapes, as well as for studies of perspectives on environmental challenges (Bauer, 2018).

This method normally involves (i) creating a set of statements about the topic of interest, this is called the *Q sample* (ii) selecting several participants and asking them to rate these statements according to their perspectives, this is called performing a *Q sort*, and (iii) analysing the resulting Q sort using factor analysis to arrive at a discourse around the issue containing shared social perspectives on the topic. The first step ensures that an exhaustive set of statements representing a wide variety of opinions is used to create a Q sample, which reduces bias that comes from preconceived notions about the topic. Furthermore, due to its use of statistics for correlating different perspectives as expressed by the participants in their Q sorts, this method is rigorous in its analysis of the discourse (Bauer, 2018).

In this study the Q methodology was slightly modified, and the third step mentioned above was not carried out. This was because of the limited time available for research and execution, and the purpose of the study. Instead, Q methodology was used to complement the interview results. This is because the topic of interest chosen was broad and quite often the interviews were short, so some topics were missed out. For instance, during the interview with a logistics-provider the focus is more on logistics, deliveries and clean technologies but not so much about collaboration in the region or the role of the personal car. Hence, the Q sort was performed at the end of the interviews with an aim to capture the small details that could have been left out from the interviews. The results from the Q sorts performed by interviewees were extracted in such a way that the thematic areas around which

there are alignments and misalignments could be brought out clearly. The next few paragraphs will explain the method further. Limitations of this approach will be discussed further in chapter 7.

During this study, statements were picked up from the strategy documents of the city of Gothenburg[10], the West Swedish Region[11] and the Swedish Traffic Agency (Trafikverket)[12] Some statements were also formulated by the researchers based on themes like urban planning that emerged during the Dialogue Sessions organised by the Challenge Lab. They were modified and made comprehensible. This was done to frame the discourse around sustainable road transportation in Gothenburg, and to make it comprehensive by expressing different views on the issues. As Bauer (2018) suggested, the point of the Q methodology is to find indicators of conflicts. So, it was important that the statements related to values, opinions, and beliefs, but not polar statements that simply can be true or false. From a total of 45 statements that resulted, a selective reduction by CLab participants based on importance, clarity of topics, and redundancy was carried out. This resulted in a list of 23 statements (the Q sample) which were used to carry out the study (see appendix C). The participants (same as those selected for interviews) were then asked to perform the Q sort after their interview, during which they placed the statements on a template which presented a scale from -3 (statements the interviewees agreed least with while considering the future transportation system) to +3 (statements the interviewees agreed most with while considering the future transportation system). See Figure 6 for the template and a sample Q sort.

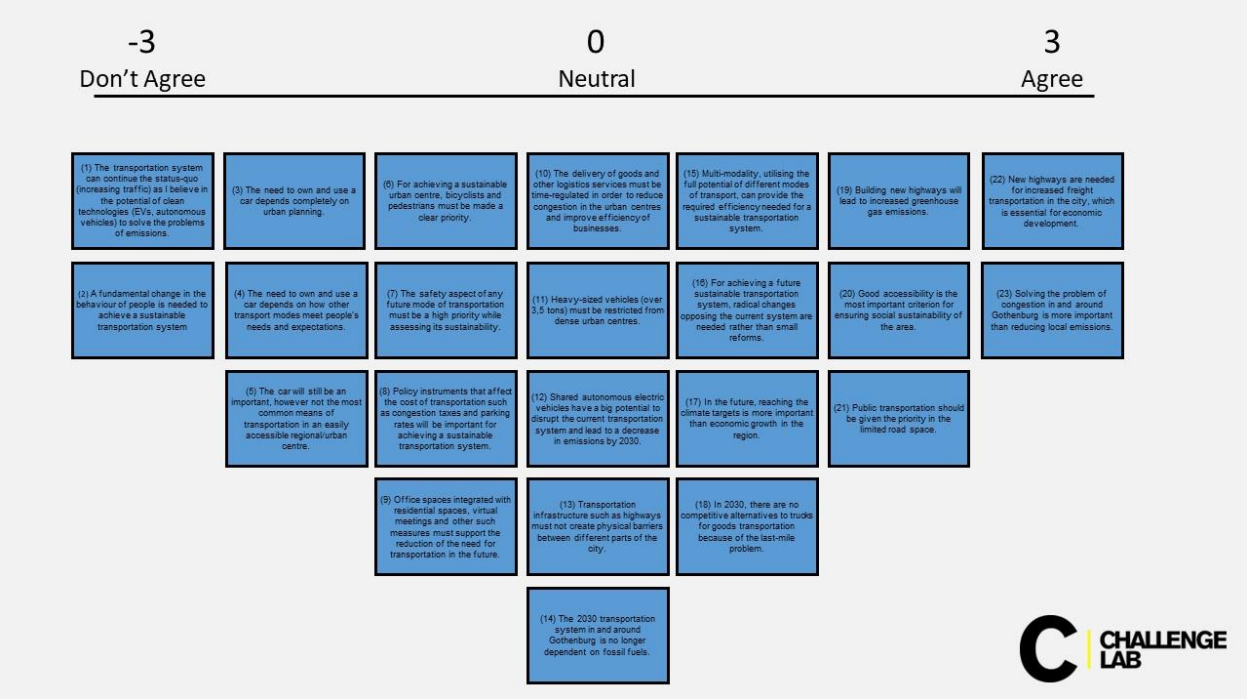

Figure 6: Q sort template with a sample Q sort.

[10] City of Gothenburg's Traffic Strategy for a close-knit city [4]
[11] VGR's Sustainable Transportation Goals [8]
[12] Swedish National Traffic Goals [9]

The Q sort was performed in presence of the researchers, and the participants were instructed to first place the statements in three piles (disagree, neutral, and agree) and then place them on the template. The participants were not asked to explain their choice at this stage, and the results were recorded as a picture.

To study the results, the Q sorts from different participants were recorded and the co-relation between them was calculated and presented in a co-relation matrix. To calculate this, the KenQ Analysis open-source software[13] was used. The initial correlation matrix represents the relationship of different Q sort configurations with each other (not the relationship of each statement with every other statement). The matrix displayed correlation values between the Q-sorts of the different participants, and there can be both positive and negative correlation values (Watts and Stenner, 2011). A positive correlation between two Q-sorts meant that they are similar, and the greater the value, the greater the similarity between them. A 100% correlation meant they are identical to each other. For example, if one participant placed statement 22 and statement 4 at +3 and another participant placed them identically. Negative correlation between two Q-sorts meant they are opposing each other, and the greater the value, the greater the opposition between them. A -100% meant the pattern in which the statements were placed are completely opposite to each other. For example, if one participant placed statement 22 and statement 4 in +3 and another in -3.

The statements were also assigned two values which are described below:

(i) **Agreement index (Ai)**: The *mean value for each statement* was calculated, and this was used to generate the agreement index. A positive mean value indicated that on an average interviewee agreed that the statement describes well the future transportation system, while a negative mean value indicated the opposite.

(ii) **Misalignment index (Mi)**: The *standard deviation*, which is the most commonly reported and important measurement of spread of a data set[14], for each statement was calculated. This was then used to indicate the level of variance in values assigned by interviewees to each statement. The greater the value of standard deviation, the greater the variance, and hence the differences in opinion around that statement (or the misalignment). A high standard deviation or misalignment index would mean large variations in opinion, and a low would indicate small variations in opinion.

The statement number 14 was “The 2030 transportation system in and around Gothenburg is no longer dependent on fossil fuels”. The responses from interviewees on a scale from -3 (statements the interviewees agreed least with while considering the future transportation system) to +3 (statements

[13] Open-source Q methodology software [10]
[14] ‘Measurements of spread ii Variance and Standard Deviation’ [11]

the interviewees agreed most with while considering the future transportation system) and are displayed in the table 2 below.

Statement 14	*The 2030 transportation system in and around Gothenburg is no longer dependent on fossil fuels.*				
	Interviewee 1	Interviewee 2	Interviewee 3	Interviewee 4	Interviewee 5
Response (R_i) (Score)	-3	-1	0	-2	-3

Statement 14	*The 2030 transportation system in and around Gothenburg is no longer dependent on fossil fuels.*				
	Interviewee 6	Interviewee 7	Interviewee 8	Interviewee 9	Interviewee 10
Response (R_i) (Score)	0	-1	2	0	3

Statement 14	*The 2030 transportation system in and around Gothenburg is no longer dependent on fossil fuels.*		
	Interviewee 11	Agreement index (Ai_s)	Misalignment index (Mi_s)
Response (R_i) (Score)	-2	-0.63	1.822

i = interviewee number (i=1 to 11)
s=statement number (s=14, in this case)

Table 2: Sample data for statement number 14

The agreement index was calculated as the mean of the responses as follows,

$$Ai_s = \frac{\sum_{i=1}^{n} Ri}{n} = \frac{\sum_{i=1}^{11} Ri}{11} = \frac{-7}{11} = \mathbf{-0.63}$$

where s=14, representing statement 14 and n=11, number of statements.

The misalignment index was calculated as the standard deviation of the responses as follows,

$$Mi_s = \sqrt{\frac{\sum_{i=1}^{n}(Ri - Ai_s)^2}{n-1}} = \sqrt{\frac{\sum_{i=1}^{11}(Ri - Ai_s)^2}{10}} = \sqrt{\frac{33.532}{10}} = \mathbf{1.822}$$

where s=14, representing statement 14 and n=11, number of statements.

Similar simple calculations were carried out for all the statements and the corresponding values of the agreement index (Ai) and the misalignment index (Mi) were calculated and the table can be found in the appendix E. The detailed results of the Q methodology are presented in section 4.2.

3.4. Workshop

Following the interviews, and a preliminary analysis of the interview content and Q-sorts, the interviewees were invited for a 3-hour workshop. The aim of the workshop was to understand and validate the results of the Q methodology as well as to gain insights into misalignments that may have been missed out (for instance, the reasons for the misalignments, and to what extent participants agree with the reasons etc.). It was organised with the support of two Challenge Lab students and all interviewees were invited. There were 7 participants in total, out of which 4 were previously interviewed. During the workshop, the participants were welcomed and taken through the steps of the research that had been completed and presented with the results of the Q-methodology.

The 12 statements which showed most alignment and most misalignments (6 each), based on the standard deviation of the Q-sorts, were chosen and divided into 5 themes (see section 4.2 for results of the Q-methodology). The themes combined similar statements together to explore bigger themes like "Public transportation and active mobility." The participants of the workshop were asked to vote for the 4 themes most relevant to them through a live online-poll and these themes were taken up for discussion in a world café format. The participants were grouped according to their opinions around the topic, with those that displayed some misalignments in the interviews and/or Q sort grouped together. The groups then moved from table to table discussing each theme for 30 minutes in a World Café format (see appendix D for list of themes for world cafe). Following this, the results were summarized and an open discussion around reflections from the workshop were carried out. During the discussion, the co-facilitators observed and took notes.

Designing and executing the World Café

The World Café is based upon seven integrated design principles[15], and is a simple, effective, and flexible format for hosting group dialogue. In this workshop, the café was used as a tool to bring out opinions around the statements which resulted in strong alignments and misalignments within the interviewee sample. As mentioned above, the statements were grouped together to form themes. Five themes emerged, and each theme was sub-divided into four questions which aimed to delve into the finer details of the statements (see appendix D). The participants were divided into two tables, and each table had a theme chosen by them through the live poll. Participants floated between the tables, ensuring that all groups have discussed all themes.

Once at the table, participants were given a 5-minute brief reflection time to ponder over the four questions around each theme. The questions were listed in the form of a grid on the table and participants discussed opinions around the questions and placed post-its on the grids for 25 minutes, before moving on to the next table. In the meantime, the co-facilitators moderated the discussion based on "hint" questions provided to them related to each sub-question, in case the conversation wasn't moving further. The co-facilitators also observed any agreements, disagreements and other important topics that emerged in the discussion on their tables. The results were then summarized

[15]Organising a world café [12]

and presented at the end of the workshop and used to stimulate a dialogue as mentioned in the previous section. The results of the workshop are presented in the section 4.3.

3.5. Triangulation

The method used in this study to derive misalignments (chapter 5) in the system was based on combined observations and inferences from the interviews, Q methodology and workshop results. This method, also called triangulation (Yin, 2013) is helpful in ensuring that biases induced by interpretation of any sort (because while writing results, inferences of a sort are made, for example, while grouping particular opinions together) are minimised by corroborating or challenging results from one method by comparison with the results of another method. Thus, misalignments are supported or challenged by combining results from the different methods.

According to Yin (2013), in qualitative research, the triangulation principle involves seeking at least three ways of verifying or corroborating an opinion, description, or fact being reported by a study. The corroboration serves as a way of strengthening the validity of this study and has been employed to validate the process of interpretation of data to find misalignments in the system. The three methods used also employ different techniques of data collection - interviews involve a two-sided conversation, Q methodology involves the interviewee giving their opinion about the transportation system without interaction with researchers or other interviewees, while the workshop involved creating ideas and consensus in a group setting, thus giving different kinds of results. Thus, if the same ideas and opinions emerge from the results of more than one method, they can be reported with considerable confidence. On the other hand, if only one source presents a misalignment in the system, while another shows alignment around the same topic, then it may raise questions which need to be investigated further.

4. Results

4.1. Interview results

This section captures the main thoughts, opinions, beliefs and values presented by the representatives of the different organisations (see section 3.2 table 1) during the semi-structured interviews that were held over a period of four weeks. The interviews were based on the backcasting principle and covered broadly the following aspects: the desired future state, the current state, the challenges on the path to a sustainable future, and strategies and solutions to get there (see figure 7 below). There were also questions regarding the perception of the interviewees about their own roles and the roles of other actors, and if they saw any misalignments in the system. However, in this section only the interview results and perceived misalignments are presented. Misalignments are analysed further in chapter 5.

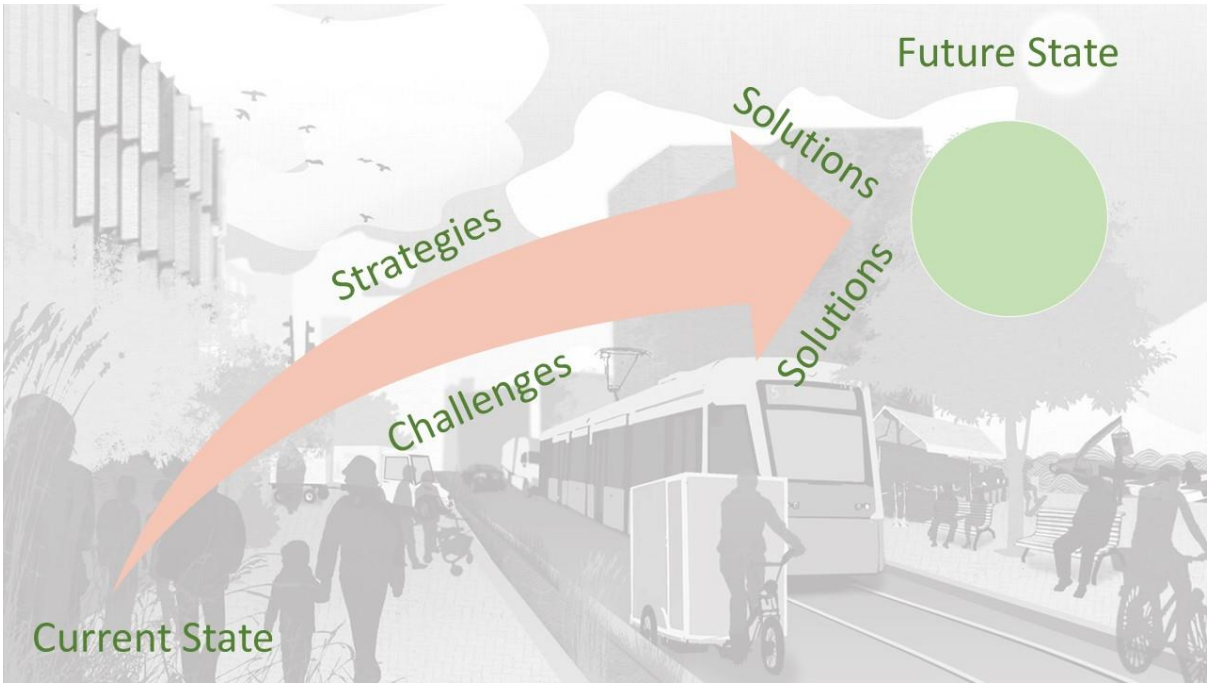

Figure 7: Interview topics based on the backcasting method[16]

4.1.1. Future State

Most interviews began with a question about the state of the future transportation system, followed by the current state, the transition (including roles, challenges, strengths and weaknesses, misalignments), and ended with strategies and solutions. It was frequently stated that in the process of the transition, many gaps are emerging in the system, especially around the use of the personal car, and these might be limitations now or business opportunities in the future. It was also stated that due to simultaneous changes in the roles, strategies and visions of entrepreneurs, transportation providers, policy makers, fleet managers, and OEMs, a lot of new solutions are being tried and tested, and everything is up for grabs. It was also the opinion of most interviewees that the transportation system

[16] Image (modified) source [13]

in and around Gothenburg has begun a transition and the momentum to a low carbon transportation system is strong.

The interviewees were asked to describe the desired state of the future transportation system and elaborate on the values that are most important in it. Certain common values such as safety, accessibility, affordability, and clean air emerged and were used to describe the future transportation system. These values were also put in context of the technologies and socio-political systems that enable them, in this section of the interviews.

From the perspectives of all interviewees, electric mobility was considered the most dominant technology, where most of the momentum was. The reason was stated as electrification being the best fit for the combined future values of low emissions, good health, low noise, and low or almost zero carbon footprint, which are shared by many actors in the region. The *representative from the region* saw it as desired because of its feasibility in the long-term, since many sources of energy can be converted to electricity, and there is near-unlimited energy supply from the sun. It was also added by them that with increase in energy use and a decrease in emissions, society will transition towards this naturally, and solutions like biofuels are short-term. There were however some disagreements about the time by which the transportation system is electrified, as some cited stringent emission laws favouring a fast transition (2030) in urban areas like Gothenburg, while another interviewee from the region opined that the complete transition would not be until after 2050 due to hurdles with the current infrastructure around EVs. It was also pointed out, due to problems with range of EVs, as well as due to more stringent emission requirements in the city centre, it is likely that there are differences in the kind of vehicles that are in urban areas and outside of them. There was however agreement that the fossil fuel-based propulsion system will play a significant role in the transportation system, at least until 2030.

A few interviewees also predicted an increase in freight transportation, and *the representative from a regime-level logistics provider* agreed that an increase in goods transportation was likely since it is essential for a growing economic region. However, there was also agreement that in the future, freight transportation could see a lot of electrification because the government will tax emissions, and that that would be facilitated by the fact that at a national level in Sweden, there is the overall climate neutral goal for 2045. There was also agreement that there could be new niches like autonomous pods that would be a more effective way of goods transportation in the future.

Automation was seen by *the representative from the urban transportation administratio*n as a key enabler of the future transportation system, which they believed would be shared and offer more options of going from point A to B. *The representative from a regime-level car manufacturer* felt that new business models will emerge and traditional roles of actors in the transportation system are likely to be challenged. They added that due to significant cost cuts expected by self-driving vehicles, improved safety, and digitalisation, the future transportation system would be safer, more accessible and affordable, and new business models would emerge in which the system would adapt to the customer needs. Once again, there were disagreements related to the time in the future when this technology would start to have system effects, *the representative from the mobility collaboration platform* predicting it following close on the heels of electrification while *the representative from the region* believing in only limited, niche-level applications like in mines or airports, but not in congested city centres. Key selling points for autonomous transportation were described as cost, efficiency, and safety by *the representative from the niche-level logistics provider* and a representative from a regime-level car manufacturer.

Interviewees also speculated that there could be different levels of applications of the autonomous vehicles (from L1-L5[17]) out of which, the L5 would be the most complex since it would require the whole transportation system to be automated. There was also a lot of uncertainties brought out by interviewees around policies and data handling of connected vehicles. *The representative from the urban transport administration* highlighted the need for discussions on data handling as crucial, since the more the fleet is connected, the more there is need for data handling, and if it is one central authority managing that information, there is a risk of totalitarianism that needs to be confronted somewhere in the future. This also brought the important question of data privacy in the system which was highlighted by *the representative from the regime-level car manufacturer*.

Shared mobility was considered an important aspect of the future transportation system but questions about the business models of both MaaS and other solutions like carpool and car sharing were raised. The universal appeal of the car as a personal vehicle, its role as the most competitive last-mile [18]solution and the obstacle of changing people's behaviour towards car ownership were seen by some interviewees such as *the representative from the niche-level MaaS provider* as big challenges to the potential of shared vehicles in reducing emissions.

The interviewees that believed in the potential of MaaS as an alternative for the future also believed that a good MaaS system is impossible without a robust and efficient public transportation system. They also stressed in finding a good business model which works for all service providers of MaaS, simultaneously creating value and profit. However, *the representative from the urban transport administration* also pointed out that with MaaS kind of models emerging, there could be positive implications like lesser last-mile problems, whereas also negative implications like competition with public transportation. They elaborated that this would imply that commercial centres will be more spread out through the city rather than being concentrated in the city centres.

Summary: Future State

- Electric mobility most likely to be dominant technology in the future because of its long-term feasibility and compatibility with future values, but fossil fuel-based propulsion to play significant role in the transportation system
- Autonomous vehicles seen as key enablers of the future transportation system – as pods for handling increased goods transportation or as shared urban passenger vehicles
- MaaS seen as a potential disruptor – however challenges described with the business model and with changing mindsets around the ownership of personal cars
- **Themes**: Electric mobility, Autonomous transportation, Data management, MaaS, Goods transportation

4.1.2. Current State

To describe the current state of the transportation system, interviewees were asked to reflect on their answers about the future state and describe where they see they are now, and in comparison, to that, highlight the current challenges.

[17] There are 5 different levels of automation with successively decreasing levels of driver assistance required, i.e., L1 – Full driver assistance to L5 – No driver assistance. [14]
[18] The last-mile problem in transportation describes the challenges in movement of people/goods from a transportation hub to the destination. [15]

When describing the current transport system efficiency, following observations were made: *the representative of the region* stated that one of the current challenges is the urban sprawl in Gothenburg, which makes the role of personal car very important in the system, both now and in the future. This was complemented by *the representative from the national transport administration*, who stated that urban sprawl makes it challenging to reach all the residents with public transportation. *The representative of niche-level MaaS provider* also saw the challenges of current urban planning, as it is stated that Gothenburg is designed for fast mobility via cars. The aspect of urban planning was also brought up by *the representative of urban transport administration*, as it was stated that cars are more seen as needed then wanted. They elaborated that the city, and especially the suburbs, were planned for accessibility with cars, and therefore the cars play a strong role. *The representative of the region* elaborated on the role of the car and pointed out that, the biggest challenge is that these personal cars are heavy, fossil-fuel propelled vehicles. Similar concerns, regarding fossil-fuel dependency in the freight transportation sector, were raised by *the representative of the regime-level logistics provider*, who mentioned that there are multiple competing alternative propulsion systems and it is hard to make a choice. *The representative* elaborated that renewal of the fleet takes long time, because of the relatively long life-cycle of the vehicles (elaborated on the following sections). On the manufacturers' side, it was mentioned by *the representative of the regime-level truck manufacturer* that, the technology already exists, the question is how to scale the sales volumes up and make the business model profitable.

Political decisions, or lack of them, were seen as current challenges, as *the representative of urban transport administration* stated that, politicians have set up a vision but have not really worked towards it. *The representative* also stated that, urban transport administration lacks the skills to work towards visionary plans (e.g. reducing emission levels), as the organisation is used to working more towards actionable plans and guidelines (e.g. building a new parking lot). Other challenge, which was brought up from *the representative of the niche-level MaaS provider*, is that the plan is to make the system unfavourable for the personal car, even if the alternatives, such as public transportation, are insufficient. In addition to the urban sprawl, interviewees saw public transportation facing other challenges also, for example, the lack of economic viability. *The representative of the region* compared the public transportation to a social service as the system works with economies of scale, and most of the routes are only profitable during peak hour traffic. *The representative* also mentioned other limitations of public transportation, as it is not possible to reach all the residents with public transportation lines, and *the representative* saw this to put limitations where people can live without owning a car. *The representative of the urban transport administration* found showing the profitability of public transportation problematic, and that the socio-economic calculations are not able to quantify the benefits of public transportation, whereas quantifying freight transportation is simplified, as freight transportation is strongly connected to the economic growth of the region.

Transportation efficiency itself was mentioned by multiple interviewees, however, in a different context for different actors. Both *the representatives of the national transport administration and mobility collaboration platform* pointed out, that balancing the road use efficiently is important. Congestion was seen as a big challenge to them, but they also mentioned, that too low occupancy of road infrastructure is not desired either (see section 4.1.4. for further details). *The representative of regime-level truck manufacturer* mentioned, that currently, there should be more focus on efficient logistics itself, not only the vehicle and propulsion system. It was also mentioned, by *the representative of niche-level logistics provider*, that the current system is missing transportation hubs, which could make multi-modal transportation possible. Currently the same mode of transportation is used both in highways and in cities.

Summary: Current State

- Role of personal car is strong, because city is designed for accessibility with cars, that has led to urban sprawl – people are scattered around, so reaching them with public transportation is not economically viable. Showing the benefits of public transportation (reduced congestion and CO_2 emissions) is also hard, as the results are not as concrete or direct as the benefits of freight transportation for example.
- There is a perceived lack of political decisions & skills in visionary planning.
- There are multiple challenges with transportation efficiency: optimal road use, efficient logistics, multi-modal transportation & transportation hubs
- **Themes**: Urban planning, Role of personal car, Economic viability of public transportation, Transportation efficiency and road use

4.1.3. Transition

Transition - chapter includes different aspects of transition to a more sustainable transportation system. Chapter covers how interviewees see their own and other actors' roles in the process, what strengths and weaknesses are present and what misalignments interviewees have experienced.

Transition Strengths
Transition strengths cover both the strengths of the individual companies in the transition to more sustainable transportation system as well as the broader context, for example, synergies, collaboration and momentum towards sustainable choices. One of the main themes, that was emerging in the interviews, was collaboration. *The representative of the urban transport administration* believed collaboration to be important to find innovative solutions between different stakeholders. This was complemented by *the representative of mobility collaboration platform*, by stating the importance of triple helix, collaboration between academia, industry and governmental levels. Also, *the representative of the regime-level car manufacturer* saw the importance of this, and especially the behavioural studies, so that they would be more aligned with customer expectations. Another benefit of collaboration between companies, mentioned *by the same representative*, was cost sharing in development projects.

Another positive trend in mobility patterns pointed out by *the representative of niche-level MaaS provider* was the increasing number of trips by public transportation. It was stated, that this is happening with or without MaaS solutions, and that the competitive edge for MaaS providers would be to complement this trend. Also, other interviewees at the regime-level pointed out that, their business decisions reflect their customer needs and slowly customers are getting interested in sustainability issues, and this might steer their products and services to be more efficient.

Interviewees considered there being multiple strengths in the process of electrification of transportation. It was stated by *the representative of the regime-level car manufacturer*, that the technology for electric vehicles is already highly developed and has proven itself to be a working concept in the urban environment, even without sufficient charging infrastructure. In this interview, the importance of right price model was also emphasized to accelerate transition to the desired electric solution. *The representative* explained company's new car leasing scheme to be one path to such a development, as this could eventually allow users to use small BEVs to cover most of their mobility need, and only use other types vehicles when the range of BEVs is not enough. *The representative* saw this car leasing scheme also as a test platform of the shared vehicles for the

company itself, as it was stated, that the customers will judge the viability of the solution. The limitations of BEV (range and load capacity) were not considered overwhelming by *the niche-level logistics provider representative*, as with automation, the fleet and the cost can be optimized, since there is no cost for driver. *The representative* believed that they could also set an example, which again could pave the way for electrification in the freight transportation as well.

The representative of the regime-level truck manufacturer brought out the strengths that connectivity and automation can provide to the transportation sector such as better efficiency and cooperation. As mentioned earlier (section 4.1.1), efficiency and safety were the drivers for *the representative from the regime-level car manufacturer* as well, as they pointed out that human errors are the biggest reason for accidents and inefficiency of the system. Automated vehicles don't have these weaknesses and they could provide safer and more efficient system. *The representative of mobility collaboration platform* complemented previous statements by stating that majority of OEMs see the need for further research possibilities of autonomous and shared vehicles in order to maintain their competitive edge.

Summary: Transition Strengths

- Collaboration needed for developing innovative solutions, finding out customer needs (behavioural studies) and cost-sharing in development projects
- Technology for EVs is already proven itself to be a working concept in urban environment. Existing limitations (range and cargo capacity) of electric vehicles can be overcome by automation. In car-leasing schemes EVs can provide the base of the mobility needs.
- Automation & connected vehicles can provide safer and more efficient system – many of the OEMs already researching these possibilities.
- Themes: Collaboration, Customer behaviour/behavioural change, Electric mobility, Shared mobility, Autonomous transportation, Connected vehicles

Transition Weaknesses

Transition weaknesses cover the challenges or lack of capabilities that the system and individual companies or organisations are facing. Regulatory framework was mentioned to be a challenge with connected and autonomous vehicles. *The representative of the mobility collaboration platform* mentioned that, there is a high risk of creating more congestion with autonomous vehicles and therefore, solutions for managing the fleet are required (see section 4.1.4). For the same reason, *the representative* mentioned that the autonomous vehicles should be also shared, and that the regulatory framework for sharing economy is missing. *The representative of the urban transport administration* pointed out that, setting the digital framework for connected vehicles is also difficult, because currently urban transport administration office is lacking skills needed for that.

From the transportation efficiency and infrastructure point of view, charging infrastructure for electric vehicles as well as volume of traffic emerged in the interviews. *The representative of the regime-level truck manufacturer* mentioned that, there is a trade-off when downsizing the truck. It was mentioned that a smaller truck is safer in the urban environment, but the amount of trucks needed could cause congestion. The question of charging electric vehicles in the residential area was mentioned by *the representatives of urban transportation administration* and *regime-level car manufacturer*. *The representative of urban transportation administration* pointed out that, charging capabilities should be considered when planning new residential areas. *The representative of regime-level car manufacturer* complemented this by stating that, infrastructure investments are crucial

before the electric mobility can be scaled up. *The representative of regime-level infrastructure consultant* pointed out the problematic nature of long-term planning, as there are still uncertainties about the demands of future transportation. *The representative of the region* mentioned that, adding features later on in the large infrastructure is costly.

The aspect of collaboration emerged when interviewees talked about transition weaknesses. *The representative of niche-level MaaS provider* mentioned that, there is almost no actor in the mass transportation who runs their operations profitably, for example public transportation is heavily subsidized. *The representative* pointed out that being one of the reasons, why service providers are hard to get on board to these mobility as a service solutions. *The representative of the region* didn't consider MaaS as a feasible alternative, as it was mentioned that, the business models builds on uncertainty and complex chain of sequences between different actors in transportation field. Another perspective to the collaboration was given by regime-level car manufacturer, who stated that there is too much focus on the product itself, not really on the auxiliary systems or enablers for the transport system (authorities, governments, regional bodies and so on). It was mentioned that technical solutions need to fit in the system. *The representative of regime-level truck manufacturer* again stated that, their organisation is not in the position to choose, what is best for the system, rather they would act upon system requirements. *The representative* added that it is better to understand the system requirements and provide solutions that fit.

The conflict of short-term and long-term planning was brought up by *the representative* of the region, as it was mentioned that system change is happening slowly, which was explained with the long lifecycle of vehicles. It was also mentioned that one of the biggest mismatches is the time factor and that, the short-term goals can be even conflicting with the long-term plans (see section 4.1.4). It was also stated, that the region can act when the window of opportunity is open, however they don't have the means to open the window. *The representative* clarified that, the region can support favourable developments, but can't initiate them since they lack the resources to do so. *The representative* elaborated that actors, who are not in the network might not see this window of opportunity opening and therefore, these actors can create external factors that are unfavourable for the development, for example unfavourable taxes or regulations.

In addition to the conflict of short-term vs. long-term planning, the challenges of visionary planning were also brought up by *the representative of urban transport administration. The representative* mentioned that, there is a need to change the organisation to work from concrete goals and plans to more visionary goals, for example reducing the traffic in the city. *The representative* pointed out that, the organisation lacks the skills to work for the decided vision. One of the existing challenges was the lack of performance indicators in the transition, it is not clear what to measure. Also testing and evaluating different solutions turned out to be a challenge for the organisation.

Consumer behaviour was also recognised as a challenge in the transition process, as *representative of the regime-level infrastructure consultant* mentioned that, the sustainable option is not always the most attractive for the customer. *The representative of regime-level car manufacturer* recognised that consumer studies and lack of robust business models were weak linkages in their organisation as well. Also, *the representative of regime-level truck manufacturer* mentioned the challenges of business models, it was pointed out that, there is no guarantees that customers will buy the solution your organisation finds the most attractive. *The representative of mobility collaboration platform* mentioned that, currently there are multiple different solutions put out to markets, without proper testing and therefore, business model disasters are to be expected during the transition.

The aspect of uncertainty was appearing when talked about transition weaknesses with the interviewees. As it was already pointed out by *the representative of regime-level truck manufacturer*, there is no guarantees that the solution organisation chooses, will be widely adopted. *The representative of regime-level logistics provider* connected to the same topic by stating that, doing bigger scale modifications to the vehicle fleet is challenging, because of the technology uncertainty. The presence of uncertainty was pointed out by *the representative of regime-level car manufacturer*, since the emerging transition has characteristics of radical change, as there are multiple things happening parallel with the electrification of transportation as well as autonomous vehicles and sharing economy. *The representative of mobility collaboration platform* concluded that many actors want to become key player in the transition, however, many of the established companies desired to simultaneously continue with the ways they are already operating. *The representative of regime-level car manufacturer* pointed out the risk of being concentrating on too many solutions and implied that focus should be given to limited number of spots.

Summary: Transition Weaknesses

- Regulatory framework seen as challenge for autonomous vehicles (to ensure that they don't create more congestion, role of fleet management, as well as the regulatory framework for sharing the autonomous vehicles).
- Charging capabilities in residential areas should be taken in consideration with new building projects, needed for scaling up the e-mobility.
- Different service providers are hard to get on board to MaaS platforms, since the economic viability of mass transportation is low.
- Challenges of planning process: long-term vs. short-term planning (goals can be even contradictory), visionary planning (lack of performance indicators & how to test and evaluate different solutions).
- Lack of behavioural studies and robust business models (in the transition).
- Uncertainty - aspects of radical change with multiple changes happening parallel.
- Themes: Autonomous vehicles, Connected vehicles, Transport efficiency, Charging infrastructure, Collaboration, Mass transportation, Long-term planning, Visionary planning, Consumer behaviour, Business models, Uncertainty

Transition roles and actors

Transition roles and actors cover the different roles organisations see themselves and other organisations having in the transition process. Regarding autonomous transportation and connected vehicles, need for standardisation emerged in the interviews. *The representative of urban transport administration* stated that, in order to make the future transportation system efficient and safe, there is a need for coordination, to set up a digital ecosystem. *The representative* pointed out the desire of urban transport administration to be proactive in finding new development projects that would help the organisation to understand their place in the ecosystem and to clarify the protocols and interfaces needed, what type of data should be shared and with whom. The question of who should operate such a digital ecosystem was raised from the urban transportation administration representative, should it be for example, national road administration or European level operator. It was also pointed out, that centralised solution is needed. Also*, the representative of niche-level logistics provider* recognised the need for standardisation to ensure safe and efficient system. It was pointed out that, also the access to the traffic data itself is crucial. On the other hand, *representative* of the urban transport administration mentioned that with the connected vehicles, there would not be need for detectors of the traffic situations, as the information could be obtained directly from the fleet. The value of the

software and data was brought up *by the representative of niche-level logistics provider*, as it was mentioned that, with machine-learning too open data-sharing would be harmful for the company's business model. The situation was seen as a collaboration vs. competition -conflict from the interviewees point of view.

The establishment of the charging infrastructure was brought up in multiple interviews. *The representative* of urban transport administration mentioned that, there is a need for harmonisation, when it comes to charging interfaces and charging itself. However, *representative* mentioned that the urban transport administration is not a big actor in this process currently. The question who should build and own the charging infrastructure was also occurring in the interview with the niche-level logistics provider. The situation where manufacturers would build their own charging grid was seen as problematic, but *representative* also stated that, if there is no grid, the company needs to build it. *The representative of regime-level logistics provider* saw the electric charging infrastructure as a combination of private and public actors, but the role of legislation to steer the business opportunities was mentioned to be important to guide the actors. Regarding the electric mobility, also the role of subsidises was mentioned. *The representative of regime-level car manufacturer* valued other type of subsidises than monetary means, for example, zoning in the city only for electric vehicles could have higher signal value. *The representative of regime-level truck manufacturer* complemented the previous statement by pointing out that, the base of the technology for electric vehicles already exists, it's only a matter of scaling up, providing market for these products. *The representative* mentioned that, immediate effects would be achieved by restrictions or taxes on existing fossil fuel -based technologies.

Collaboration was another emerging topic among the interviewees when discussing about roles and actors in the transition process to future transport system. It was stated by *the representative of regime-level car manufacturer* that, collaboration platforms are the place where the change will happen, as there all the stakeholders have the chance to make an impact. The role of urban administrators was also mentioned by *the representative of regime-level truck manufacturer*, in the context of urban consolidation centres. It was stated by *the representative* that, the city needs to take the role of providing the space and bringing different actors together. *The representative of regime-level logistics provider* also concluded that city needs to act in order to provide right circumstances to UCC type of solutions.

The role of industry was also brought up by *the representatives of regime-level logistics provider* and *infrastructure consultant*, and it was mentioned that, industry can both educate and create awareness among their partners and customers. *The representative of regime-level logistics provider* also mentioned the advantages of the organisations global network, when scaling up a new technological solution, for example. The role of triple helix was also mentioned in the context of collaboration, as the representative of regime-level car manufacturer called for collaboration between academia, especially in the form of behavioural studies, industry and users. The importance of user perspective was also recognised by *the representative of infrastructure consultant*, as it was mentioned that the infrastructure solutions need to fit in with the user behaviour. *The representative* pointed out that, they can prioritise sustainable solutions, like public transportation, in their work but they are still limited by the set of parameters given to them. Public transportation was also mentioned in the context of MaaS, as *representative of niche-level MaaS provider* mentioned the difficulties of convincing all the relevant actors on board. It was stated that, collaboration needs to bring value for all the actors in the chain. *The representative of niche-level MaaS provider* also mentioned that urban planning and public transportation have biggest impact on the transportation system, and the role of MaaS providers would be to make the system more flexible and accelerate the transition. The

importance of urban planning was also recognised by *the representative of national transport administration*, as *representative* mentioned the debate about the allocation of urban space. It was mentioned that, it is also a question of cost sharing with the urban transport administration, if the solutions were to benefit the city.

The role of governmental offices and legislation was also brought up by the interviewees. It was recognised by *the representative of regime-level infrastructure consultant* that, a big part of the transition is driven through legislation and therefore, many different organisations should be part of that legislation process. In this context, it was also pointed out by *the representative of niche-level MaaS provider* that, the cities need to take control over the streets and make sure that the system doesn't become clogged with the adoption of autonomous vehicles. A challenge in legislation, pointed out by *the representative of the regime-level truck manufacturer*, was its slow pace. *The representative* believed that if legislation allowed bigger scale trials with different technologies, it could speed up their adoption. On a different note, the current roles of the governmental offices were also brought up in the interviews. *The representative of regime-level logistics provider* mentioned that governments are trying to find solution by taxing emissions, adding that if the emissions rise too high the governments would regulate them. *The representative of niche-level logistics provider* stated that, lot of progress is happening in the workshops, regarding the legislation of autonomous vehicles. The perspective of *the representative from the urban transport administration* was that, the bureaucracy is up to date with what the industry is doing and reacting to the changes.

The role of shared vehicles and emergence of mobility operators raised the question of business models in the interview. *The representative of regime-level car manufacturer* expected the position closest the customer to be the most profitable and stated that's the place their organisation aims to be, however, in the future this could mean joint ventures with mobility operators, for example. *The representative of mobility collaboration platform* also mentioned the changes that shared autonomous vehicles might bring and expected vehicle manufacturers that, are not agile enough, to end up hardware providers for mobility operator companies. *The representative of niche-level MaaS provider* also pointed out the disruptive potential of the mobility operators and stated that the question will be if the vehicle manufacturers act as suppliers for mobility operators or include mobility operations in their business models. *The representative of urban transport administration* believed that, the transition in the mobility field will bring more freedom of choice and flexibility to users.

Summary: Transition roles and actors

- Need for digital ecosystem (some type of centralised solution) to handle the big data with connected vehicles – what data should be shared and with whom is the essential question.
- Need for harmonisation of the charging infrastructure, big question is who should establish the charging infrastructure – might be combination of private and public actors.
- Triple-helix important (collaboration of academia, industry and users) – cost-sharing in infrastructure projects – collaboration platforms have huge role in the transition as they bring the different stakeholders together.
- Urban planning and public transportation have the biggest impacts to the system – MaaS could complement this.
- Big part of the transition is driven through the legislation, so many organisations should be part of this process – governments will control the emissions by taxing and that will steer choices towards more environmentally friendly options.

- New business models emerging - how will mobility operators change the transportation system, will the vehicle manufacturers act as suppliers for mobility operators or include mobility operations in their business models – expected impacts: more freedom of choice and flexibility to the users.
- **Themes**: Connected vehicles, Charging infrastructure, Collaboration, Legislation, Business models

Transition misalignments
Interviewees were asked to reflect upon whether they feel there are any misalignments in the transportation system. They were also asked to mention actors or solutions which might be going in a different direction than their own strategy for the future. However, in this section there are also results from interviewees who reported misalignments within the current system itself, rather than specific actors. It must be emphasized here that the misalignments presented in this section are perceived by the interviewees themselves and are distinct from the ones presented later in section 5.1.

One of the misalignment brought up by several interviewees was the presence of several competing technologies to achieve similar market and policy goals. Giving historical examples, *the representative of the region* set the premise that one dominant technology always emerges from multiple competing technologies, they cannot co-exist. Their views were elaborated with an example by *the representative from the regime-level logistics provider* about the indecisiveness they face when buying new trucks as they are unsure what technology to invest in – gas or electric or hybrid, for instance. This problem is further amplified by the nature of vehicles in the transportation system – they have a long life-cycle. This means if a gas truck is bought today, it will last at least 8 years, and if there is a policy change in the future favouring electric instead, this could be difficult for the company. As will be explained further in section 4.1.4*, the representative from the regime-level truck manufacturer* believes that currently there is too much focus on technology itself rather than the entire system. Lastly, another misalignment in the vehicle manufacturers' strategy which demonstrates the uncertainty in the system was highlighted *by the representative from the mobility collaboration platform* – that the manufacturers are taking two paths, adding more features to their vehicles and at the same time investing in mobility as a service type of business.

The representative from the niche-level MaaS provider also pointed out that the business model of most car-manufacturers is directly related to personal car and low car utilization rates benefit them as there is a greater demand for cars, and this is a conflict with any form of shared mobility services. So long as the car is seen as an individual "mobility insurance" this would continue to be the case, they added. Finally, it was pointed out by *the representative from the region*, that policy makers need to bear in mind that services like Uber are utilising the existing infrastructure, and taking customers away from public transportation, and this is a conflict that needs to be addressed to reduce car use.

The representative from the regime-level infrastructure consultant observed that there is often difficulty to follow the right direction while working on projects in the city because there are conflicting ideas that emerge from goals of the city, the region and from the Swedish national level. *The representative from the mobility collaboration platform* stated that there is a misalignment when it comes to the city's goals for the new River City project as there are no credible last-mobile solutions in the vision for all the user groups. They also pointed out that there is a misalignment between the city and the regime-level car manufacturer, as the strategy documents of the city, that aim for decreasing cars in the system, could in fact be hindering their progress in the development of smarter and cleaner cars.

There was a misalignment in the system induced by a lack of directives on the amount of data sharing between connected, autonomous vehicles brought up by *the representative of the niche-level logistics provider* who on one hand believed there should be a high level of transparency and companies must share the data their self-driving vehicles gather as this would mean a better, more efficient, safer transportation system. However, if too much data is shared then, the companies might also lose their competitive edge, and therefore it is essential to find the middle ground.

Some interviewees commented that there were not many misalignments in the system. *The representative of the mobility collaboration platform* believed that since the national traffic administration is not building new highways (only upgrading the infrastructure based on requirements), there shouldn't really be a misalignment with the urban traffic administration. However*, a representative from the urban transport administration* pointed out that the national traffic administration thinks that they can use and have the same highways that work on the countryside, with the same scale, also inside the city. This is however seen as problematic and as barriers by the city authorities.

On the other hand, *the representative from the national transportation administration* believed that the real misalignment was when it comes to the city constructing housing around highways and claiming it won't cause any congestion because, the city intends to decrease the number of cars in the city. The representative presented two arguments against this: (i) any project that causes congestion in the highways is considered a problem by the national transportation administration because their aim is to ensure smooth traffic flow and building around highways would mean people access them by cars creating congestion on adjacent highways (ii) the claims of the urban transportation administration that they will reduce the number of cars do not really add up because they have done nothing to that effect. According to the representative, this stark difference in expectations arises through different styles of working. The national transportation administration adapts a prognosis-based working style, which uses facts like road investments, taxes on fuels and roads etc., to estimate how people will live in the future. This prognosis gives them a state of the system, and the need for transport infrastructure. Their numbers indicate that cars will not reduce, and they have also not seen enough efforts to think that the urban transportation administration's traffic strategy will work.

Bringing the perspectives of the region into consideration, *the representative from the region* believed that there were also some misalignments within their own plans. There is a need from the region to increase trips by public transportation, and to that effect they have been expanding it, but at the same time they have been building more roads, and this will lead to an increased travel by car. The reason for building roads is to ensure smooth accessibility and boost economic growth but *the representative* believed that it still is doing things in the opposite directions. They also expressed the dilemma they experience when planning for cars: if there are lower number of lanes for cars and it's less attractive to drive, there is also reduced accessibility which has an economic cost. On the other hand, they expressed that since there are no competitive alternatives for using the car, if there are more lanes made for cars, everyone will use them and that is also harmful for society causing congestion and emissions. *The representative* concluded this train of thought, by arguing that from the perspective of the region, economy is important and decreasing transportation capacity, implies decreasing economic growth and that also means decreased capacity of the region to provide healthcare, or education. etc.

The representative of the region stated another misalignment within urban planning, which was the trade-off between liveability and accessibility. Liveability provides space for pedestrians, bicycles and public spaces, but must be balanced with accessibility for goods transportation, which is not

possible without allocating space for transportation infrastructure. Another misalignment would be if urban planners deprioritise car use without improving other modes of transportation as this could have adverse impacts like reduced accessibility, cautioned *the representative from the niche-level MaaS provider*. There was also a conflict in the system pointed out by *a representative from the urban transportation administration* that most of the research at Chalmers has focussed on improving (and increasing) traffic flow of cars, and this would also mean that it is difficult to monitor on the number of cars in the city.

Summary: Transition Misalignments

- Speculation and uncertainty around technologies seen as a misalignment in the system – especially because most vehicles have a long lifespan and investors are afraid to invest in technologies.
- Misalignment in business models of car manufacturers – on one hand investments in shared solutions and on the other still directly related to low utilization rates of personal car.
- Even though there is a focus on reduction of cars, due to weak alternatives, decreasing the number of cars would imply decreasing economic growth and that also means decreased capacity of the region to provide healthcare, or education etc.
- Misalignment in styles of working of the urban and national transport administrations – one visionary the other prognosis-based.
- Conflict in planning and designing urban centres between liveability and accessibility – the former provides wide spaces for pedestrians and public spaces, while the latter good transport infrastructure but that is conflicting in the limited space in urban centres
- **Themes**: Urban planning, Public transportation, Styles of working, Disruptive technologies, Conflicts in future goals

4.1.4. Strategies and solutions

In this section, interviewees were asked about strategies and solutions to reach the desired future state. A host of strategies from the management, policy, technology and business perspective emerged, and will be discussed in this section.

The representative from the regime-level car manufacturer described a strategy they are using to try out if customers can move away from car ownership. (As explained further in section 4.1.3 *Transition Strengths*) They believed if they can get the customers to downsize the car they most frequently use to meet their minimum needs, that is already a step in the transition towards a more shared transportation economy.

For the electric future agreed upon by most interviewees, some strategies towards a transition emerged. *The representative from the regime-level car manufacturer* commented on the design of the EVs and considered it crucial and highlighted that a separate design and the right battery size must differentiate vehicles that are urban movers and those that ply on highways. *The representative* added further that this would be a good strategy to ensure that the urban movers with their smaller batteries do not take too much charging time, and therefore cause less congestion around the charging stations, if most of the fleet is electric. Sharing further from their experience, they mentioned that purchase cost is very important for customers to decide what kind of vehicle to buy, hence, the cost of EVs either must be subsidised or the manufacturers must sell with a less margin. However, they believed

that the chances of the latter are slim since the car manufacturers have a very small profit margin already, and their capacity to subsidise is limited. *A representative from the urban transportation administration* believed another important strategy must be harmonizing of the infrastructure, and there is a need of different types of charging like dynamic charging (charging vehicles on the go) and opportunity charging (smaller batteries that can be charged while trucks/buses are not in service) to allow for a wide range of charging infrastructure. They also added that the urban planning needs to ensure that there is enough power capacity in new areas of the city that are being developed, and all this must be designed without affecting the national electric grid. Furthermore*, the representative* pointed out that there have to be strategies to provide sufficient charging infrastructure in residential areas with limited parking spaces, as most of the charging is done at home.

Regarding urban planning issues, *the representative from the mobility collaboration platform* emphasised on the risk of congestion with more and more people opting for autonomous vehicles, and that strong policy measures and regulatory systems are needed, for which they imagined an air traffic-control like set up. They also added that that would mean important questions that need to be answered: would it be national, regional or city level? And would it vary depending upon fleet type? This check on congestion was also seen as highly important from the perspective of *the representative of the national traffic administration*.

The role of personal car was also often brought up in the interviews, and one solution to reduce emissions from car use was seen as making urban planning less car friendly and keeping the incentives for car use to a minimum. Also, different perspectives were raised by a *representative of a regime-level infrastructure provider*, who felt that it was not making car use difficult that would drive the change away from cars, but it is how efficiently other transportation modes meet people's needs – and this would mean providing high priority to public transportation while urban planning.

Another strategy being used by urban planners and real estate developers according to *a representative of the niche-level MaaS provider* is to modify principles for how many parking spaces there should be for newly built areas and trying to reduce them to make it more difficult to own a car. This in their opinion is also in favour of a shared service-based transportation system. The need for good strategies for goods transportation in the city centre was highlighted repeatedly, and it was said by *the representative from the region* that even in a dense, liveable city, you need to have goods that are going in and out, as people will continue buying and consuming.

When it came to achieving good transport efficiency in logistics, *the representative from a regime-level logistics provider* believed that the potential of connected vehicles in that domain was enormous. They believed using data about traffic in real-time, the coordination of deliveries can be made much better, which can improve both economic and ecological efficiency of the logistics system. Furthermore, they stressed the need to use consolidation as a solution, not just in terms of consolidated deliveries, but also high capacity transport which ensures better efficiency.

The representative from a regime-level truck manufacturer felt the need of continuous learning to manage the transport system. They believed in having intermodal connections and/or by improving the utilisation rate of the current infrastructure and trying to find the right mix between different solutions. While speaking of their own enterprise, *the representative from a regime-level logistics provider* highlighted the need for green and clean fuel, an efficient vehicle with a clean life-cycle and maintaining a high transport efficiency of the vehicle as their most important strategies to meet the sustainability criteria. They also brought to light the inherent requirement of ensuring high transport efficiency for logistics company as it makes "business sense" and that in that context, economy and

environment go together. Lastly, they believed that costs are a big driver for behaviour change and so legislation affecting costs like taxes can have a large impact.
Around the recent changes in the weight allowed for trucks[19] the representative from *a regime-level logistics provider* said that many times the packages being transported are not that heavy and instead for better transport utilization they need legislation that allows for longer and higher trucks.

Another important theme that emerged under strategies was around MaaS and how to unlock its potential as a disruptor in the current system. *A representative from a niche-level MaaS provider* believed that customers must have incentives to use the option of car as little as possible, even with MaaS, and that the service should be designed such that there are very little incentives to use the car. *A representative from a mobility collaboration platform* stressed on the need to have an optimum level of fleet occupancy that ensures availability of cars at all times, without clogging the system. *The representative from a niche-level MaaS provider* said that in their opinion, the service must target a geography, (an area of the city) not a demographic, implying that the regions of the city with good public transportation could also be great places where MaaS could operate. Furthermore, the current need for them is the creation of value for public transportation providers by telling them that they will get them a new customer segment they can't get themselves - "Car Owners". *The representative* also stressed on the fact that this is also the case for other companies that could be service providers, as currently they might not participate because they don't see where they make money - so value creation for all mobility providers is essential.

To market the MaaS model, it was stressed by the niche-level MaaS provider, that at the core, it must be that the service is as tangible and attractive as owning a car. This move away from ownership was acknowledged as a massive challenge by most interviewees, but *the representative from the regime-level car manufacturer* felt that young people were changing their minds and moving more towards a setup where they have this option of a solid cost per month for mobility instead of owning a car. But they added that a first step towards shared mobility could be utilising travel time to uncomplicate people's lives (e.g. sending e-mails while commuting to work).

All interviewees believed that collaborations with other players are very important to achieve the transition. *A representative from a regime-level infrastructure consultant* stressed the need to collaborate early in the projects, from planning to procurement to execution and implementation in order to avoid having add-on features in the end as this was not feasible. The co-development of new products was mentioned by *the representative from the regime-level car manufacturer*, who cited co-development between companies, such as sensor and algorithms development as an example for benefits like cost-sharing. Commenting on collaborations with governments, *the representative from the national transport administration* said that one solution they use while building high-speed rail or roads demanded from the cities/municipalities is to use the service as a leverage point for environmentally friendly behaviour.

The representative from a regime-level truck manufacturer said that it is very important to understand the complexities of the socio-technical system before implementing new solutions. They said that the system needs to be prepared for the technical solutions, that is all the supporting mechanisms must be in place, and they must "fit" seamlessly into the system. For example, as pointed out by *the representative from the mobility collaboration platform*, changes in personal mobility have impacted goods transport as well, and so there is a need for inspecting the bigger

[19] Proposal for further increase in truck weight allowance. [16]

picture. Lastly, they added that for technical solutions, a combination of attractiveness to the customer and viability of the business models for all actors involved was the formula for success.
At a policy level, standardization of procedures, like procurement, was brought up and it was highlighted by *the representative from the regime-level logistics provider* that, while the standardization is needed at some level, to ensure free competition, it is also important for companies, to be able to source from different kinds of products and services, to ensure innovation and avoid lock-in. For policy makers and companies, a balance between these aspects must be considered.

Another possible area of intervention for policy makers was highlighted by *the representative from a regime-level truck manufacturer*, who says legislation should be designed or defined in such a way that large-scale testing of technical solutions must be allowed. Right now, the biggest challenge is market penetration, for example, designing an excellent electric truck, proving its performance on a small-scale test track, but then nobody wanting to buy it. They argued that for system effects to be visible, large-scale testing is required, and that is the only way to convince customers to buy a product. Adding to this point, *the representative from the mobility collaboration platform* stated that zoning where large-scale testing of solution is allowed should be decided by the policy makers. Finally, it was observed by *the representative of the logistics provider* that it is also important that the policies are fair in such a way that they don't interfere with the market competition (example of stricter requirements for Swedish companies when compared to elsewhere leading to a backlash and a need for restructuring policies).

Additionally, *the representative from the national transport administration* highlighted ensuring the right level of infrastructure utilisation to maintain sufficient transport efficiency. In other words, they clarified that traffic management must be such that roads should not be too empty, because of high congestion charges, as this would have impacts on other transportation services, and perhaps also negative economic impacts from low levels of transport utilisation. Along with this, what is needed, according to *the representative from the mobility collaboration platform*, are novel solutions like small, shared vehicles to address the first and last-mile problems.

In terms of goals and visions, *the representative of the region* mentioned that strict requirements for meeting short-term environment goals could be counter-productive for long-term goals, and so one solution could be to use the goal documents to set a vector for the work being carried out at an organisation. They believed focussing too much on lower emissions now, without thinking about the implications of doing so now, versus in the future can be counter intuitive, and cause system problems, citing the use of biofuels as an example.

Touching upon the economy versus environment debate, *the representative of the niche-level MaaS provider* highlighted the need for making the most environmentally-friendly option also the most convenient and cheap and gave the example of Copenhagen where people bike because it is the easiest mode of transportation. *The representative from the regime-level logistics provider* expressed similar thoughts and believed that solutions where economy and environment go together are desirable. For many customers, cost is a trigger for changing behaviour and this should be borne in mind while designing new solutions, they added.

Taking this discussion to a broader policy level, *the representative from the region* said that it could be a good short-term solution to take incremental steps instead of radical changes that hurt the economy. They added that such decisions also need to be implemented at the right time, or when the "window of opportunity" for the political system to act is open and the technological, societal and

economic conditions are conducive (see section 4.1.3). *The representative from the national transport administration* added that to act when the time is right, it is important to also know what to prioritise in the planning, for example, focus on a high-speed rail instead of cutting down flights.

Summary: Strategies and solutions

- Focus must be on entire socio-technical system, not just the technology
- The most economically attractive option is the one favoured by customers so make the environmentally friendly options economically attractive
- Begin collaboration at an early stage - from planning to procurement to execution and implementation in order to avoid having add-on features in the end as this was not feasible
- Legislation should be innovative in its approach and also, designed or defined in such a way that large-scale testing of technical solutions is allowed – this could help visualise the impact of these technologies and facilitate market penetration.
- Policy decisions must be made at the right time, or when the "window of opportunity" for the political system to act is open and the technological, societal and economic conditions are conducive
- **Themes**: Electric Mobility, Business Models, Urban planning, Public transportation, MaaS, Short-term v/s Long-term goals, Policy Making, Goods transportation, Economy v/s Environment

4.2. Q methodology results

As described in section 3.3., the Q sorts of all participants were recorded in a spreadsheet, and the mean and standard deviation were calculated respectively as the agreement index (Ai) and misalignment index (Mi). Apart from these indices, the KenQ software was used to provide the correlation matrix. This is presented in the appendix F. From the results of the matrix, it was clear that there is a significant level of negative correlation between the responses of the interviewees. Out of 11 interviewees, 7 had a negative correlation with at least one other interviewee, meaning that there was a tendency to have opposing opinions with at least one other interviewee. The study of the nature of misalignments between specific interviewees is beyond the scope of this study, and below the nature of misalignments at an overall level will be presented.

The agreement index (Ai) indicates the average value of the scores that were assigned to each statement by the interviewees, and thus can indicate in general the level of agreement with the importance of a statement. The value of Ai could vary between -3 and +3 which was also the range of the choices the interviewees had on the template. The misalignment index (Mi) on the other hand was the standard deviation of the scores that were assigned to each statement by the interviewees, and thus indicates the possible variation in these numbers from the mean, and in this study is used as an indicator of the misalignment around that statement. The calculation of these indices has been explained in section 3.3. As mentioned in section 3.3., the agreement index (Ai) represents how the average agreement with a statement from the Q sample. A positive mean value indicates that on an average interviewee agreed that the statement describes well the future transportation system, while a negative mean value indicates the opposite. The misalignment index (Mi) indicates the level of variance in values assigned by interviewees to each statement. The greater the value of standard

deviation, the greater the variance. (Hence, the differences in opinion around that statement or the misalignment). A high standard deviation or misalignment index would mean large variations in opinion, and a low would indicate small variations in opinion. In the table 3 below, the statements that interviewees agreed with the most while considering the future transportation system, are presented. These have the 6 highest[20] agreement index (Ai) values among the 23 statements.

Statement number	Statement	Agreement index (Ai_s)
4	The need to own and use a car depends on how other transport modes meet people's needs and expectations.	1.46
15	Multi-modality, utilising the full potential of different modes of transport, can provide the required efficiency needed for a sustainable transportation system.	1.45
8	Policy instruments that affect the cost of transportation such as congestion taxes and parking rates will be important for achieving a sustainable transportation system.	1.363
7	The safety aspect of any future mode of transportation must be a high priority while assessing its sustainability.	0.818
21	Public transportation should be given the priority in the limited road space.	0.727
2	A fundamental change in the behaviour of people is needed to achieve a sustainable transportation system.	0.636
6	For achieving a sustainable urban centre, bicyclists and pedestrians must be made a clear priority.	0.636

Table 3: Statements with the highest values of the agreement index (Ai)

In the table 4 below, we present the statements that interviewees agreed with the least while considering the future transportation system, and these have the 6 lowest agreement index (Ai) values among the 23 statements.

[20] 6 highest values and 6 lowest values of the agreement index were chosen to ensure quality discussion during the workshop, as discussing all the statements in depth would be too time consuming. However, since two statements have the same Ai (2 and 6), 7 statements are presented.

	Statement number	Statement	Agreement index (Ai_s)
	22	New highways are needed for increased freight transportation in the city, which is essential for economic development.	-1.909
	18	In 2030, there are no competitive alternatives to trucks for goods transportation because of the last-mile problem.	-1.818
	23	Solving the problem of congestion in and around Gothenburg is more important than reducing local emissions.	-1.454
	1	The transportation system can continue the status-quo (increasing traffic) as I believe in the potential of clean technologies (EVs, autonomous vehicles) to solve the problems of emissions.	-1.272
	11	Heavy-sized vehicles (over 3,5 tons) must be restricted from dense urban centres.	-0.818
	14	The 2030 transportation system in and around Gothenburg is no longer dependent on fossil fuels.	-0.636

Increasing disagreement

Table 4: Statements with the lowest values of the agreement index (Ai)

In the table 5 below, we present the statements that interviewees have the most differences in opinion about, and these have the 6 highest misalignment index (Mi) values among the 23 statements.

	Statement number	Statement	Misalignment index (Mi_s)
	12	Shared autonomous electric vehicles have a big potential to disrupt the current transportation system and lead to a decrease in emissions by 2030.	1.970
	3	The need to own and use a car depends completely on urban planning	1.876
	14	The 2030 transportation system in and around Gothenburg is no longer dependent on fossil fuels.	1.822
	2	A fundamental change in the behaviour of people is needed to achieve a sustainable transportation system.	1.720
	8	Policy instruments that affect the cost of transportation such as congestion taxes and parking rates will be important for achieving a sustainable transportation system.	1.553
	16	For achieving a future sustainable transportation system, radical changes opposing the current system are needed rather than small reforms.	1.542

Increasing misalignment

Table 5: Statements with the highest values of the misalignment index (Mi)

In the table 6 below, we present the statements that interviewees have the least differences in opinion about, and these have the 6 lowest misalignment index (Mi) values among the 23 statements.

	Statement number	Statement	Misalignment index (Mi_s)
	22	New highways are needed for increased freight transportation in the city, which is essential for economic development.	0.899
	18	In 2030, there are no competitive alternatives to trucks for goods transportation because of the last-mile problem.	0.936
	11	Heavy-sized vehicles (over 3,5 tons) must be restricted from dense urban centres.	0.936
	21	Public transportation should be given the priority in the limited road space.	1.135
Increasing alignment	20	Good accessibility is the most important criterion for ensuring social sustainability of the area.	1.149
	17	In the future, reaching the climate targets is more important than economic growth in the region.	1.226

Table 6: Statements with the lowest values of the misalignment index (Mi)

These statements were grouped together into themes and explored together with the interviewees in a workshop (see section 4.3 for the result of the workshop). The implications of the agreement/disagreement and misalignment/alignment around the statements was used to provide credibility to the results of the interviews and while formulating the misalignments. This will be presented in further detail in chapter 5.

4.3. Workshop results

Four different themes, chosen by the participants, were addressed in the workshop. These themes were: role of the personal car, transition, disruptive technologies and active mobility & public transportation. Below, each topic with sub-questions is explained in greater detail, as well as the results of the small group discussions.

Role of the personal car

Q-statements related to this theme were statement 3 “The need to own and use a car depends completely on urban planning” and statement 5 “The car will still be an important, however not the most common means of transportation in an easily accessible regional/urban centre”. Statement 3 was mostly disagreed in the Q-sorts and it also caused misalignment. Statement 5 again was agreed by most of the interviewees and they were also aligned with this statement. The sub-questions to guide the discussion were: Why is the personal car still important in the future? What are the

alternatives for personal car? How do we make these alternatives more attractive? How can urban planning affect car ownership?

During the small group discussion participants brought up the electrification of transportation. They agreed that full electrification of transportation would not be reached in the near future (following decades), however they considered different reasons for this. It was brought up that electrification would move the dependency of fossil fuels elsewhere, from vehicles to electricity production. Also plug-in hybrid vehicles were believed to have strong role in the transportation as they could compensate the limited range of electric vehicles. Participants mentioned also the possibility of other more sustainable technologies, than electricity, to rise.

Participants agreed that the need for car ownership connects also to other aspects than just urban planning - it is a political, value-based and emotional question for the society. It was stated that, the flexibility personal car offers is irreplaceable, but the subjectivity of the flexibility was also pointed out. Therefore, it was pointed out that, more focus should be paid on how vehicle is used and how it interacts in the system, rather than the vehicle itself. Participants concluded that, more modes of transportation are needed, but implementation is challenging, as urban planners are not used to design cities around these forms of mobility. In order to make other modes of transportation more popular, they must enjoy the public acceptance. To achieve the public acceptance, other modes of transportation should not be made more attractive with the expense of personal car.

Transition

Q-statements related to this theme were statement 1 “The transportation system can continue the status-quo (increasing traffic) as I believe in the potential of clean technologies (EVs, autonomous vehicles) to solve the problems of emissions”, statement 2 “A fundamental change in the behaviour of people is needed to achieve a sustainable transportation system” and statement 8 “Policy instruments that affect the cost of transportation such as congestion taxes and parking rates will be important for achieving a sustainable transportation system”. Statements 2 and 8 were mostly agreed, but they still caused misalignments between interviewees. Statement 1 was caused also misalignments between interviewees but was mostly disagreed. The sub-questions to guide the discussion were: Are technical solutions enough to achieve a sustainable transportation system? How can user behaviour be impacted in the transition? Are current policy measures to achieve the transition to a sustainable transportation system enough? How long will the transition take? Electrification of transportation in 2030 or 2050?

Participants mentioned in the small groups discussions that the transition is already happening, however, the exact path is not clear and there will be a lot of obstacles. It was mentioned that, policies should set a vision, that will guide actions towards right direction, instead of favouring specific technology or solution. Policy makers were also expected to frequently communicate with public and show commitment about the measures towards sustainable transportation system. This was expected to create trust towards the system, an essential feature regarding the public acceptance.

Participants also concluded that, big regime-level companies should take more risks and actively favour more sustainable solutions.

Disruptive technologies

Q-statements related to this theme were statement 12 “Shared autonomous electric vehicles have a big potential to disrupt the current transportation system and lead to a decrease in emissions by 2030” and statement 14 “The 2030 transportation system in and around Gothenburg is no longer dependent on fossil fuels”. Statement 12 was mostly agreed in the Q-sorts and it also caused misalignment. Statement 14 caused misalignment as well and was mostly disagreed between the participants. Disruptive technologies were divided to autonomous vehicles, connected vehicles, electrification and shared vehicles. The sub-questions to guide the discussion were: How big is the impact (disruptive potential)? What are the system effects (social, economic and ecological)?

Participants considered connectivity to be key enabler in the system to make it more efficient and useful. However, with connectivity, the questions of data security and responsibility were brought up. It was also pointed out that, personal integrity must be balanced with system efficiency. During the small group discussions, lot of focus was paid to shared vehicles, and trust was mentioned to be an important factor regarding the shared and connected vehicles. Participants considered ownership of a vehicle as a burden, taking care of maintenance and insurances of vehicle was something, most of the participants were willing to let go. However, it was mentioned that lot of scientific research is missing about the shared vehicles. The concept of space efficiency was also brought up and participants pointed out that, the biggest problem of current system is one person occupying lot of road space, when driving alone in the big fossil fuel propelled vehicle. It was mentioned, that shared vehicles, wouldn’t help to that issue and the concept of ride-sharing should be examined as well. Participants were concerned about the negative impacts of autonomous vehicles, as the free-floating fleet could take people away from public transportation and cause more congestion in the city. Participants concluded that, together all these technologies (autonomous, shared, electric vehicles) have remarkable disruptive potential.

Active mobility & public transportation

Q-statements related to this theme were statement 6 “For achieving a sustainable urban centre, bicyclists and pedestrians must be made a clear priority” and statement 21 “Public transportation should be given the priority in the limited road space”. Both of the statements were mostly agreed as well as aligned between the interviewees. The sub-questions to guide the discussion about active mobility were: How can we prioritise this in the limited road space? What are the consequences? Why is this important? What drivers, barriers and incentives for active mobility exist? Do they have a potential to cause a big change (like in Copenhagen) or are better served in niche areas? Questions to guide discussion about public transportation were: How can we prioritise public transportation? Should public transportation be the backbone of the urban transportation system? What drivers / barriers exist?

Participants raised up some challenges that, are related to active mobility (biking and walking). It was mentioned that it is challenging to get the policy makers on board with the vision, as in overall, active mobility is not in the focus of policy makers. They don't consider walking as a mean of transportation nor assume that people are willing to bike longer distances. Participants mentioned that, the distance is not an issue, especially with electric bikes. It was mentioned that, electric bikes have disruptive potential for the transportation system. What was lacking, is the place where to store the expensive electric bike in the city centre. Space allocation was seen as an important topic regarding the active mobility. It was stated that, it is important to separate the all modes of transportation and adjust the speeds to different lanes accordingly. To make bicycling more popular, participants mentioned the role of demonstration projects, such as having dedicated zones for bicycling and public transportation only, on specified days. Participants believed could make it easier for people to accept such solutions and show that the visions are actionable. It was also mentioned that removing barriers for bicyclists could lead to positive feedback loop, where allocating more space to bicyclists would lead to more people to choose bicycling and therefore, even more space could be allocated to this mode of transportation. Also, possibility to combine bicycling and public transportation was believed to make bicycling more popular.

5. Analysis

This section consists of two parts which present the analysis of the results of the interviews, Q methodology and the workshop, and through them, builds up the answers to the research questions posed in the beginning of the study. The first section (5.1) defines, classifies and details the misalignments that came up after the analysis of the results section, using the triangulation approach, described in section 3.1.5. The second section (5.2) compares and contrasts the misalignments described in the first section with the academic theories about sustainability transitions in a socio-technical system. Finally, section 5.3. describes the questions that emerge from the definition of the misalignments and discusses their reasons, effects and implications.

5.1. Misalignments

This section involves the triangulation of results to explore and define misalignments in the system. According to the work of Derzsi and Gordijn (2006), conducted on the alignment of businesses in a 'network value constellation' where a set of inter-connected actors form a system where innovations happen, alignment between actors provides a robust foundation for the development of coherent strategies, action plans, ideas and knowledge. In this study, the road transportation system has been treated as a socio-technical system consisting of a network of inter-connected actors interacting with each other to provide a robust and sustainable system. Thus, alignment of the actors is important in this context as well.

In this study, a misalignment is very broadly defined as two or more forces (actors, technologies, business models, organisational working styles etc.) in the socio-technical system that have conflicting positions of agreement or alliance. These misalignments can occur at several levels within the system, for example, either within an organisation or within two or more organisations (Derzsi and Gordijn, 2006). Misalignments can also occur at more conceptual/intangible levels (as perceived by one or more actors) such as between a technology and its users, urban plans and consumer behaviour, which agrees with the study of Molina (1997) who concluded that (mis)alignment can occur between people, institutions and/or societal, and technical elements. Additionally, several alignment processes occur during the development of the socio-technical system around a new technology, and this could be between the system and other systems of competing or complementing technologies (Molina 1995).

In this section, misalignments are classified into two types – strategic and systemic misalignments. *Strategic misalignments* arise between different actors in the system. As mentioned in section 3.2., different actors from organisations of the three levels (landscape, regime and niche) were chosen to participate in this research. The differences in their strategies, goals, and visions for the future of sustainable road transportation in the region are classified as strategic misalignments. They also include differences in opinions, values they believe in, and the processes and solutions they adapt to achieve the transition. *Systemic misalignments* represent the (more) abstract misalignments such as occurrences or tendencies that oppose the movement of the socio-technical system towards a sustainable future. They include system requirements that the interviewees felt were missing, nature

of collaborations, etc., and present conflicts in the inherent nature of the system itself that need to be resolved. They affect the entire system and are difficult to be resolved by the capacity of a single actor in the system. However, it must be cautioned here that sometimes in the subsequent sections there is not a clear distinction between strategic and systemic misalignments since some misalignments show features of both. To facilitate further understanding, five misalignment clusters (figure 8) are presented consisting of misalignments around a similar theme; M1 (Speed and nature of transition), M2 (Roles), M3 (Planning), M4 (Modes of Transportation) and M5 (Uncertainty). The arms in the figures represent the themes and the connections between them.

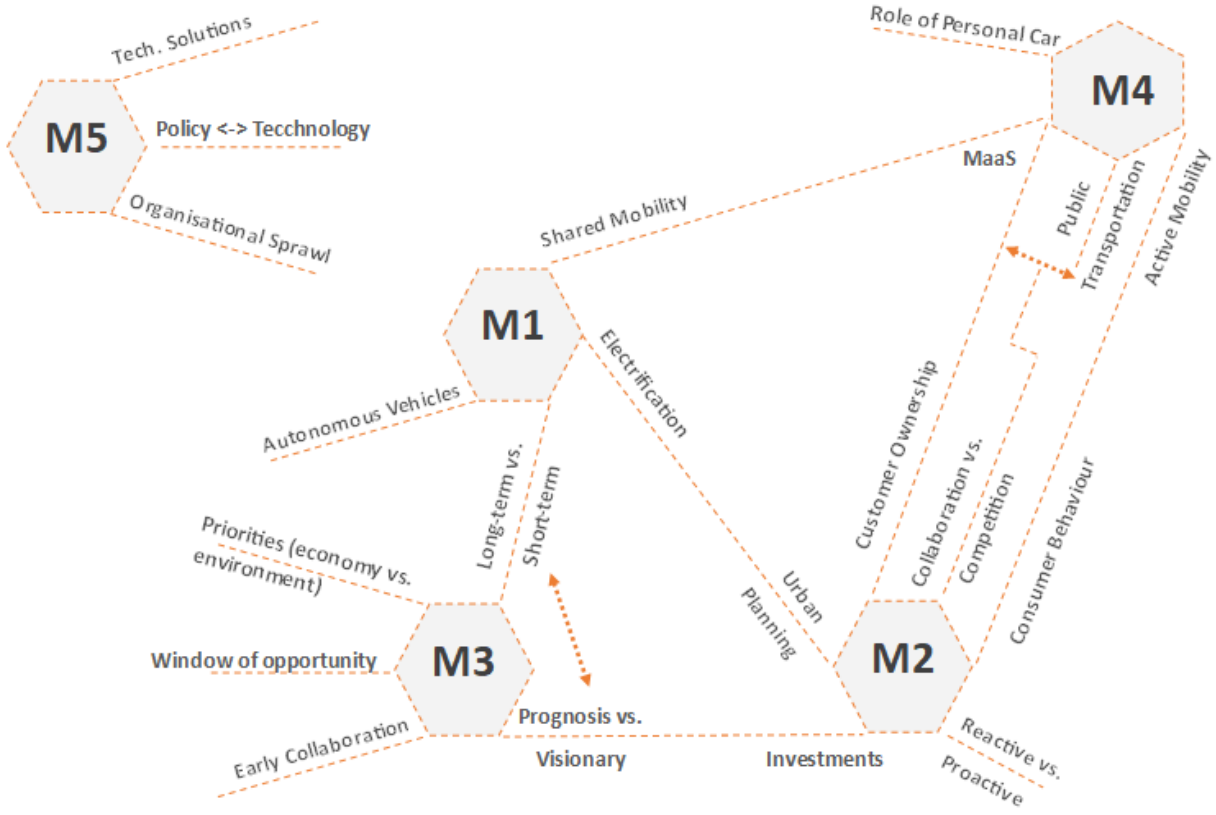

Figure 8: Misalignment clusters and the connections between them

5.1.1. Speed and nature of transition (M1)

This misalignment cluster deals with the misalignments around the speed and nature of the uptake of different solutions such as electrification, shared mobility, autonomous vehicles, and the conflict between long-term and short-term goals. In the interview results (section 4.1) one of the technologies that was often described as a future solution was electrification. It was argued that there has been a lot of driving forces in its favour, and it is also closely related to two other novel concepts for future mobility – connected and autonomous transportation. Autonomous vehicles on the other hand, were viewed as a key enabler for the future transportation system because of their safety and their capacity to drive down costs. However, when in the future these technologies would be diffused into the

socio-technical system and the extent of the diffusion remained areas around which there were some misalignments. There were also misalignments around the role of the personal car (further described in section 5.1.4) through the transition and the impact of shared mobility services on car ownership in the future. These misalignments can be supported from the Q methodology results, as can be seen from Table 5 where the statements that caused the highest misalignments are reported. Statement number 14[21] and 12[22] capture the essence of this theme well and confirm disagreements around them. The main features of this misalignment are summarized in the figure 9 below.

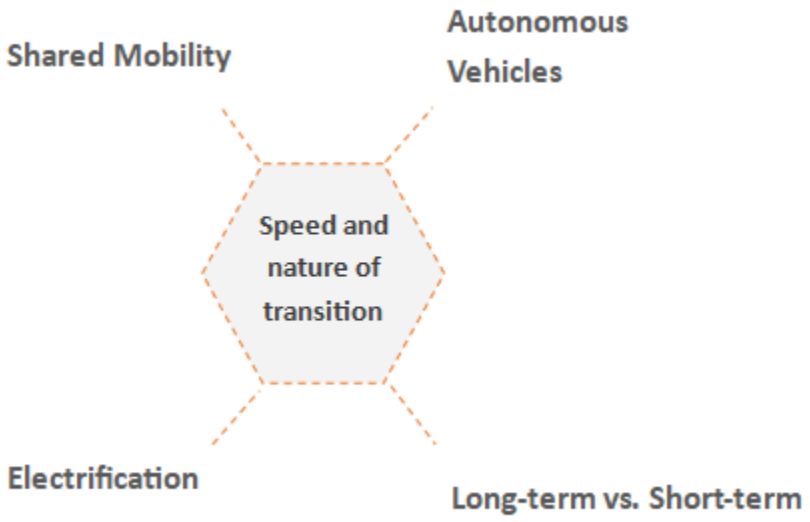

Figure 9: M1 - Speed and nature of transition

The representative from the regime-level truck manufacturer believed that electrification will be the clear winner in some segments such as city busses in the next few decades. This will affect all other vehicles, like trucks, operating in the same environment, and they will follow as well, was the belief. This view was shared by *the representative from the niche-level logistics provider* who believed that technologies like theirs that get the electric trucks out in the system, will make the regime-level players follow and to an extent the internal combustion engine will be replaced by electric ones. These beliefs were contradicted by *the representative from the region* who believed that overall there would be an increase in the need for transportation in the short term, and due to challenges associated with the introduction of new technologies, complete electrification will not happen until 2030 but

[21] " Shared autonomous electric vehicles have a big potential to disrupt the current transportation system and lead to a decrease in emissions by 2030."

[22] " The 2030 transportation system in and around Gothenburg is no longer dependent on fossil fuels."

that there will only be a gradual shift towards electrification. They believed that after 2030, and towards 2050, larger volume of EVs is more likely.

Related to the nature of electrification, it was discussed among participants in the workshop that plug-in hybrid vehicles would play a strong role in the transportation system as they could compensate the limited range of EVs. This however, is a misalignment if the point-of-view of EV manufacturers is brought into the picture, since *the representative from a regime-level car manufacturer* expressed that development of hybrids is tricky territory for manufacturers because of pricing – having two powertrains (electric and ICE) involves costs that need to be reflected on the price, but if hybrids are expensive, they are difficult to sell to consumers for whom low costs are a big driver for consumption. It was also discussed in the workshop that two different EVs – one with a small range for urban areas and another with a large range could move around in urban or rural areas. It was cautioned that a sudden rise in electrification could move the dependency of fossil fuels elsewhere, and so there is a huge importance of ensuring supply of renewable and clean electricity in the region. There was also some confusion around the roles of different organisations in providing enablers like charging infrastructure, and this will be discussed further in section 5.1.2.

A similar misalignment was observed around autonomous transportation. *A representative from the urban transport administration* believed strongly that the long-term effect of automation is reducing costs. They added that by 2050, automation would be the key enabler for providing future transportation services like MaaS, since the versions today do not work as they are not affordable, and automation will bring costs down. Opposite to this view was *the representative from the region* who believed that there will not be automated transport in the large share of the total transport volume even until 2050. They however added that there will be niches where automation is very important, and autonomous functions in the transport system will have increased. They believed that this development has already started, will become more visible until 2030, and will have some impacts on the transport system in all the sectors in 2050, but there won't be cars driving around by themselves, especially not in urban traffic, and not as a total paradigm shift.

Finally, when it came to the role of the personal car, there were some misalignments around the number of cars in the system in the long and short-term. *The representative from the region* believed that there will not be a decrease in the number of cars, especially not until 2030, but that the environmental impact of cars in the city centres would have decreased. They believed that the car was very competitive in terms of functionality, and suitable for individual use, and only in the very long-term would the number of cars decrease. However, individual car ownership was considered a big challenge if the future transportation system was to be shared, by many interviewees. Additionally, some interviewees believed that mindsets were changing, and young people were moving away from the model of car ownership to a service-based model, but this was disputed in the workshop by some participants who pointed out that some research suggests that this is not true since young people just buy a car at a later stage in their lives. This raises questions about the role of the personal car in the future and will be discussed further in section 5.1.4.

5.1.2. Roles (M2)

Urban planning, customer ownership, consumer behaviour, collaboration vs. competition-situation, reactive vs. proactive-approach and investments all caused disagreements and were therefore recognised as misalignments. They are grouped under misalignment cluster of roles, as presented in the figure 10.

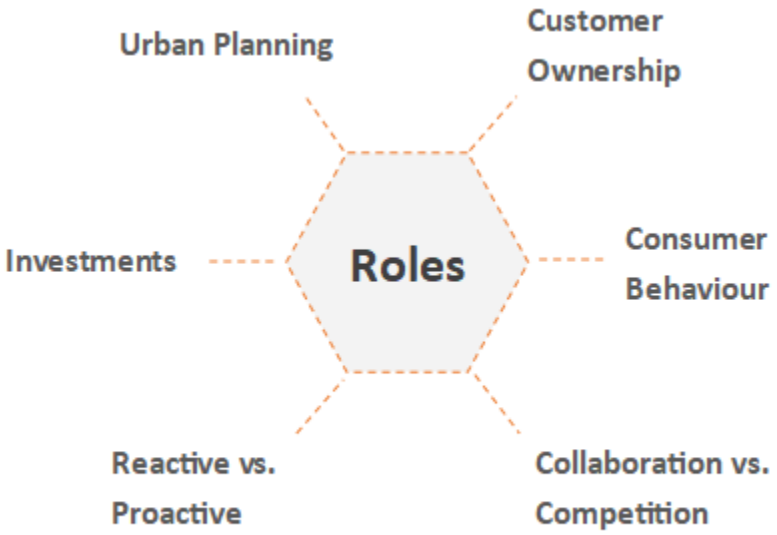

Figure 10: M2 - Roles

Aspects of urban planning were related to charging infrastructure for electric vehicles and the space allocation between different modes of transportation. There is a limited space in the urban area and the question how different actors should allocate this space, was brought up in the interviews and workshop. The topic of space allocation between different modes of transportation is elaborated further in the section 5.1.4. Contrary opinions were brought up, as it was not clear which actor should build the charging infrastructure and be responsible for it. The need for the harmonisation was mentioned by *the representative of urban transportation administration*, but at the same time they continued that, it's not something the administration is working with currently. Logistics providers were addressing the situation as well by concluding that if there is no charging infrastructure, they need to build it themselves, even if that kind of situation was seen problematic. Therefore, it was expected that the charging infrastructure for electric vehicles would be provided by combination of private and public actors. Question of who should build the charging infrastructure, connects to another aspect of misalignments in different roles: the investments – who should make the investments and by so help to buy down the costs. In the interviews, the capability of car manufacturers to subsidise the costs of transition was mentioned to be limited. *The representative of regime-level car manufacturer* mentioned that, they can focus on solutions, but the essential part of selling the vehicle is to make it a more attractive option. However, their capability to bring down the price is limited, so monetary or other form of subsidises were expected from the other actors in the

transportation system. *The representative of regime-level logistics provider* believed taxing and legislation will steer the choices of other actors in the system. *The representative of the region* mentioned that they have limited budget to participate in large-scale testing of new innovations, the capacity to do so was with the big industries. Similar thoughts were raised in the workshop, where the role of big established companies was brought up, as participants called out the responsibility of big companies to make more sustainable choices in their operations. However, some representatives of these big companies (regime-level logistics provider) pointed out that, the first investments are the ones with the biggest financial risks. The question of who should make the environmentally friendly options economically viable is further elaborated on section 5.1.3.

The aspect of reactive and proactive approach (whether actors were actively working for transition on reacting to the occurring chances in the system) was also occurring in the interview results. Some representatives mentioned their organisations taking proactive roles by launching test-platforms (urban transport administration) or launching innovation projects (regime-level car and truck manufacturer). However, the aspect of reactive approach was also present, when *representative of regime-level truck manufacturer* mentioned that, they cannot choose what is the best for the system, rather their role is to understand the system and their solutions needs to fit in. Here, the misalignment is not only in the reactive and proactive roles adapted by organisations but also in the perception of these roles by other organisations. For example, it was brought up during some of the interviews that the planning and regulations are too slow and have to lead (indicating that they are reactive) even though *the representative from the urban transport administration* believed that they were taking a proactive approach. This difference in perception is captured here by this strategic misalignment.

The level of cooperation in the misalignment cluster of roles, especially in terms of collaboration versus competition setting, raised lot of open questions, which are indicators of future misalignments. One of the emerging point was the question about data sharing regarding connected vehicles, what kind of data should be collected and to what extent it should be open and shared. Overall opinion about the data sharing was that, more open and accessible data is more efficient, and leads to a more efficient transportation system. However, it was recognised that, there is a need for a framework on how to handle data (urban transport administration) and standardisation of the shared data (niche-level logistics provider). It was also pointed out that the data itself is valuable, and too open data would be harmful for the organisation's business model. Another question brought up was, if there is a need for centralised data handling and in what level (national, EU).

Regarding business models, the question about who owns the customer (i.e. which actor is closest to customer in the supply chain) was also raised. Especially actors between public transportation and MaaS, as well as between MaaS and the vehicle manufacturers were speculating about different scenarios, which are elaborated further in the section 5.1.4. regarding the connection between public transportation and MaaS actors. From the vehicle manufacturer's point of view, it was clear that they desire to be closest the customers, instead of becoming suppliers for mobility operators. *The representative of niche-level logistics provider* pointed out that their aim is to act as a logistics

provider directly for the customer and acquire their vehicles from suppliers. These conflicting goals point out a strategic misalignment between these actors.

Additionally, the role of the consumer was mentioned in the sense of consumer behaviour. Perceived misalignment in this field was that, actors in the system make lot of assumptions regarding the consumer behaviour, even if the actual situation might be contrary to their assumptions. This lack of behaviour studies was also mentioned during the interviews.

5.1.3. Planning (M3)

This cluster of misalignments presents gaps and conflicts while planning, prioritising and strategizing for the future. This was a theme mostly covered during the interviews and relies from the experiences of interviewees while working on projects with other actors in the transportation sector. The topics of these misalignments are pointed out in figure 11 and are briefly explained below.

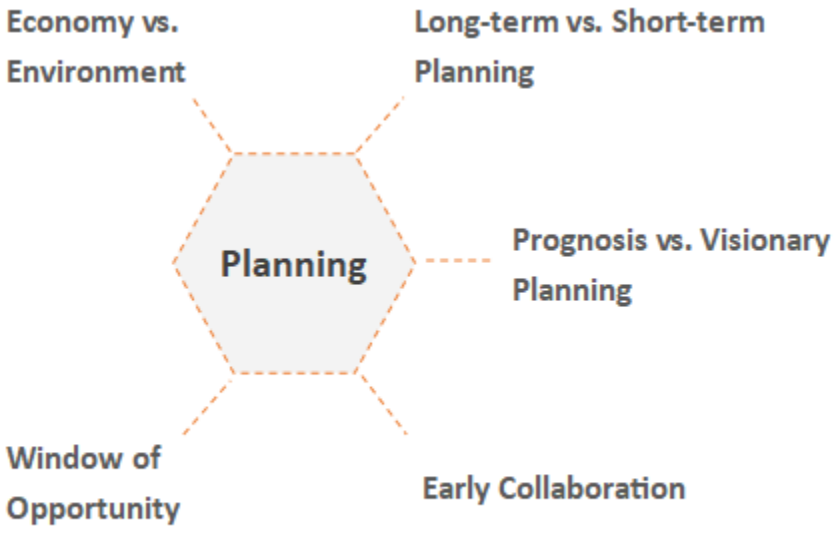

Figure 11: M3 – Planning

First, *the representative from the region* mentioned a systemic misalignment in understanding the conflict between long-term and short-term goals (see below for further explanation). They pointed out that from their perspective, in the long-term, the goals are not conflicting, just in the short-term. While this is related to the misalignment brought up in section 5.1.1, it is different since here the plans and strategies based on long-term and short-term goals are discussed while in the first the prognosis around car ownership in the long and short-term is discussed. The second misalignment was a clear strategic misalignment due to different planning styles between the national and urban transport administrations. This clash of techniques was brought up by *the representative from the national transport administration* and can be confirmed by looking closely at the results section – that individuals at the urban transport administration tend to work on a visionary-basis while

individuals at the national transport administration work on a prognosis-basis. The third misalignment was around collaboration and early involvement of actors in the system while project planning. The fourth misalignment describes the conflict of political goals within an organisation like the region, and the narrow time window to act on a certain technology/business solution. Lastly, the most commonly appearing debate around sustainability issues: economy versus environment is also covered below.

The representative of the region opined that there is a gap in understanding the conflict between environmental and economic goals. Taking the example of aviation, they described how emissions from aviation would stabilize (good for environmental goals) in the long-term even though people fly more (good for economic goals) because of improvements in technology and better fuels. So if the focus is on short-term goals, then environmental goals and economic goals are conflicting but not in the long-term. The choice between the two is a decision to be made by organisations weighing the short-term effects of reducing emissions (and reducing transport volume) and improving economy. From their own perspective, it isn't a good choice to reduce transport volume because that would decrease the economy growth and hence decrease the capacity of the region to provide healthcare or schools. In the long-term, this could also decrease their possibility to find technical solutions to reduce emissions. So, especially from the political side, too much focus on achieving short-term goals that hurt the economy could be counter-productive as it could hamper the ability to achieve long-term goals.

As highlighted in section 4.1.3, there is a misalignment in the styles of working of the national and urban transport administrations. This difference in working styles, where the national traffic administration works in areas where they see there is a lack of something or a problem (prognosis-based working) and the urban traffic administration works by setting visions, goals and achieving them (visionary-planning) causes misalignments. For instance, apart from the conflict around whether cars will reduce in the city centre, there was also some concerns from the side of the urban transport administration that the expansion of highways (which are massive structures in their opinion) around the city does not fit with their vision of a liveable city as they create barriers. But from the perspective of the national transport administration, however, congestion-free highways are an important focus area for them, and they carry out these projects because they predict economic and population growth in the region, which they believe requires fast access by cars.

The third misalignment was also at the system level and was brought up multiple times in the interviews. During collaborations, one challenge identified was to start collaborating (discussing roles, evaluating solutions) earlier in the process, for example during procurement, since changes and modifications in plans are easier, before the project becomes more concrete. The consensus was that if actors work together throughout, and make dynamic plans for projects, both economic and environmental costs can be reduced. However, due to the complexity of the projects involved in the transportation system, and due to different priorities while working, this early collaboration happens only with partial success. Thus, even though there is a need for early collaboration, the nature of the system prevents that from happening, and that is a misalignment.

The next misalignment, also at a system level, represents the conflict between different goals, requiring funds, time, and resources – all of which are limited for an organisation. While this was brought up by *the representative from the region* while talking about their organisation's limited ability to test innovative solutions due to low funds, it presents a very important systemic misalignment. *The representative* believed that sometimes the choice to focus on one of the options (between different solutions) is sometimes easy, and the opportunity costs indicate which alternative to choose. But, other times they can be tricky because they do not necessarily indicate the entire system effects that decision may have, so even if a decision seems obvious, there may be socio-technical effects at play which are being ignored. So, a comprehensive analysis of the choices an organisation makes, especially policy makers are very important. This is especially important in cases when a conducive atmosphere has been created for a technology and the "window of opportunity" is open. This could mean that it is easy and in-line with the goals of an organisation to support the opportunity and/or that acting upon it during that instance would create beneficial impacts for them as well as to others in the system. It is important for them to react at that instance, but otherwise, it might be costly and tedious to act upon them.

The last misalignment covered in this cluster elaborates on the trade-off between economic and environmental viability of a product or service. There is a need to make environmentally responsible consumption choices as resources depletion increases and we approach the planetary boundaries (Rockström et al 2009). Currently, the environment-friendly solutions face an uphill task to lower their costs because very high investment costs are involved. For example, even if for electrification the cost of procurement of batteries has come down, the cost of investments in charging infrastructure remain high, and overall manufacturing costs are high. However, according to several interviewees, more often than not, it is the cost that becomes the most important parameter when consumers make a choice, and it becomes difficult for them to choose the new options which are better for the environment. When environmental impacts and costs to consumers are both reduced, it is a win-win for all, but in most cases, the current economic system favours the old regime which causes immense environmental damage. Thus, this continues to remain a systemic misalignment. The new competition between different actors who want to profit while making their business models as environment-friendly as possible leads to conflicts in the system, and also makes it difficult to collaborate to achieve the sustainability targets, as mentioned by the regime-level logistics provider. This point also ties back to the misalignment around data sharing brought up in the previous section.

5.1.4. Modes of transportation (M4)

All the data collection processes (interviews, Q-methodology and workshop) raised up differing opinions and expectations on what would be the potential of different modes of transportation. Different modes that divided opinions were personal car, public transportation, MaaS and modes of active mobility, as presented in the figure 12. Overarching questions regarding the misalignment cluster of the modes of transportation were: will the number of trips increase and with what mode should most trips be taken? As mentioned earlier in the section 5.1.2., these questions connect to urban planning; how the limited space is allocated in the city and what modes are prioritised.

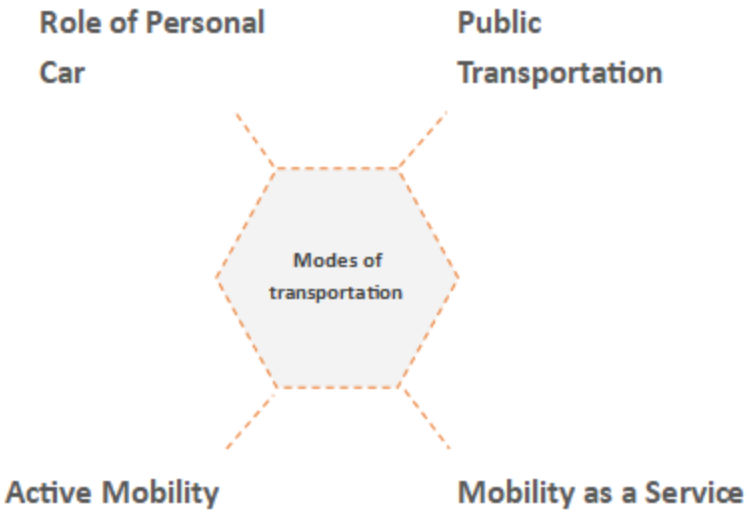

Figure 12: M4 - Modes of transportation

The role of the personal car was believed to stay strong in the transportation system of Gothenburg, because the city is very spread out. This leads to long distances between different parts of the city and therefore, organising an encompassing public transportation is seen as insufficient in many cases. Therefore, some of the interviewees *(the representative of the region)* saw the personal car to maintain its role as a backbone of the transportation system, whereas most of the interviewees believed that public transportation should take this role. In order to make public transportation more popular, differing opinions were mentioned as some actors believed that the transportation system should be made worse for the car whereas, other actors thought public transportation should be made more attractive. Making the system worse for cars was questioned during the workshop, as this could be harmful for the public acceptance and decrease trust to the system. *The representative of niche-level MaaS provider* expressed concerns about making the transportation system unfavourable for cars without having an efficient alternative.

Transport strategy of the city[23] mentions the goal of transferring more trips from private cars to public transportation, which was considered to be the backbone of the transportation system by many actors, as mentioned in the previous paragraph. However, the economic viability of the public transportation appears as a systemic misalignment. *The representative of the region* pointed out that, public transportation is heavily subsidised and as it works with economies of scale, it is only profitable in few routes and during the peak hour traffic. Therefore, it was described as a social service. The misalignment regarding this is that, showing the socio-economic benefits of public transportation is difficult. As it was pointed out by *the representative of urban transportation administration*, the benefits are very indirect and hard to quantify (reduced congestion and

[23] Gothenburg 2035 – Transport strategy for a close-knit city. [4]

emissions), whereas the benefits of freight transportation, for instance, are tightly connected to economic growth and therefore, much easier to point out.

Mobility as a service type of solutions also raised differing opinions regarding the mindsets of the consumer and business models. Both interviews and the workshop pointed out that, different actors believed there being demand for MaaS solutions, as the ownership of the car was seeing as a necessary burden. However, personal car was considered as a mobility insurance and it was unclear to what extent shared vehicles or MaaS solutions could provide such an insurance. The business model of MaaS was also questioned by *the representative of region*, as it was mentioned that it builds on complexity and is not cost-efficient. The cost was recognised to be big obstacle for MaaS, but *representative of the urban transport administration* believed automation to bring the cost down and act as an enabler for MaaS. It was believed that, shared vehicles would lead to more personalised transportation system. At its worse, this could create a competition with public transportation and make more people to choose more convenient ways than public transportation, which could have negative impacts, such as increased traffic. *The representative of niche-level MaaS provider* mentioned that, mobility as a service solutions should therefore rather complement the public transportation system than compete with it. From the service provider perspective, it was mentioned that, the profits in the personnel transportation sector are small, so there are difficulties to get service providers cooperate. This connects back to the question, presented in the section 5.1.2. about who owns the customer and are the service providers willing to become suppliers for MaaS providers. Currently, there is also a lack of framework for shared vehicles and this caused uncertainties about the role and impact of shared vehicles and mobility as a service -solutions in the transportation system.

The aspect of active mobility was brought up during the workshop by multiple interviewees as a conflicting topic. The importance to increase modes of active mobility is mentioned in the Traffic strategy document[24], but in the workshop participants mentioned that the policy makers don't consider walking as a means of transportation or that it is feasible to cover longer distances with bicycle. *The representative of the region* mentioned during the interview that they consider the potential of bicycling to be limited. However, in the workshop the participants raised up the potential of active modes, by mentioning that especially with the electric bikes distance is not an obstacle anymore. Connection points were made to urban planning, as it was mentioned that, to ensure safe and efficient system, separate space must be allocated to these modes. Multi-modularity of transportation was also pointed out during the workshop, as participants mentioned the potential of bicycles to address the insufficient public transportation network.

5.1.5. Uncertainty (M5)

One of the most obvious and recurring misalignments is around the uncertainty in the system. Electric mobility, shared mobility, ride hailing, carpooling, autonomous vehicles, electric highways, platooning, connected vehicles etc., present business models that offer both challenges and

[24] Gothenburg 2035 – Transport strategy for a close-knit city. [4]

opportunities. This meant that it was challenging for manufacturers to prioritise investments. There were also uncertainties around the potential of solutions like shared mobility, automated vehicles and MaaS. During the interviews, opposing opinions emerged and are described further below. The main focus areas of this misalignment cluster are pointed out in figure 13.

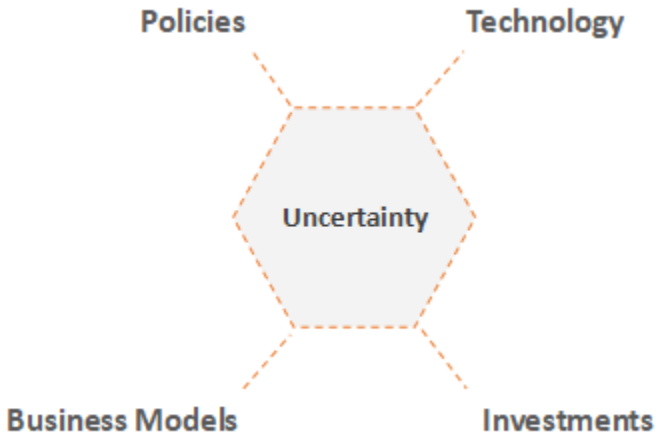

Figure 13: M5 – Uncertainty

During the interviews, *the representative of the niche-level MaaS provider* brought up the flip side of uncertainties surrounding the mobility market – it becomes difficult for niche players like them to find business investments because investors do not want to fund high-risk ventures. A similar concern was expressed by *the representative of the regime-level logistics provider* who explained the need for clarity of what the technology will dominate in the future, because their trucks have long life-spans. An example was given by *the representative* - suppose an investment is made today on an electric truck, and four years down the line there is a sudden policy shift that subsidises low-emission gas vehicles. In this case, their competitors might move to those more easily, (since they haven't invested in new electric trucks) and they will be locked-in because their trucks must complete at least 8-10 years of service if they have to operate profitably. Thus, this prevents them from completely investing in a new technology, and they look for interim solutions like biodiesel which enable them to partially stick to the previous regime.

This was also the opinion of the regime-level car manufacturer who said investments require a lot of risk assessment, adding further that right now they are in too many places on the map (of solutions) and that is not a pragmatic approach since they have limited resources and collaboration potential. Furthermore, it is not economically feasible to have many solutions because they often require different types of support and enabling infrastructure (functioning charging stations for EVs or special autonomous zones for AVs, for example). *The representative from the regime-level truck manufacturer* also agreed and believed that it must be a strong political, social and business desire to pursue a technology and allow for its large-scale testing, and aid it reach a level of maturity after which it is suitable for market penetration. They felt that right now that is not the case, because there is a problem of plenty in the system – there are too many solutions, but none has penetrated the

market enough to begin showing impacts. To summarize this view point, despite having an array of technologies to achieve a low-carbon transportation system market uptake is still weak, and clarity from both a policy and industry level is needed.

During the workshop, and in some interviews, it was stated that the role of policy makers must follow technology neutrality and is in fact often a principle that is complied with. It was brought up during the interviews that the role of the policy makers is to ensure negative externalities are penalised, and clean technologies are favoured but not determine which means to employ to achieve those goals. From research studies conducted by Bowyer et al. (2015), it can be observed that achieving true technology neutrality requires more subtlety than using one policy instrument across multiple technologies. Some technologies always require differentiated support and a policy framework that facilitates and enables the development of a range of solutions is favoured and is the case in the Gothenburg region, as observed during the interviews and workshop. Thus, according to this point of view, it is natural to have a range of possible technical solutions and let the market factors do their work and pick the dominant technology. To summarize, there is a misalignment around whether there should be dedicated focus to one technology from the policy perspective or follow a more technology-neutral approach.

5.2. Transition paths

In order to gain more insights about misalignments, pointed out in the section 5.1., connections to different transition theories and frameworks are compared in the table **7**. This is done because, in many cases, the long-term goal is shared by all of the stakeholders but what are the necessary steps to get there was not as clear. By utilising the theory of transition patterns by Geels (2005) and disruption framework by Seba (2016), these differences are explained further in this section.

Misalignment	**Transition path**	**How does it apply**
Speed of electrification / Roles	Actor related (section 2.3.3.)	Speed and impact of electrification can be to some extent explained with actor-related transition patterns. Theory suggests that, it is expected for multiple developments to link up. This appears in interviews when, *the representatives of regime-level truck manufacturer and niche-level logistics provider* expected city busses or trucks penetrate markets first in specific segments and afterwards affect to also other vehicles in the same area. Theory emphasizes the role of actors in the process, as they are the ones making the connections between various developments and strategic interactions, either slowing down or accelerating the process. Regarding the information gathered with interviews, there is currently a situation where the need for harmonisation is recognised, however, not prioritised by administration level. At the same time regime-level logistics provider expects combination of public and private actors to build up the needed infrastructure. In addition, niche-level logistics provider need to establish the infrastructure to enable

		operations. Regarding this information, it seems that the strategic interactions are perhaps not supporting the acceleration of the process.
Speed and impact of autonomous transportation	Disruption framework (section 2.4.) / Fit-stretch (section 2.3.2.)	As the speed of adaptation and impact of autonomous vehicles were causing misalignments with the interviewees (between *the representatives of the region and urban transportation administration for instance*), two different theories can be considered in this case. Some interviewees believed that, level 5 autonomous transportation is unlikely and that the large number of vehicles would not be automated even until 2050, rather AVs would act in niche-markets. A transition like this has features of fit-stretch pattern, where the autonomous vehicles first fit in the existing system, for example by adding new features to existing vehicles. Eventually, autonomous vehicles would stretch the existing system, in terms of autonomous zones in the urban centres, for instance, as mentioned by the interviewees. Transition like this can be described as a gradual development process. On contrary to this, some interviewees believed that autonomous vehicles could have much larger impact to the transportation system, for example by enabling services like MaaS to revolutionise mass transportation. This kind of impact can be explained with disruption framework, that suggests that, convergence of technologies, with business model and product innovation enables exponential growth in the adaptation rate of the new solution and from the point of disruption, changes are happening fast. Current situation has features of disruption from above-model, where the autonomous vehicles have superior performance (in the means of system efficiency and safety), but higher cost. Because of the technological cost curves, the cost is expected to decrease and hence enable the disruptive potential of the technology.
Speed and impact of MaaS	Disruption framework (section 2.4.) / Fit-stretch (section 2.3.2.)	Since it was believed that autonomous transportation would bring the cost down, which was recognised as the biggest obstacle for MaaS solutions, same transition patterns can be applied with MaaS than autonomous transportation earlier. Some interviewees believed that shared vehicles would make the transportation more personalised and convenient and therefore, create competition with public transportation. This kind of transition has features of disruption framework, as new innovation (shared autonomous vehicles) would compete and eventually replace public transportation, being more flexible and adapting better to customer needs. Again, the convergence of technologies (machine learning, radar/sensor development, cloud service, etc.) would act as enabler for shared autonomous vehicles. Interviewees expected such a disruption to have negative effects, like congestion, when shifting the users from

		public transportation to shared AVs. On the other hand, some interviewees believed that MaaS solutions would be complementing the public transportation rather than competing with it, by dealing with the last-mile problem and unprofitable public transportation routes through shared AVs. For a situation like this, fit-stretch pattern can be considered, where shared AVs would fit to existing system by providing connection to public transportation for customers, who live far away from the transportation hubs and eventually stretch the impact by replacing unprofitable or unfavourable public transportation routes.
Investments / Roles	Disruption framework (technology cost curves – section 2.4.) / Actor related (section 2.3.3.)	According to disruption framework theory, technology cost curves are one of the factors explaining convergence of technologies. Theory suggests that technologies improve in economic terms over time exponentially, because of multiple factors, such as R&D, standardisation and market segment growth. However, interviewees mentioned that, in order to bring down the cost of new technologies, there needs to be market demand for the products, EVs for instance. *Representative of regime-level car manufacturer* mentioned that, the share of EVs on their sales volume is still rather small and that they need support from other actors. Therefore, also actor related patterns explain the situation, as they include strategic interactions and connections between developments. Some of the interviewees mentioned that big companies should take proactive role and make investments to more sustainable technologies. *The representatives of regime-level companies* however mentioned that, first investments are always riskier, and it seemed that they were planning towards more gradual process. It seems that, the question regarding this topic was, how is the cost of early investments compensated to the actors or how is the market segment of the new technology ensured.
Customer ownership	Disruption framework (business models – section 2.4.)	Disruption framework can be applied to explain the misalignment regarding customer ownership. According to theory, technology convergence enables new possibilities for value creation in the value network through business model innovation. With shared AVs and MaaS concepts shifting car owners to service consumers, mobility operators could capture value with new business models in the value network. Such a transition could make vehicle manufacturers suppliers to mobility operators, a position where they are not willing to end up.
Uncertainty	Actor related (section 2.3.3.) / Wider transformation route	Uncertainty relates to many points mentioned above, as it was pointed out that, currently there are many things happening in the transportation system. It was mentioned from the vehicle manufacturer's point of view, that it's difficult to concentrate on multiple solutions (ICE, EV, AV and shared mobility), as there

(section 2.3.1.)	are limited resources. Connection to wider transition pattern can be made by pointing out that, changes are happening with policies, consumer behaviour and technologies for example, which opens up the regime for experimentation with different innovations. However, it was also pointed out that there needs to be strong political, social and business desire to pursue new solutions and allow large-scale testing in order to solution to reach maturity. This connects back to actor related patterns in the means of strategic interactions and connections between developments.

Table 7: Transition path theory applied to misalignments

As the analysis in table 7 indicates, many of the misalignments have features of actor related transition pattern, which implies that the connections between different actors in the system have a strong impact to the transition process itself. Actors in the network are dependent on each other's development and strategic interactions.

Another common feature regarding the misalignments is that, both fit-stretch pattern, as well as disruption framework, seems to be suitable for interpreting the situation, i.e. both models can be applied depending upon whether actors believe in a gradual transition path or a strong disruptive potential of the technology/solution respectively. These kind of differences in thinking lead to different level of preparation and resource allocation, which in turn accelerates or slows down the transition. A possible explanation could also be that, before reaching the point of disruption, adaptation of new technology/solution seems to follow more fit-stretch pattern, until the adaptation rate accelerates and enables the exponential growth associated to disruption framework. The fundamental difference between these two styles of thinking is, if the innovation is fitted for the existing system and gradually shaping it, or if the system is reformed around the innovation.

5.3. Further questions based on misalignments

The results of this study present an analysis of the misalignments between visions, opinions, ideas and beliefs about the road transportation system in Gothenburg. A variety of opinions are reflected in the study and the stakeholders involved can get an understanding of the areas (such as business models for MaaS) where the misalignments are, and with whom (which actors).

By analysing the interview results in section 5.1., misalignments in the transportation system were pointed out. This process raised questions, which when answered could clarify some conflicts within the system. These questions are below divided into two different clusters: who and how -questions. How-questions were emerging from topics: urban space, connected vehicles and MaaS & public transportation. Some of the questions below can be used as a scope of future research in order to gain further understanding around topics.

How to allocate/prioritise urban space?

This question builds on the fact that, the urban space is limited and connects to misalignments M2 and M4 (Roles & Modes of transportation). Interview and workshop results pointed out that the consensus is that, public transportation system should be improved, however, whether if that should be done at the expense of personal car caused some disagreements. The traffic strategy of Gothenburg[25] shares similar aim but points out that this should not be done at the expense of the accessibility of personal car. Other aspect of urban space was, how much of it should be allocated to active modes of transportation, which connects to anticipated potential of these modes to transport people. It was mentioned that separate space should be allocated to bicyclists and pedestrians to ensure safe and efficient system. When considering all these modes together in the context of limited space and the visions of dense city, a question raises if it seems that too many functions are trying to be embedded in the system without making compromises on other modes. From the system efficiency perspective, it might be more efficient to allocate space to certain modes of transportation at the expense of others.

How should the data be shared?

The question about data sharing is of importance when considering both personal integrity as well as system efficiency and it connects to misalignment M2 (Roles). Another important aspect of data sharing that was brought up during the study was what is the value of the data, or how it should be valued. The disagreement occurred since, on one hand companies saw an incentive for sharing the data since it improves system efficiency which is beneficial for everyone, but on the other hand, the data they collect is valuable for machine learning for instance, and gives them a competitive edge, so there is an incentive to protect it. Standardisation and framework for data sharing was a crucial aspect regarding connected vehicles. Therefore, a question arises, how would it be possible for companies to have open data without disadvantages for their business models – how should the data be valued & included into business models?

How should MaaS be embedded with public transportation?

As presented earlier, the impact of autonomous vehicles to transportation system caused misalignments in this study, connecting to misalignments M2 and M4 (Roles & Modes of transportation). Autonomous transportation was seen as an enabler for MaaS solutions, but to what extent MaaS solutions would change the transportation system raised different opinions. Particularly, the relationship of MaaS with public transportation was brought up. Some of the interviewees believed that the business model of MaaS is not viable, when again it was mentioned by some interviewees that public transportation system is based on the economies of scale, which is not achievable in many of the public transportation routes, implying that the business model of public transportation is not viable. Therefore, it is favourable to consider what is the role of autonomous vehicles in the system. Would AVs be owned by private mobility operators, competing with public transportation? Or would AVs be part of MaaS solution? And if so, is public transportation supplier to MaaS providers or vice versa?

[25] Gothenburg 2035: Transport Strategy for a Close-Knit City. [4]

Who owns the customer?

Section 5.1.2. brings up the disruptive potential of MaaS solutions for vehicle manufacturers and also connects to the previous question by challenging customer ownership. Car manufacturers are reluctant to give up the position closest to the customer but at the same time mobility operators are challenging the initial setting. Question is, will OEMs become suppliers to mobility providers or vice versa, or if there's going to be joint ventures? Currently many of the OEMs are announcing partnership deals with mobility operators, which would point to the latter option[26]. The question of customer ownership is also relevant, when considering the relationship between MaaS providers and public transportation operators, as mentioned earlier. Are MaaS operators directly providing services to the customers or are they suppliers for other instances that are controlling the fleet? These topics connect also to the fleet management itself: should there be municipality or national level administrative level controlling the fleet or should this be done by the operators themselves? How centralised should the structure of the fleet management be?

Who should buy down the cost (of new innovations/solutions)?

One of the aspects of roles in section 5.1.2. were the investments – who should buy the costs down. Since the socio-technical system is a rather complex entity and involves multiple actors, perhaps a better question would be how the cost can be brought down, as now many of the actors felt that investments (in manufacturing or operations) are too risky, because of the uncertainties in favourable policies or customer demand. The question is how to ensure value for all the actors in the value chain in order to accelerate the transition. It was pointed out by the interviewees that economic driver is strong and in order to make the transition happen, sustainable choices should be favoured also economically. Legislation and restrictions were believed to guide actions within the network of actors. Question that remains is, if there should be some kind of framework for the process of bringing the cost down.

What are the implications of misalignments?

The aim of this section is to pose questions that would further facilitate the understanding of the misalignments. Rather than providing definite answers to the questions, a flowchart with the reasons, effects and implications of the misalignments is presented. First, the question about the effects arises – Are they causing problems? Are they slowing down the transition? Are they hindering the success of some business models? Could the misalignment between actors be related to drivers and barriers of a business model? Is there a hierarchy of misalignments as in some are more important to understand than others? These kinds of questions could be answered by looking at very specific parts of the system. Second, the reasons for the misalignments can be questioned. Are the reasons for the misalignments different belief systems or different working styles? Or do misalignments arise from previous misalignments? Third, this gives rise to the importance of the misalignments for the system and for the actors involved. Should there be efforts to align organisational perspectives to remove misalignments? How can actors react to misalignments to adjust their business models and operations

[26] Volkswagen and Didi Chuxing Have Teamed Up on a New Self-Driving Venture [17] & Volvo Cars and Uber join forces to develop autonomous driving cars [18]

to fit better in future? Can misalignments be removed completely or reduced? Is it worth the efforts, resources and time to try and remove them? These important questions can be answered through some of the findings of this thesis, by considering strategic and systemic misalignments separately (see figure 14).

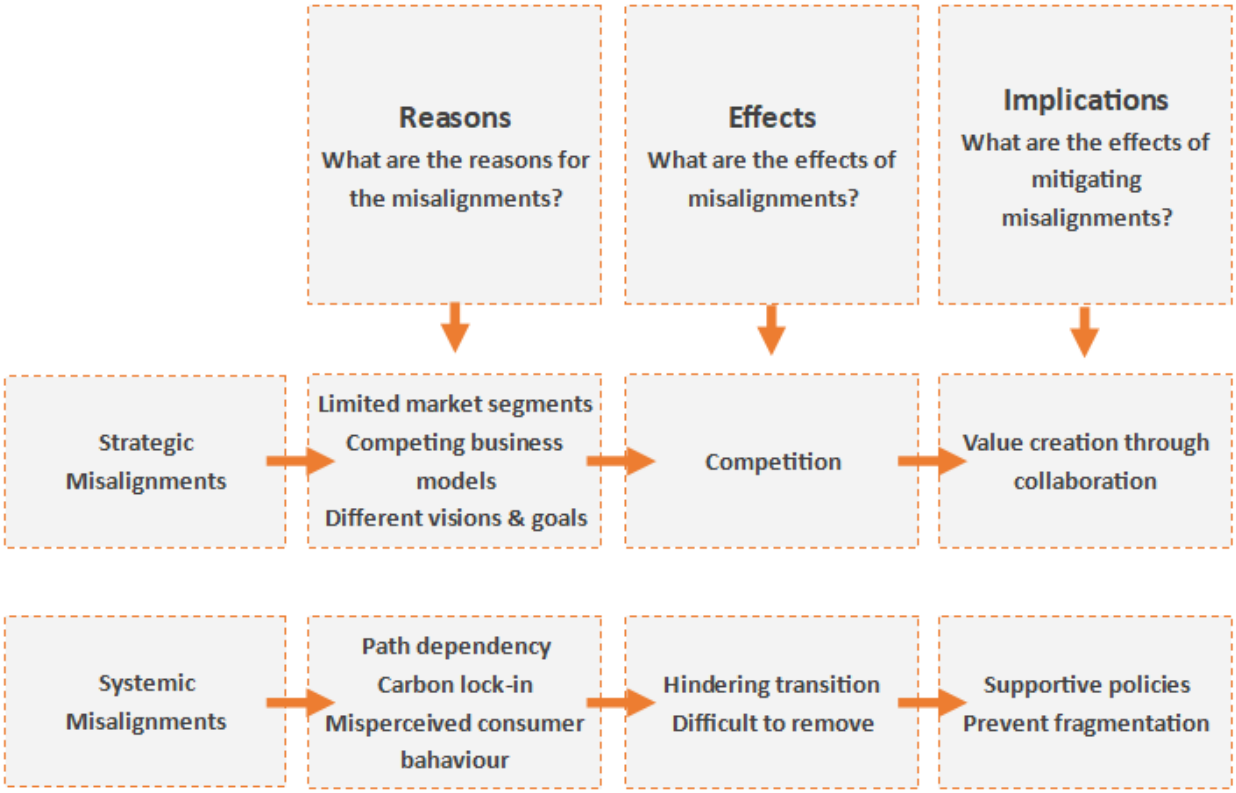

Figure 14: Reasons, effects and implications of misalignments

Strategic misalignments arise between actors, and are caused by different business models, visions, goals and multiple actors competing within the same market segment. They generally only affect the actors directly involved and can be considered as a "natural" consequence of having a market-based economic system. Thus, the efforts to align organisational perspectives for actors involved are only worth it if, in doing so there is value creation for both actors and they can move from a competitive setting to a collaborative setting with benefits for both actors. On the contrary, the systemic misalignments arise due to path dependency, lock-in mechanisms, a misconception in perceptions of roles of actors and a lack of understanding the intricacies of consumer behaviour. They are not necessarily between specific actors and the problems caused by them are of a more critical nature. They are also difficult to remove and are risky because they can set the wrong vector. Hence, acting upon these misalignments has incentives for the entire system, as they are hindering the transition process and supporting the status quo. Supportive policies create the required environment to unlock the potential of alternative solutions and enable the transition itself. It is also desirable to remove these misalignments from a policy perspective because of their effects on an already fragmented policy making system in the region – overlaps and interference can be avoided.

6. Discussion

This chapter begins with a critical evaluation of the findings of this study followed by a discussion on the limitations of the methodology employed. The chapter concludes with discussions around the common ground among stakeholders that emerged from the study (as a contrast to the misalignments) and the implications of the misalignments for the system.

Critical evaluation of the study

This thesis gives an idea of the current state of the road transportation system in Gothenburg and the most pressing challenges, solutions and conflicts in the system. The analysis presenting misalignments has been produced after comparison of similar data from three different methodologies (triangulation) and hence can be considered robust. This analysis was done in order to understand the role of misalignments in the system by trying to find implications and effects of misalignments and whether or not, they hinder the transition.

However, misalignments are presented at a superficial, general level (such as data sharing) but the nuances of the complex systems and organisations involved around the topics of misalignments that lead to them and/or are impacted by them are not covered. The expanse of the research is far greater than its depth, and the depth of the misalignments could have been investigated had the study focussed either on a theme (such as electromobility) or only a set of actors (such as national and urban transportation administration). Further, the reasons for the misalignments are only provided using transition and disruption theories from the academic world, but not from follow-up interviews/verification with the interviewees themselves. The thesis was carried out by interviewing a handful of individuals from different organisations, who are not a representative sample, which means the conclusions are limited based on the experiences and opinions of those individuals who participated in the study.

Limitations of methodology

Under this section the limitations of the methodologies, described in chapter 3, are presented. Before the semi-structured interviews, the interviewees were selected and classified based on the MLP (Geels, 2005). There are some limitations in this classification, first the landscape is a difficult term to characterise as it consists of values, opinions, trends in consumer behaviour, and the policies that affect them. So, in that sense, the policy-making organisations have been placed in the landscape level, even though they do not necessarily directly constitute abstract ideas and values. Similarly, the mobility collaboration platform is a part of the system, and interacts with regime-players, while having niche-like characteristics and does not really aim to compete with them. So, it is placed in between these levels.

Due to the semi-structured nature of the interviews, some room was allowed during the interviews to ask additional/follow-up questions. The interviewer's bias on the topic might be reflected while framing these questions and limit the completeness of the study (Bryman & Bell, 2015). Furthermore, interviewees could have had their own bias regarding the topic. Another limitation here is that since they were partaking in the interviews not just as representatives of their organisations but also as individuals, it is difficult to differentiate opinions that are individual and those that are from an organisation point-of-view. While most interviewees can be assumed to be seasoned in

differentiating between the two roles, it is still a fine line, and indicators of bias induced by these roles was hard to trace while interpreting the answers. Sometimes, the interviewees provided short, surface-level answers, as most interviews were time-limited (normal interview length of 1-2 hours), even though the perspectives covered were broad. There is also the problem of social desirability – which involves interviewees giving the most socially-acceptable response to a question or saying what the interviewers want to hear. It is also important to point out the ethical considerations around the anonymity of the interviewees – even though utmost care was taken in ensuring anonymity, while presenting the results, it is difficult to maintain complete anonymity (Bryman & Bell, 2015).

Q methodology involves rating statements on a scale which has opposites on either end and involves an implicit "relativity" between them – that what the interviewee thinks about these statements in isolation from the set of Q statements cannot be brought about by this method (Stenner and Watts, 2005). The modes of reasoning behind an arrangement of statements is certainly more important than the arrangement itself (due to relativity of statements), and hence without a discussion with the interviewee or subsequent participation in a workshop, the data obtained cannot be interpreted or used to draw conclusions. In this study, while a workshop was carried out to understand the collective results of the Q methodology, due to time constraints follow up with the interviewees for an explanation of the reasoning for their Q sorts was not done. There were also some interviewees who could not participate in the workshop and their opinions were missed out from the evaluation of the workshop results. Lastly, the results from the Q-sort are dependent on the set of Q-statements picked by the researchers. If the set of statements is not complete, exhaustive and thorough, the results may only provide a partial or incomplete picture of the system. There is always a possibility that some aspects of the transportation system have been missed out.

Another limitation manifests in using the standard deviation as an indicator of the misalignment. While the standard deviation is an excellent detector of skewness, it cannot measure the dispersion[27] of the skewed data. For example, there are at least two possibilities if a statement had a high misalignment index: (i) Most interviewees agreed with a statement but one or two have a significantly different opinion than the rest. (ii) There are significant differences in opinion and there is a lot of dispersion in the placement of that statement by interviewees. Due to the lack of time and extent of research work, further tests to evaluate the skewness of the data were not conducted, so there remains some lack of clarity.

The world café often requires a clear and relevant set of questions to facilitate conversations. While an attempt was made to ask specific questions and go into the details of the misalignments that emerged from the Q methodology, the process did not deliver clear and accountable decisions, detailed plans or strategies. Due to limited time for the workshop, the exact reasons behind the misalignments were also difficult to bring out.

Common ground among misalignments

Finally, it is very important to highlight that even though several conflicts in the discourse for sustainable transportation have been pointed out hitherto, there were also several themes around which there was a lot of alignment of actors' perspectives. This is evident from similar arguments for certain aspects like charging infrastructure mentioned in the section 4.1.4, from the similarities in patterns of thinking exhibited by positive correlation between Q sorts (see Appendix E) and from the

[27] Limitations of standard deviation. [19]

table 6 which shows Q statements that have a low misalignment index. It may be easier for actors to form new collaborations around these topics and/or strengthen existing ones to realize a shared vision which can enable a sustainable road transportation system. On an overall level, there was agreement that climate change mitigation is important and aspects like safety, accessibility and efficiency must all be features of a good transportation system.

While there were some misalignments around the data sharing as mentioned earlier, it was agreed that data standardisation was an all-important for enabling a well-developed, high efficiency connected vehicles system. The legislative framework around what kind of data to be share, defining the optimum level of transparency while sharing data, ensuring data privacy is upheld, and a standard format to facilitate sharing were all considered important aspects of data standardisation. Further, there was also consensus that this needs to be done in a collaborative fashion, keeping in mind the benefits and drawbacks of such a system for all actors directly and indirectly involved in the process.

It was also brought up constantly in the interviews that policies play a very important role in the system – even though the responsibility to transform the system is on all actors involved, the vectors and principles must be set by policy makers, and they must proactively lead the change rather than just follow developments. It was also agreed that the public offices must lead by example and display commitment to making sustainable choices. It was also brought up that a proactive approach is needed from national, regional and municipality level administration in managing anticipated system effects of new technologies – like congestion from self-driving vehicles. Another example from the logistics perspective was that the responsibility of setting up and making actors route deliveries through consolidated centres in urban centres rests with the urban administrations.

Perceived and analysed misalignments

This section presents a discussion on the similarities and differences between the misalignments that the actors perceived (in section 4.1.3) and the misalignments that emerged as an analysis of the results (section 5.1). From a review of the two sections, the misalignments expressed by the actors (perceived) are verified by the analysis of the results (analysed). This can be exemplified from the speculation and uncertainty around technologies brought up as a misalignment in the system in section 4.1.3, especially because most vehicles have a long lifespan and investors are afraid to invest in technologies. In the analysis section in 5.1.5, this has been confirmed, classified as a systemic misalignment and described further. Such similarities between perceived and analysed misalignments are found consistently in the study. However, in the analysis section, there are also some misalignments that are not perceived directly by the actors, but emerged from the interview, Q sorts and workshop results, such as the differences in the potential of active mobility as a future solution.

7. Conclusions

This chapter answers the research question formulated in section 1.3, ***What are the current misalignments in the transition to a sustainable road transportation system in Gothenburg?*** This is done by summarizing the main findings of the thesis through a brief presentation of the misalignments. A summary of the important questions for further research and investigation follow. The usefulness of the analysis of misalignments, and the implications of the two kinds of identified misalignments (systemic and strategic) are also highlighted below.

Table 8 below, presents identified misalignment clusters to answer the research question and briefly describes them.

Misalignment clusters	**Explanation**
Speed and nature of transition	Differences in beliefs about the potential of electrification, shared mobility and autonomous solutions in the future transportation system.
Roles	Different expectations of roles and anticipation how these roles are going to change. What kind of strategies are needed.
Planning	Delves into the different styles, methods and visions of actors while planning for the future transportation system.
Modes of transportation	Builds on the question: what modes of transportation should be prioritised and how.
Uncertainty	Explores different opinions on how to address the uncertainty in the system around technologies, business models, investment costs etc.

Table 8: Summary: Misalignment clusters

Further analysis around misalignments raised a series of *how* and *who* questions, as presented in the section 5.3. When discussed, it turned out that, who-questions had a lot of elements of how-questions and it would be more beneficial to ask the questions from how-perspective. This could be explained because, it is difficult to place strong responsibilities for single actors in a socio-technical system (thereby answering the who-questions), as the system itself is a complicated net of interconnected actors. Market demand and supporting policies play a strong role in the transition process, and in many cases, it boils down to the economic viability of the solution. Therefore, a question remains how to make the most sustainable option also the most economically viable for all the actors in the system. It should be kept in mind that, by adjusting the scope, the definition of the most sustainable solution can change.

Presented misalignments can be helpful to gain understanding about the road transportation as a socio-technical system and help organisations to plan their actions accordingly. By understanding the nature of misalignments, with the help of theoretical framework (section 5.2.), there is greater clarity in visualising the on-going transition process in the system. This could be especially useful for

individual actors, since through understanding misalignments and mapping them, they could understand the barriers they face due to the misalignments. They can also anticipate when in time the barriers will start affecting them. Based on this knowledge, they can tweak their strategies to combat these barriers as and when they arise. Since the role of collaborative platforms was emphasised, they could be used as a space to understand misalignments better.

Through the entire thesis process, one of the most striking features of the road transportation system in Gothenburg is the entropy. There are many complex, simultaneous, inter-connected developments happening at the same time and multiple actors are involved. In this complex system, two types of misalignments – systemic and strategic have been identified and detailed through the study. Systemic misalignments present problems within the current that could serve as obstacles to transition and need to be tackled, as there are benefits to all actors in the system by doing so. Their effects and implications, highlighted in section 5.3., can be an interesting point for future research and analysis. On the other hand, given the differences in priorities, belief systems and visions of the actors, strategic misalignments are bound to exist in the system. Their presence is a natural consequence of the market-based economy, so from a transition point-of-view, need not be the focus of attention.

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Appendix A: Phase 1 Report

1. Theory

1.1 Stakeholder management

Stakeholder management is an important skill to have constantly for sustainability transitions. In order to work with problems for sustainability in the current system multiple actors are involved, each having a claim to the proposed solutions. This means that communicating with these stakeholders in a timely and effective manner, keeping them engaged throughout the process, and ensuring consensus among them are all very crucial for the success of the thesis. There is a risk of mis assessment of current problems in the system if the stakeholder management process is not carried out adequately. The stakeholder management theory gives directives, perspectives and best practices for doing so.

1.1.1 Stakeholder identification / mapping

The first step in stakeholder management is identifying the relevant stakeholders. Many different definitions of a stakeholder are found in the literature (Mitchell et al, 1997), most easily, however, a stakeholder can be defined as someone who has a stake in a certain issue or decision. This could include actors that can be affected by or affect either positively or negatively the realization of an organisation's goals (Freeman, 1984). While working on the problem space of the current situation, stakeholder theory can be applied to identify which stakeholder(s) are the most relevant. A first obvious screening of the system can provide the key stakeholders – especially in academia, industry, policy making, niche technologies and civil society. There are some effective tools that can be utilized to facilitate visualising the stakeholders and are often classified in categories of the Triple Helix (Etzkowitz & Leydesdorff, 1995). Often, there are models which go beyond this academia-industry-government model and into a quadra-helix or penta-helix (Figure 1) in order to add "civil society" or "the public" into the model as a fourth helix.

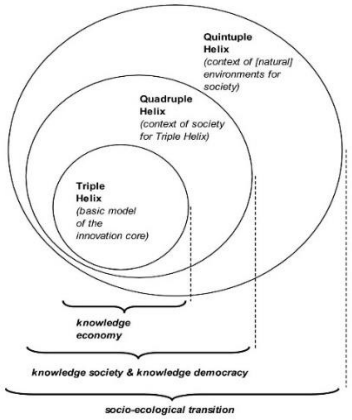

Figure 1: A broader map to identify relevant stakeholders suggested by Carayannis and Campbell conceptualization of the penta-helix (Carayannis & Campbell, 2010)

A deeper dive into the system reveals that there is always more than meets the eye, and upon talking to the stakeholders other small but highly relevant stakeholders might come up. While defining problems and designing solutions, as well as while identifying and engaging with them through the process, three attributes of the stakeholders must be kept in mind. Mitchel et al (1997) describe these as power, legitimacy and urgency. Depending largely upon the problems that are identified, and on these attributes, the most important stakeholders can be identified. Legitimacy means that a stakeholder has a legitimate claim in influencing the direction of the problem at hand, and at the same time is influenced by it - a stakeholder may then further have high or low legitimacy. High legitimacy would be if a claim is backed by strong ethics, for example. Power can be defined as how strong the influence on the problem a stakeholder has. Typically, large industrial organisations exert power over such issues, and must be identified and included in the process. Urgency on the other hand, is if identifying and involving a stakeholder involves a time factor, for example, if the perspectives of a stakeholder are time-sensitive, and the problem at hand would be unresolved if they are not involved early - then that is a stakeholder with high urgency.

According to this paper, power, legitimacy and urgency are all relevant in prioritizing stakeholders, but none is important by itself. Power is important because a stakeholder with power can influence the transition by using their power, but if there is no legitimate claim, nor an urgent claim, then this stakeholder can be considered dormant, and no longer necessary to be considered for the stakeholder involvement process. However, it is warned these attributes are transient and thus the managers of the transition process must be aware of these dormant stakeholders as they may acquire urgency or legitimacy. Similarly, if the sole relevant attribute of the stakeholder is urgency, the stakeholder is demanding. They have urgent claims but have neither power nor legitimacy, and thus, not warranting more than passive attention.

1.1.2 Stakeholder engagement

Once the stakeholders have been identified, the engagement approach has to be decided. While there are many different approaches, the most commonly used one was developed by Arnstein (1969) in the form of “the ladder of citizen participation”. It shows the different levels of how to engage stakeholders in a participatory process, via a simplified categorization of them (Figure 2). At the bottom of the ladder the rungs represent low or non-participation, which means the stakeholders are not enabled to participate in a significant way that contributes to the decision-making process, but the upper rungs of the ladder there is more consultation and participation, but not enough power yet to change or direct the decision-making process. This is only achieved in the top-most rungs.

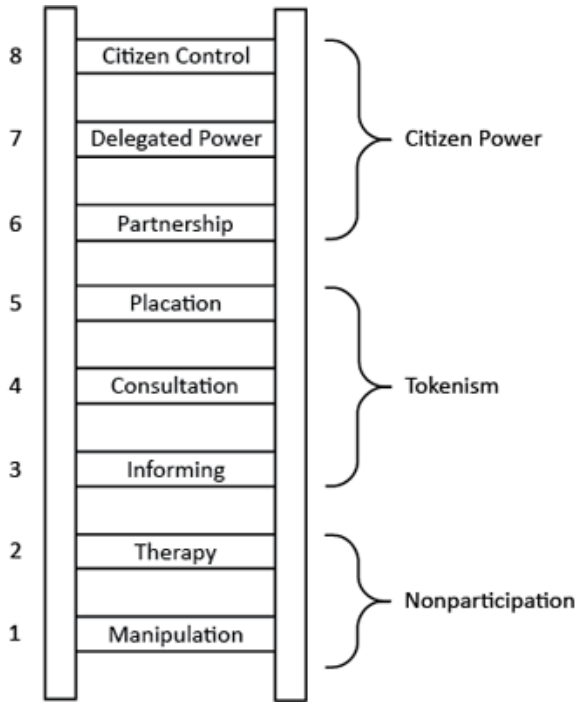

Figure 2: Eight rungs on a Ladder of Citizen Participation adopted from Arnstein (1969). This can also be used to determine the level of stakeholder engagement

As mentioned in the previous section, the attributes of the stakeholders must be kept in mind throughout the engagement process as well, this is because the level of engagement, the frequency of communication with the stakeholders, the amount of collaboration with the stakeholders can all be determined through these attributes. For example, a stakeholder with high power and urgency would typically be involved a lot more collaboratively and actively than a stakeholder with just a legitimate claim, but neither power nor urgency.

1.1.3 Dialogues as a tool for stakeholder engagement

Dialogue is a specific type of guided or semi-guided conversation between different stakeholders often representing different but shared interests. Dialogue can be used where participants are physically engaged in a process. Two broad types of conversations are possible – defending and suspending. (Issacs, 1999) Defending conversations, as the name suggests, are debate-like in nature, where the stakeholders present try to make coherent arguments for their stand-point while trying to convince each other of their own opinion, while on the other hand in suspending conversations the actors are listening to each other with occasional interruption. Suspending conversations can lead to a more constructive dialogue as it can bring out insights and perspectives from all stakeholders, and unlike defending conversations not just let the one or two dominating stakeholders trying to drive home their stand point stand out.

Dialogues as a tool are highly effective tools for co-creation utilising the strengths of all parties involved, thus allowing a collective intelligence to emerge and direct the co-creation process. They can also be effective in building consensus. This can be demonstrated by the effect of listening and observing during a disruptive event in a double-loop process (Figure 3) that is self-reinforcing (Sandow & Allen, 2005).

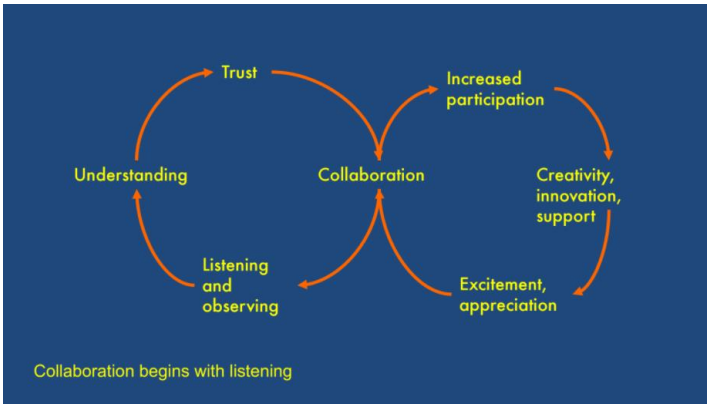

Figure 3: Increased trust and participation due to dialogues in the face of a disruptive event (Modified, Sandow & Allen, 2005)

In comparison, not using them will lead to division instead of participation, as well as negative impacts for all actors involved. The resulting lack of trust from the separation and disruption can cause a drop in efficiency of the organisations involved. (Figure 4)

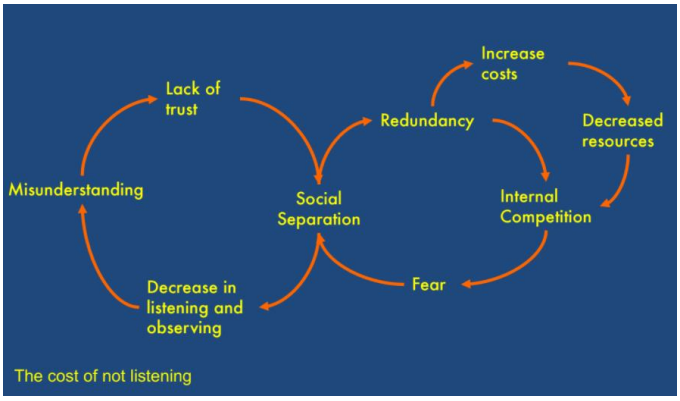

Figure 4: The cost of not listening in the face of a disruptive event (Modified, Sandow & Allen, 2005)

2. Method: Phase 1

2.1 Inside out: Step 1

As highlighted previously, C-Lab uses the potential of students as changemakers who identify leverage points in the system and intervene by taking small, transformative actions. The C-lab hones the skills of the participants to make them leaders that can take on future sustainability challenges. This is however, not possible if the participants have not reflected profoundly on their values, beliefs and principles – a critical aspect often missed out during the education we receive as engineers. During phase 1 of the C-Lab, through a set of tools and exercises, both individually and in small groups our strengths, values and purpose are identified, developed, reflect upon and understood. The idea behind this is to generate self-awareness which, when coupled with awareness of the outer system can enable the decision to know where to intervene in the system, as well as what areas of the system are most aligned with one's own internal compass, which is an important motivation factor for aspiring changemakers. This can be considered an important abstract discussion to be had, serving as a crucial intermediate step between the problems of the past and the solutions for the future. The different steps in this process are explained below further.

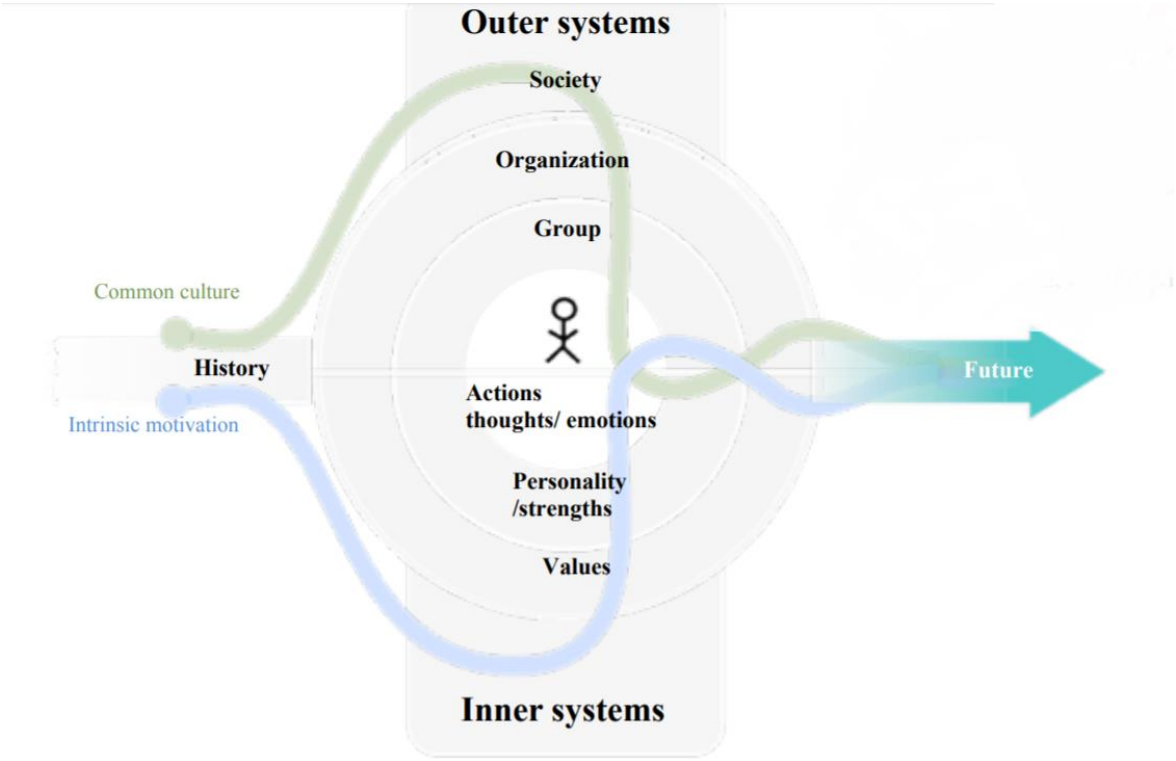

Figure 5: Exploring the self gives changemakers a powerful sense of purpose, as well as intrinsic motivation and purpose to keep moving forward – depicted here by the Meta-model for integration of personal and organisational development Self-Leaders (2009) Stockholm School of Economics

2.1.1 Values clarification exercise

This exercise was carried out with an aim to help the CLab students identify the 10 most important values they associate with. An exhaustive list of values was provided to serve as an inspiration to choose from, but the participants were free to add values outside of the list. After this individual exercise of self-reflection, groups of 3 were formed and, each participant could share a story about a personal experience which lead them to attach the most importance to one or two of their selected values, as other participants in the group listened. Apart from enabling a more profound understanding of the self, this exercise also helped set up trust among the participants through active listening.

The last part of the values clarification exercise was exploring the strengths. Once again in groups, the participants were given 3 strengths that their fellow group members thought they possessed from the stories they heard, and the participants were then given time to balance their strengths. This exercise involved choosing a strength that is most important, and then asking the question "how may the strength be perceived if it is exaggerated" which led to an overdone strength, the next step was to find a "positive opposite" which if exaggerated could lead to a "challenge" which is balanced by the original strength which is a "positive opposite" Operating between "my strength" and "complementary strength" (Figure 6) of this loop could be a great way to work with one's strength was appreciated by many participants as a valuable tool going forward.

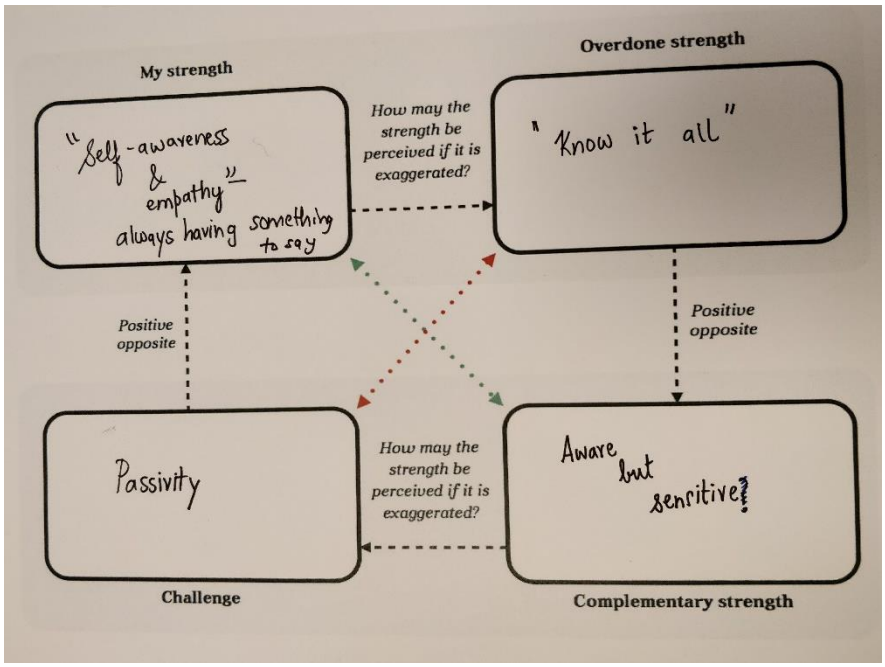

Figure 6: Balancing the strength(s) exercise: Participants further develop and understanding of their strength(s) and develop a complementary strength(s) which balances their strength and prevents it from being over/under played

These methods are designed to serve as strong intrinsic motivations for the participants of CLab, who take on complex challenges and lead from the front. Self-awareness, relatedness to the system, competence and autonomy (through reflection of the self) are all provided through these exercises which according to Ryan & Deci (2000) are highly important for fostering productivity, creativity and engagement within people. Participants develop their own research question and carry on their thesis work subsequently which is directly opposite to controlled behaviour and micro-management which undermine the expression of human beings' natural desire to create, connect and innovate. The participants are thus made self-aware and prepped for the future steps and can then also go on to motivate others they work with, while demonstrating consistent commitment, passion and performance.

2.1.2 Forming Sustainability Principles

Having explored the self, this exercise was designed to envision the future by formulating a set of sustainability principles that steer or direct society towards sustainable development. This forms the first step of the backcasting process. According to the famous Brundtland report titled "Our Common Future" sustainable development is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Before the participants began this exercise, the four broad categories of sustainability principles, were presented to them. The principles address ecological, social and economic dimensions of sustainable development, and at the same time, describe certain principles for human well-being. All these principles together can be expected to direct society towards meeting its needs without compromising or creating irreversible changes to the natural systems in the earth. Furthermore, they were also provided with the "sustainability lighthouse" developed by Holmberg & Larsson (2017) which provided some guiding questions under each dimension which could help us think in some categories or directions to come up with principles. (Figure 7)

Figure 7: The sustainability lighthouse provided sub-dimensions and guiding questions to think about keywords for the different dimensions of sustainability (Meadows 1997)

While framing principles was usually the case in previous editions of the lab, this year we moved towards framing guiding keywords. The reasoning behind this was that framing principles led to very specific statements that could not be adapted very well with the next stage of the process, which was to work with specific thematic areas like mobility or circular economy.

Following this presentation, and with a fair knowledge of what the social, economic, ecological and well-being parameters for sustainability mean, we moved on to the actual framing of sustainability frameworks. We worked with groups, and each group was given one of the four parameters. The groups then brainstormed together and thought about keywords under the dimension that was assigned to them. Further, within each group, we elected a group chair who stayed permanently with the group while the rest of the group switched to another parameter of sustainability. This was done until all groups (Except the chair) had been to all the other groups and returned to their original one. After a final brainstorming, the keywords were presented to the whole group. The final list of keywords under each dimension are found in the results section.

In Phase I the focus was on the backcasting step 1 and 2. As explained earlier, step 1 is to look backwards from the future, to see what needs to be done now to achieve the desired future state. The guiding keywords were an essential take-away from this process as they helped us to connect the assessment we made of the current situation in step 2, and relate better to what kind of research question is most relevant for us. At this stage, we were aware of both the internal values that guide us as individuals, which are important to us and drive motivation, as well as aware of the values that we as a group agree are essential to ensure a sustainable future. For instance, in the topic we have chosen, we are guided by the values of justice and empathy because the end result is to develop a shared understanding of the system by reducing conflict, and collaborating together instead of working separately, and to achieve that goal through an equal, fair and participatory process so all stakeholders are included. In the future, this would help achieve an equal (social), accessible (well-being), clean (ecological) and affordable (economic) transportation system for the citizens and state alike.

2.1.3 The Mission statement

The mission statement is a brief 1-2 sentence statement that captures one's personal purpose, reflecting both personal values and guiding principles. This exercise was envisioned to help capture the essence of the previous exercise of values and principles, and was done individually, followed by a discussion with one fellow participant of the lab. To frame the mission statement, an example from Howard Behar was used, who is the former president of Starbucks, and in a brief podcast explains the importance of his mission statement, and how it not only simplifies the complex challenges he deals with but also gives him a sense of purpose and fulfilment.

During the individual reflection, a list of core values was listed alongside the most important sustainability principles from the previous exercises, and then a first draft of the mission statement was made. The mission statement was supposed to be indicative of what becomes important for each student in the process of realizing their values and achieving sustainability goals. The core values

identified represent the “why” that motivates an individual and gives them a direction in life whereas the key words are more about the “how”, the how one goes about realising these values.

2.2 Outside in: step 2

In Step 2, of the backcasting process, the CLab participants divert their attention to the external world by analysing the current situation around three thematic areas where they can have maximum impact in the region of West Sweden – mobility, circular economy and urban futures. Here the main focus was to build on the findings from the dialogue sessions in the Fall 2017 to describe what is happening and gain more detailed perspectives by organising dialogue sessions with more focussed stakeholders. The idea was to relate this understanding of the system with the criteria (keywords) for sustainability developed in Step 1, and find the most tangible places to intervene in the system, that is, leverage points, and then develop those into research questions.

The objective of mapping out the current situation and to find the leverage points, is to generate impact from the thesis, by diving deep into them through the thesis and as a result, creating momentum or finding fresh perspectives to resolve blockages in the system. As highlighted by Meadows (1997), most people recognise where the leverage points are, but most fail to realize that there are more processes behind the scenes, and a lot more than meets the eyes. The main procedures followed in Step 2 of the backcasting process are highlighted below.

2.2.1 Identifying sustainability challenges

This step involved a systematic review of the most important findings of the dialogue sessions held under the Managing Stakeholders for Sustainable Development course held at Chalmers in the fall of 2017, This was done by highlighting issues brought out by the different stakeholders in attendance at the dialogues, and mapping them out onto three levels – landscape, regime and niche.

Three groups were created, and the participants joined the thematic area that they preferred the most, based on this a systematic list of topics were generated within the broad issues brought up during the dialogues under the three levels. Post-its that share aspects were grouped together while keeping the level, and they could be grouped based on the issue they address, the stakeholders they affect etc., and in the next exercise, each post-it having a topic was related with the post-its to keywords, and this was also placed next to it on another post-it.

After another round of discussion, topics that had no relation to the principles/keywords (that didn’t get any post- its with keywords) were removed and put on a sheet of paper in the bottom of the whiteboard so that they are still kept in memory. After this exercise there was room for the participants to move groups, and reflect on the topics and towards the end, there was a group reflection about the exercise, and the most important topics were highlighted. In the next step these were brought up during dialogue sessions with the stakeholders.

2.2.2 Preparing and organising dialogue session

Dialogue sessions, as described previously (section 1.1.3) are a very effective tool in stakeholder management. At the lab, the participants got an opportunity to practice autonomy and hone their leadership skills by facilitating and preparing a week-long session of dialogues with different actors in the three thematic areas – mobility, urban futures and circular economy.

The aim of these dialogues was to mainly get insights and really get into the crevices of the current system of actors by asking questions that are specific to each one's role in the system. The dialogue sessions held previously, as well as the previous step of identifying the most pressing challenges in the system built a substantial foundation for asking precise questions to the right stakeholders. The participants took turns to facilitate the dialogues, take notes, review the results and record them. The sessions were held over the second week of the Phase 1.

While some discussions involved presentations from stakeholders followed by a question-answer interview format, others were facilitated, structured dialogue sessions involving discussions around a theme. In some there were also smaller focus groups that worked with the stakeholders around their area of work within the broader theme (such as biofuels under urban futures) in order to get a vivid picture of what problems and solutions are unravelling in the region. The guiding idea for this entire process was exploratory interviews, to answer the big question, "Where we are right now, and what exactly is going on?"

2.2.3 Identifying leverage points

Week 3 began with the goal of summarising the findings of the dialogue sessions by creating a short list of leverage points. A leverage point (LP) was defined as a clear, actionable gap between the current state and the desired future state, which could be addressed within the 5 months of the CLab process, as well as which merits the attention of the stakeholders who were at the lab. The leverage points were so defined in order to enable impact creation, while also making way for further research or clearing congestion in the current system for the stakeholders.

Each LP included the following: (i) challenge (ii) topic (iii) stakeholders (iv) main stakeholder (name of person/s) (v) Contact information to main stakeholder (vi) Benchmark(s) (vii) Projects to connect to (related to the LP) (viiii) Student perspectives (interest, master program connection) (ix) Academic connection (proposed supervisor) These LPs were identified based on interests developed by participants within each thematic area, and in total each area could have about 5 LPs. These were then presented to the CLab Team and the participants and opened for feedback.

They were discussed in depth once again, revaluated and after incorporating the feedback, there was a round of "speed dating" where participants discussed with each other their interests, passion, strengths and weaknesses. A round of individual discussion with the CLab team, then followed, as participants continued to refine the LP further. After this, all the LPs were put up on a white board, and every participant chose the one which interested them the most. The thesis pairs were thus formed. The leverage points were then refined further and developed into a research question within the thesis pair.

2.2.4 Defining the Research Question

The thesis pair then worked together to update the leverage point they chose to work on together. More information regarding the background to the leverage point via literature review, or via direct discussion with relevant stakeholders were added to zoom-in and provide a better picture.

Based on this clearly defined leverage point and its significance, a research question (RQ) was defined with inspiration from previous RQs at the Challenge Lab. The background, the method, the strengths and weaknesses of the thesis pair, and the proposed timeline were all kept in mind while

defining the research question. Other factors decided based on this were step(s) of backcasting which would be the focus through the thesis process, proposed academic supervisor(s) and related theses which could provide guidance and/or benchmarking for the thesis. Finally, in keeping with the collaborative and co-creation principles of the lab, a list of possible thesis from this year's CLab that had either thematic overlaps or common stakeholders were listed, also in the interest of creating synergies.

3. Results: Phase 1

3.1 Sustainability Criteria

The following sustainability criteria (keywords) were identified for each of the four-dimensions of sustainable development.

3.1.1 Well-being dimension

Category	Keywords
General	Equity, Equal opportunities
Knowledge	Access, Education, Broader connection, Global participation
Autonomy	Deciding one's own fate, Freedom, Ownership of time, Independence
Self-fulfilment	Space for self-expression, Self-development, Recreation, Opportunity to pursue happiness, Spirituality
Purposefulness	Sense of purpose, Love, Appreciation, Respect, Contribution
Belonging	Community, Culture, Acceptance of diversity, Personal independence, Family, Acceptance, Freedom, Positive social interaction, Identity, Inclusion
Subsistence	Sufficiency, Clean water, Clean air, Food security, Minimum wage, Nutritious food, Home, Safety, Secure, Employment
Health	Green spaces, Weather, Access to healthcare services, Recreation

3.1.2 Social dimension

Category	Keywords
Horizontal Relations	Helping each other, Trust, Empathy, Acceptance, Openness, Communication, Cooperative, Learning, Respect, Participation
Vertical Relations	Transparency, Awareness, Responsibility, Accountability, Representation, Integrity, Alertness, Adaptability, Trust, Respect
Equity/Justice	Legal/normative rights and opportunities, Fairness, Power balance, Impartiality, Consciousness, Inclusion, Access to education/freedom/safety, Welfare, Freedom of movement

3.1.3 Ecological dimension

Category	Keywords
Meeting needs (of)	Planet, Living beings, Today, Tomorrow
Alterations to the Earth's crust	Reversible
Service to the Environment	Preserve, Protect, Restore, Regenerate
Produced Substances/Extracted substances	Degrade, Reabsorb, Reasonable Timeframe

As visible from the keywords, they are rather abstract for this particular dimension and were further expanded by the participants into principles to provide clarity.

1. Today's needs, both of the planet and living beings must be met without compromising the ability to meet the needs of tomorrow.
2. Alterations made in the crust or biosphere are reversible.
3. The environment is served by preservation, protection, restoration and regeneration.
4. Substances are produced and extracted so that they can be degraded or reabsorbed within a reasonable timeframe.

3.1.4 Economic dimension

Category	Keywords
General	Long-term vision, Conscious consumption, Fair distribution, Transparency
Natural capital	Efficiency, Sufficiency, Substitutability
Man-made capital	Sharing, Dematerialization, Flexible & adaptable systems, Life-cycle assessment, Maintenance
Human capital	Shared & accessible knowledge, Collaboration
Financial capital	Growth indicators, Fair distribution of wealth, Responsible investments

Economic keywords were also too broad and were explained a bit further through the following principles.

1. Economic activities are carried out with long-term considerations and consciousness
2. Natural capital is treated efficiently and used with consideration to sufficiency and substitutability
3. Man-made capital is shared, dematerialized, flexible, adaptable and carefully maintained
4. Human capital is collaborative, shared, transparent and accessible
5. Financial capital is responsibly invested

3.2 Leverage points

A list of 12 LPs were formulated by the participants, we will focus on providing the result of the three LPs identified under the thematic area mobility, as these are the most relevant to this particular thesis. After doing so, a deep-dive will be done into the various facets of the LP identified for this thesis and then developed into a research question.

LPs identified under the mobility thematic area were:

- Bringing multi-stakeholder perspectives on developing the concept of shared parking considering the current changes in Gothenburg's cityscape and analysing its impacts.
- Using blockchain technology to create a collaborative platform to increase efficiency for intermodal connections
- Exploring misalignments between mobility network actors' goals in Gothenburg and suggesting strategies to cope with uncertain future mobility scenarios

The last one was developed further into a research question and is broken down into its components in the following table.

Facets of the LP	*Details*
Challenge behind the LP	Lack of coherence in goals between organisational, regional, national and sustainable development goals
Topic addressed by the LP	Diverging goals between related stakeholders in the system for a shared future vision and impact(s) to the business models of the industry
Stakeholder(s)	
Main Stakeholder(s)	Urban transportation administration (Trafikkontoret), Trafikverket, VGR
Connected Stakeholder(s)	Stadsbyggnadskontoret, Volvo Cars, Volvo Trucks, Einride, DB Schenker, KNEG, Sweco, Drive Sweden, UbiGo
Benchmark(s)	A case study of sustainable urban transportation in Oslo, Norway
Related Project(s)	Traffic Strategy 2035, ElectriCity, Closer, Historisk stadsplaneanalys för Göteborgs Stad
Skills and areas of interest(s) of participants	Strategy creation, stakeholder management, Sustainable development, Policy planning, Sustainability transitions, Automotive industry & design, project management, Energy systems analysis, Sustainable development
Academic connection (Proposed supervisor)	Frances Sprei
Proposed Methodology	Guiding goals: SDGs and Climate 2030. Method: Q-factor mapping (Social/behavioural sciences), workshops, interviews with a focus on Backcasting steps 2 and 4

Through the dialogue sessions held during Phase 1 of the lab, and as part of the "Mobility" dialogues in the *Managing Stakeholders for Sustainable Development* course, gaps in future visions and problems in coordinating around similar fields of work or projects were highlighted by some of the stakeholders. These gaps were picked up on to formulate this leverage point and a decision to explore this misalignment of goals of different actors who influence planning and development of the region was made. The goal was to map out the differences, especially amongst the planning bodies

(Trafikverket and Trafikkontoret) but also involve other stakeholders such as private companies like Volvo, and a few other services such as logistics providers which will impact what a future sustainable transportation system in Gothenburg will look like.

3.3 Research Question

After receiving feedback from the CLab team and other participants, the LP was analysed and revaluated, in order to generate the following research question:

What are the current misalignments in the transition to a sustainable road transportation system in Gothenburg?

The limitations of time and the proposed methods were considered, and the facets of the LPs mentioned in the previous section were refined, reworded, and transformed to offer more clarity going forward into Phase 2. The academic supervisor was confirmed at this stage, and the RQs were refined based on feedback from them as well.

4. Discussion: Phase 1

This part of the report focussed on describing the methods and results of the Challenge Lab Master's Thesis. This thesis significantly differs from other master theses at Chalmers University of Technology because it begins with an inner and outer exploration of the system based on which participants decide to work on a research question they design themselves. The research question decided does not just reflect the values of the students, but is also validated by the interest of stakeholders in the region. This coupled with the expertise that the CLab team has developed and nurtured through iterations of the CLab process set the stage for an impactful thesis.

The inside-out perspective was a fresh approach which brought the most interior passions and ulterior motivations out in a safe and comfortable setting, and the participants felt that the time they had for self-reflection about values, principles and mission was very fruitful and a rare feature in engineering education. This was a good way to keep the motivation and passion up through a hectic and packed 3-week Phase 1 process because of the effects of self-leadership mentioned in previous sections.

While leverage points and research questions, seem like the obvious results, there were other results both for participants at a personal level which were brought out during reflective dialogues held frequently through the process. Mapping out the systems in the thematic areas of mobility, circular economy and urban futures in big groups combining different disciplines of engineering and different styles of working was challenging, but it helped bring out the nuances of the system which would have been difficult to do individually or in small homogenous teams. There was also a constant zooming-in and zooming out into the specific leverage point and out to the big picture which aided in keeping a good focus on the problem at hand. A too zoomed in perspective can lead to solutions which cause problems elsewhere in the system, while a too broad perspective can lead to ineffective solutions. Thus, a balance was maintained which was highly appreciated. The dialogue sessions helped gain new insights, clear doubts and back up the desk research done around the thematic areas. However, some participants felt that a longer time to do the desk research and more participation in

choosing the stakeholders attending the dialogue could make the process more effective. It felt like to get the leverage points out of the 1-2-hour dialogues was a challenging task.

The process of arriving at the research question around the misalignment of goals was framed through involvement of the various actors, especially the urban transport planners. Several actors at the dialogue sessions mentioned their concern for uncertainty in the future transportation system because of conflicting or diverging interests, and a lack of consensus among the stakeholders in planning for sustainable transportation. Their interest in the question, coupled with the participants' need and interest for using tools such as the Q-methodology were helpful in deciding the methodology to be followed in Phase 2. The interview results might lead to ambiguous information around the goals and visions of the actors and have to be scrutinized carefully. Coupling them with the results of the Q-methodology and the dialogue to be facilitated by the workshop in a coherent way will certainly be another challenge during the final leg of the thesis.

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Appendix B: Questionnaire

1. **Future State (FS):** Can you describe the future state of sustainable transportation system (2030 & 2050)?
    a) guiding values for future state (accessibility, good health, environment friendliness, profitability)
2. **Current State (CS):** Where are we right now? What are the current challenges?
3. **Transition:**
4. Do you see a need for transition? If so, how do you see the transition happening?
5. **Transition Strengths & Weaknesses (TS & TW):** In this transition, what are your strength and weaknesses?
6. **Transition Roles (TR):** How do you see your role in this transition process?
7. **Transition Actors (TA):** What other actors are relevant and making the change happen? Are they influencing on your role?
8. **Misalignments (TM):** Do you see any the misalignments? (explain misalignments - between different documents and goals)
9. **Solutions & Strategies (So):** What seems to be currently the most relevant solution(s)

Appendix C: List of Q statements

1. The transportation system can continue the status-quo (increasing traffic) as I believe in the potential of clean technologies (EVs, autonomous vehicles) to solve the problems of emissions.
2. A fundamental change in the behaviour of people is needed to achieve a sustainable transportation system.
3. The need to own and use a car depends completely on urban planning.
4. The need to own and use a car depends on how other transport modes meet people's needs and expectations.
5. The car will still be an important, however not the most common means of transportation in an easily accessible regional/urban centre.
6. For achieving a sustainable urban centre, bicyclists and pedestrians must be made a clear priority.
7. The safety aspect of any future mode of transportation must be a high priority while assessing its sustainability.
8. Policy instruments that affect the cost of transportation such as congestion taxes and parking rates will be important for achieving a sustainable transportation system.
9. Office spaces integrated with residential spaces, virtual meetings and other such measures must support the reduction of the need for transportation in the future.
10. The delivery of goods and other logistics services must be time-regulated in order to reduce congestion in the urban centres and improve efficiency of businesses.
11. Heavy-sized vehicles (over 3,5 tons) must be restricted from dense urban centres.
12. Shared autonomous electric vehicles have a big potential to disrupt the current transportation system and lead to a decrease in emissions by 2030.
13. Transportation infrastructure such as highways must not create physical barriers between different parts of the city.
14. The 2030 transportation system in and around Gothenburg is no longer dependent on fossil fuels.
15. Multi-modality, utilising the full potential of different modes of transport, can provide the required efficiency needed for a sustainable transportation system.
16. For achieving a future sustainable transportation system, radical changes opposing the current system are needed rather than small reforms.
17. In the future, reaching the climate targets is more important than economic growth in the region.
18. In 2030, there are no competitive alternatives to trucks for goods transportation because of the last-mile problem.
19. Building new highways will lead to increased greenhouse gas emissions.
20. Good accessibility is the most important criterion for ensuring social sustainability of the area.
21. Public transportation should be given the priority in the limited road space.

22. New highways are needed for increased freight transportation in the city, which is essential for economic development.
23. Solving the problem of congestion in and around Gothenburg is more important than reducing local emissions.

Appendix D: List of themes for World Café

Theme No.	Theme Name	Q statements used	Questions explored on each table
1	Role of the personal car	"The need to own and use a car depends completely on urban planning." "The car will still be an important, however not the most common means of transportation in an easily accessible regional/urban centre."	1. Why is the car still important in the future? 2. What are the alternatives to the personal car? 3. How do we make these alternatives more attractive? 4. How can urban planning affect car ownership?
2	Freight Transportation	"In 2030, there are no competitive alternatives to trucks for goods transportation because of the last-mile problem." "New highways are needed for increased freight transportation in the city, which is essential for economic development." "Heavy-sized vehicles (over 3,5 tons) must be restricted from dense urban centres."	1. Should there be a restriction on the kind of freight vehicles that enter the city centre? Why / Why not? 2. Trucks are the primary alternative to the last-mile problem in the delivery of goods. What alternatives exist and how should we handle freight transportation in the new dense urban centre? 3. What are the system effects of increased freight transportation? (+ and -) 4. Is the current system equipped to handle the increase in freight transportation? What is missing? What could make a difference?
3	Transitions	"The transportation system can continue the status-quo (increasing traffic) as I believe in the potential of clean technologies (EVs,	1. Are technical solutions enough to achieve a sustainable transportation system?

		autonomous vehicles) to solve the problems of emissions." "A fundamental change in the behaviour of people is needed to achieve a sustainable transportation system." "Policy instruments that affect the cost of transportation such as congestion taxes and parking rates will be important for achieving a sustainable transportation system."	2. How can user behaviour be impacted in the transition? 3. Are current policy measures to achieve the transition to a sustainable transportation system enough? 4. How long will the transition take? Electrification of transportation in 2030 or 2050?
4	Disruptive Technologies	"The 2030 transportation system in and around Gothenburg is no longer dependent on fossil fuels." "Shared autonomous electric vehicles have a big potential to disrupt the current transportation system and lead to a decrease in emissions by 2030. "	1. Autonomous Vehicles How big is the impact? (Disruptive potential) What are the system effects? (Social, Economic and Ecological) 2. Connected Vehicles How big is the impact? (Disruptive potential) What are the system effects? (Social, Economic and Ecological) 3. Electrification How big is the impact? (Disruptive potential) What are the system effects? (Social, Economic and Ecological) 4. Shared Vehicles How big is the impact? (Disruptive potential) What are the system effects? (Social, Economic and

			Ecological)
5	Active Mobility & Public Transportation	"For achieving a sustainable urban centre, bicyclists and pedestrians must be made a clear priority." "Public transportation should be given the priority in the limited road space."	1. How can we prioritise this in the limited road space? What are the consequences? Why is this important? 2. What drivers, barriers and incentives for active mobility exist? Do they have a potential to cause a big change (like in Copenhagen) or are better served in niche areas? 3. How can we prioritise public transportation? 4. Should public transportation be the backbone of the urban transportation system? What drivers / barriers exist?

Appendix E: Q Methodology Results

Statement	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Participant 1	-2	1	1	3	0	2	-1	2
Participant 2	-2	1	-2	2	-1	2	0	1
Participant 3	-3	2	1	2	-1	-1	-2	3
Participant 4	-3	1	2	3	1	1	-1	3
Participant 5	2	-3	-2	-2	3	3	1	0
Participant 6	0	-1	-2	0	2	-1	2	1
Participant 7	0	1	-3	3	1	-2	2	0
Participant 8	-3	3	0	1	0	0	1	3
Participant 9	-1	-1	2	2	2	1	3	3
Participant 10	-1	3	1	0	-1	1	2	-2
Participant 11	-1	0	-3	2	1	1	2	1
Agreement Index (Ai)	-1.27	0.64	-0.45	1.45	0.64	0.64	0.82	1.36
Misalignment Index (Mi)	1.48	1.72	1.88	1.50	1.30	1.43	1.53	1.55

1.31	1.44	0.94	1.97	1.24	1.82	1.44	1.54	1.23	0.94	1.53
-0.09	-0.09	-0.82	0.45	0.09	-0.64	1.45	-0.27	0.36	-1.82	-0.18
-1	0	-1	3	1	-2	3	0	0	-2	-3
2	0	0	1	-1	3	2	-2	1	-2	-1
-3	0	0	-3	1	0	0	-2	-1	-2	1
-1	1	0	-1	-2	2	2	2	1	-2	0
0	-2	-2	3	0	-1	2	1	1	-1	-1
1	2	-3	3	3	0	1	-2	0	-1	-2
0	2	-1	-1	0	-3	1	-2	0	-1	1
-1	-2	-1	-1	0	-2	1	0	-2	0	0
0	-2	0	2	-1	0	3	1	1	-3	0
1	-1	0	0	0	-1	3	-1	3	-3	0
1	1	-1	-1	0	-3	-2	2	0	-3	3
9	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**

1.15	1.14	0.90	1.23
0.36	0.73	-1.91	-1.45
-2	2	-1	0
0	0	-3	-3
0	1	-1	-2
-1	-1	-2	-3
2	0	-1	-3
1	-1	-3	0
1	2	-1	0
2	2	-3	0
0	1	-2	-1
1	2	-3	-2
0	0	-1	-2
20	**21**	**22**	**23**

Appendix F: Correlation Matrix

Correlation Matrix	Participant 1	Participant 2	Participant 3	Participant 4	Participant 5	Participant 6	Participant 7	Participant 8	Participant 9	Participant 10	Participant 11
Participant 1	**100**	38	38	49	6	-12	9	38	35	-3	3
Participant 2	38	**100**	65	41	19	22	49	47	22	51	51
Participant 3	38	65	**100**	57	-35	3	41	63	12	34	37
Participant 4	49	41	57	**100**	0	3	19	31	50	0	22
Participant 5	6	19	-35	0	**100**	32	-4	-29	26	-16	25
Participant 6	-12	22	3	3	32	**100**	47	0	9	22	53
Participant 7	9	49	41	19	-4	47	**100**	28	1	28	57
Participant 8	38	47	63	31	-29	0	28	**100**	35	49	21
Participant 9	35	22	12	50	26	9	1	35	**100**	6	15
Participant 10	-3	51	34	0	-16	22	28	49	6	**100**	15
Participant 11	3	51	37	22	25	53	57	21	15	15	**100**