CHALMERS
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Backcasting Approach to Sustainable Transport and Mobility in Gothenburg

- Stakeholders' Perspectives on Challenges, Barriers, and Opportunities for Sustainability Transition

A project in the Challenge Lab 2014

Master's Thesis within Industrial Ecology programme

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Gothenburg, Sweden 2014

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ABSTRACT

Challenges coming along with global sustainability issues, e.g. climate change, cannot be solved with conventional, linear thinking approaches. Transition towards sustainability is a non-linear process and involved a wide variety of actors. Therefore it requires in-depth understanding of barriers and drivers that disable or enable transition in the current unsustainable system. Adopting systems perspective with backcasting approach and inspired by the "think global, act local" paradox, the Challenge Lab project takes on the present challenges in the unsustainable transport system in Gothenburg, Sweden by introducing a new two-phased methodology, called 'the Challenge Lab (C-Lab) process', to address a societal challenge. The first phase focuses on understanding the system from different perspectives to identify critical leverage points and helps intervene in ill-structured systems. The second phase consists of a study that identifies the challenges, barriers, and opportunities in the transport system of Gothenburg, based on opinions gathered from the interviews with 10 stakeholders. These challenges, barriers and opportunities are shown on the conceptual model of the system. Unlike similar studies considering Gothenburg as the case city, the present master's thesis covers both passenger and goods transport, and considers academy – in addition to industry and government- as another relevant stakeholder. The new methodology was useful to have a systemic understanding of the complexity and dynamics of societal challenges. The findings showed that collaboration between the stakeholders and integration of transport into the city planning are among the main challenges towards a sustainable transport system, but could become opportunities, if addressed. Main barriers identified are the limited space in the city and the politician's fear of loss when proposing and implementing sustainable strategies. The findings also revealed that the majority of the stakeholders interviewed think that there is no or partially consensus on the vision for sustainable transport system in Gothenburg. The transition towards a sustainable transport system can be achieved by increasing dialogue among stakeholders and by having a 'systems thinking perspective' when planning the future transport system of the city.

Key words: challenge lab, sustainability transition, sustainable transport system, challenges, barriers, opportunities, stakeholders, socio-technical systems, backcasting, transition management, multi-level perspective

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Contents

Abbreviations

GHGs – Greenhouse gases
LDCs – Least Developed Countries
STS – Sustainable Transport System
MLP – Multi-level Perspective
TM – Transition Management
DG – Directorate General
SCOT – Social Construction of Technology
ANT – Actor-Network Theory
TIS – Technological Innovation Systems
VGR – Västra Götaland Region
ICT – Information and Communication Technologies

1 Chapter One - Introduction

1.1 Background

The world keeps on following its unsustainable march (Donella Meadows, Randers, & Meadows, 2004). Human economic activity together with the world population has increased dramatically. In return, the world has witnessed rapid depletion of the environment with vital ecosystems being degraded. Given their interconnectedness, several factors at the global scale have created a reinforcing effect accelerating the impairment of the Earth's supply and demand balance. Challenges coming along with the notion of sustainable development and global sustainability objectives, e.g. GHGs emissions reduction objective to combat the climate change, cannot be solved with conventional tactics and techniques (Hjorth & Bagheri, 2006). Adopting system dynamics perspective and basing on the 'thinking globally, acting locally' paradox, the Challenge Lab (C-Lab) takes on the present challenges in unsustainable transport system in the city of Gothenburg (hereafter Gothenburg or the city).

The issues around human's overexploitation of the natural resources and its consequences were subjected by many scientific works throughout the near history (Du Pisani, 2006). All those sources in this regard point out the possible destructive impact of unsustainable use of the resources endowed by the nature on the future of human- and other living-beings. It is this unsustainable trend and the perturbation of its consequences, e.g. climate change etc., that stimulated the actors to initiate the Challenge Lab. For this reason, understanding of what sustainable development and sustainability are and require must be well understood.

'Sustainability' is not a new phenomenon of science but traces back to the year 1713 when Carl von Carlowitz mentioned in his book *Sylvicultura Oeconomica* that the forest resources should be used sustainably (Du Pisani, 2006; Grober, 2007). Sustainability can be defined as the ability of the ecosystems to support life. The notion of sustainable development, on the other hand, is, as coined by the Brundtland report *Our Common Future* (the United Nations, 1987), 'to meet the needs of present generation without compromising the ability of future generations to meet theirs'. It is considered as a guiding principle (Drexhage & Murphy, 2010) for developing responses to the uncertainty of the future and for enabling a transition towards sustainability (Dovers & Handmer, 1992).

Sustainable development is, without having to mean 'growth', to ensure the wellbeing of the global society both now and in the future while recognizing the carrying capacity of the ecosystems. For the sake of simplicity, sustainability can be regarded as the ultimate desired goal (Brown et. al., 1987) which can be reached through the path of development that is sustainable; that does not necessarily seek for growth; and that takes into account matters related to both the nature and society and the economy. Nonetheless, it must be noted that, expressed by many scholars (B. J.

Brown et al., 1987; Dovers & Handmer, 1992; Drexhage & Murphy, 2010; Juma, 2002; Mebratu, 1998; Tilbury et. al., 2002), the term 'sustainable development' is ambiguous and might be interpreted differently by different nations and even different interest groups. In their book *Education and Sustainability Responding to the Global Challenge*, Tilbury et. al (2002) mentions the existence of different categorization of these definitions and congregates them into two groups: *sustainable economic growth* and *sustainable human development*. They state that:

> *The 'sustainable economic growth' group (which includes the Brundtland Report, itself) is reformist in that it does not support the transformation of current social or economic systems. In this approach, the natural environment is conceived in a utilitarian way with conservation treated as one of a range of policy options. (...) By contrast, 'the sustainable human development' view demands radical departures from the current system. Sustainable human development provokes a fundamental challenge to established interests, primarily because it focuses upon issues of social equity and ecological limits, and, thereby, questions world views and development models that are predicated on assumptions of unlimited economic growth.*

It is worthwhile to specify that, according to Tilbury et. al. (2002)'s categorization, the present thesis takes *'sustainable human development'* as the understanding of sustainable development while setting the vision for the sustainable future. It is because many studies (Rockström et al., 2009; Meadows et al., 1972; Wijkman & Rockström, 2012) have proven that transformation of existing regimes is needed to avoid the possible destructive impacts of human's overexploitation of natural resources. Therefore, ecological sustainability and the conservation of ecosystems upon which the economic system is dependent are of great importance for life.

The issues that the sustainable development endeavour has to deal with are quite complex. Scaled up by this ambiguity in the definition, the requirements of sustainable development together with the current global challenges, e.g. resource depletion, poverty, unfair distribution of wealth, climate change, brought even bigger complexity to its proper implementation. Sustainable development requires ecologically sustainable, socially equitable, and economically sufficient decisions and actions at global, regional and local level. It requires international cooperation (Tilbury et al., 2002) for dealing with these issues stemming from human's social-economical activities. To work together is very important because, in such an interconnected world, it is extremely difficult, if not impossible, to predict the scale of the impact one's socio-economic activity today may possibly have on both the quality of life of others and ecosystems elsewhere today and in the future (Azar et. al., 1996).

However, international cooperation is not the only key to this endeavour given the sovereignty of nations. This must be supported by the integration of international responsibilities and commitments into national policies. It is of course not an easy

task because it requires different approaches to the problems faced by the nations and a shift in society's life style. Therefore, at the national level, there must be a firm communication and dialogue between society's key institutions, and common understanding – a vision- of sustainable future. In order to bring the principle guidelines for sustainable development down into policy at national level, *Local Agenda 21* was signed by most countries – Sweden being a frontrunner for the ratification- at Rio Summit in 1992 (Collier & Liifstedt, 1997).

To this end, Dovers and Handmer (1992) suggest that the first measure that is to be taken in this regard is to have a system dynamics thinking perspective. System dynamics thinking is important to understand how society and nature interact with each other as well as patterns of and relations between complex problems (Haraldsson, 2000). It enables researches, policy makers, businesses to capture the 'bigger picture' to tackle the societal challenges at the local level, collaboratively. Considering the top-down structure of global governance for sustainability, i.e. international agreements and commitments leading to national objectives and strategies turning into action by local goals and policies, it would be right to say that collaboration at the local level, therefore, is in the core of achieving global sustainability objectives.

Therefore, urban areas and their sustainable development play a significant role in this regard in driving the efforts for global sustainability in the right direction. Among many others, one of the most important reasons to this is that cities are hubs for social-economic activities of humans, business enterprises, and governmental authorities. Thanks to their feature of attractive agglomerations, cities function as an engine for economic growth and social development of countries. Additionally, considerably large amount of production of goods and waste, and consumption of these goods and resources takes place in cities. As of 2010, slightly more than half of the world population for the first time in human history started living in the urban areas (United Nations Human Settlements Programme, 2011). It is further projected that this number will rise up to 70% of the world population living in cities by 2050 (OECD, 2012b). In parallel to increasing number of population, it is certain that its indispensable consequence will appear such as increasing urbanization.

This means that the human's social-economical activities in cities will naturally increase resulting, in return, in further increase in the rate of production and consumption and in an increasing demand for the supply of resources such as water, food, and energy, and services such as transport and education. Through these activities, cities transform resources into physical structures and waste (Decker et. al., 2000). As a consequence, great amount of waste in the form of air, water, and soil pollution, and greenhouse gas emissions are produced. This metabolism of cities makes them the major contributor to the climate change as they are responsible for 70% of total GHGs based on a consumption-based method, i.e. irrespective of the origin of production, GHGs emissions stemming from the production of all good

consumed by urban residents (United Nations Human Settlements Programme, 2011).

From the consumption-based approach, it would not be wrong to say that transport is at the heart of sustainability given its function in society. By this, it is meant that it is transport which is closely intertwined with other systems (Goldman & Gorham, 2006), which determined the location of industries and cities, enabled people to move and consume, and goods to be delivered and consumed around the world. Therefore, to achieve sustainable transport is in the centre of seeking for achieving transition in cities and towns towards sustainability when considering what (Button & Nijkamp, 1997) states *"if cities are to be both socially and environmentally sustainable into the next century, transport systems will need to be redefined and developed"*.

Gothenburg in this regard has been facing great challenges in terms of sustainability, including (un)sustainable transport in the city (Göteborgs Stad, 2012). The city continues to grow (*ibid.*). It is projected that Gothenburg is going to expand by further accommodating 1.5 millions of inhabitants by 2020 (Enhörning, 2010). This growth in population will increase demand for transport in the city requiring even better connections within and between the inner and outer city (ibid.). The city is also home to the largest harbour in Scandinavia where 65% of container traffic occurs. Furthermore, the Västra Götaland region, whereof Gothenburg is the significant part, provides 25% of the overall national export[1], which makes the city's economy dependent on transport of goods (Göteborgs Stad, 2012). In return, these will increase the need for resilient and efficient transport system in the city.

In order to cope with these challenges in transport and reduce city's overall impact on the climate in this regard, the city set its aim as to "create an attractive, sustainable city from social, environmental, and economical point of view" (*ibid.*). In this regard, five clusters – urban future, the marine environment and maritime sector, transport solutions, green chemistry and bio-based products, and life science-, which will develop multi-sectoral collaborations, were defined to seek for new, alternative, and resource efficient solutions for urban sustainability in Gothenburg (Kullendorff, 2012).

The Challenge Lab, consisting of 12 M.Sc. students – called as *change agents* forming the Challenge Lab team[2]- having diverse academic and cultural backgrounds, acts as 'glue' between the actors of the triple helix (see *Figure 1.1*) to deepen multi-sectoral collaboration (Holmberg, 2014). The Challenge Lab particularly focuses, in addition to researches, on students as of their importance in a knowledge-based society (Holmberg, 2014). The C-Lab seeks for solutions that will help local

[1] Hellberg, S. 2014, *Mobility Gothenburg: History, System, Implementation, and Strategy*. Powerpoint presentation given on January 2014. Can be contacted via sofia.hellberg@trafikkontoret.goteborg.se.
[2] The Challenge Lab team is sometimes also referred to as *the team* in the thesis.

initiatives achieve sustainable transport in the city as well as for creating circumstances to carry out activities to reach the city's sustainability objectives mentioned in Kullendorff, (2012) and Göteborgs Stad (2012) (*ibid.*). In its essence, the Challenge Lab meets "the necessity to apply an interdisciplinary approach with multi-level involvement actors and institutions across different scales" (Spickermann, Grienitz, & von der Gracht, 2013) in order to deal with the transport as a socio-technical system in Gothenburg and bring about a transition towards its sustainability.

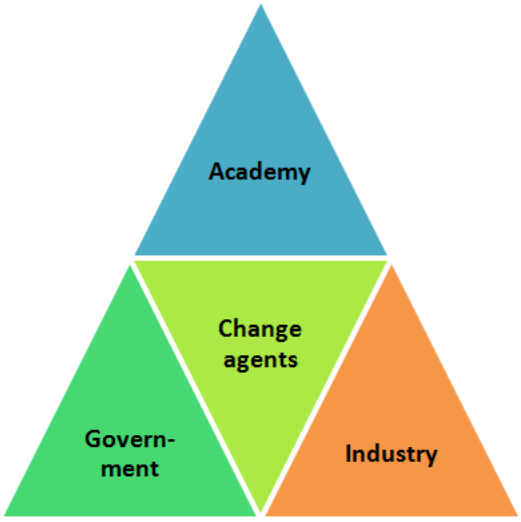

Figure 1.1 The Challenge Lab in the triple helix concept

However, to bring about sustainability transition itself is a challenging task (Spickermann et al., 2013). A transition in socio-technical systems, e.g. transport, is "a set of processes, involving a broad range of actors, which leads to a fundamental shift" (Markard, Raven, & Truffer, 2012). On the other hand, transport system is quite complex given its interconnectedness with other systems, and the existence of different institutions, infrastructure, and technology and service providers in the system (Richardson, 2005). This also the case in Gothenburg, meaning that there are several ambitious actors from government, industry, and academy involved in the transport system. The interactions between these actors and the elements within the transport system create the circumstances, e.g. path dependency, an innovation, which may hamper or enable a transition. Therefore, it is crucial to understand and address challenges, barriers, and opportunities that the stakeholders encounter in the transport system in Gothenburg.

Aims of the Challenge Lab project

Echoing the vision 'Chalmers for sustainable future' (Holmberg, 2014), the aim of the Challenge Lab project is to serve as 'glue' that will bring together the actors underlying the triple helix[3], and by this, collaboration between them to contribute to

[3] *The Triple Helix* refers to "the three institutional spheres, namely academy, industry, and government, as well as at their intersections". http://triplehelix.stanford.edu/3helix_concept. viewed on June 2014.

co-creating a sustainable society. Among many others, the Challenge Lab particularly aims at:

- Strengthening the educational dimension of the knowledge triangle within the Areas of Advance4
- Providing a platform where the actors within the five regional knowledge clusters (Kullendorff, 2012) can be brought together around the enthusiastic students seeking for creating solutions for transition towards sustainability based on the concept of triple helix
- Operationalizing the (sustainability) objectives at the local and regional level
- Developing trust between the actors of the clusters through students
- Enabling students to develop and strengthen their transdisciplinary working skills with the challenge-driven perspective
- Providing knowledge transfer with other cities and countries around the world through networking with similar projects taking place in the different regions of the world

The long term objective of the Challenge Lab project is then, by being an important enabler of integration of research, education, and innovation – the knowledge triangle- into the triple helix, to create knowledge-based and sustainable society in the Västra Götaland region. Because of the characteristics of the Challenge Lab mentioned in the background of the present thesis, its long-term potential to change the way the important institutions of society, e.g. universities, funding agencies, industry, and government, operate deemed to be large and transformative (Holmberg, 2014).

1.2 Aims and objectives of the Master's Thesis

This study firstly aims to serve as a reference tool for decision-making processes related to the adaption and improvement of current plans and strategies, as well as those regarding the selection of further actions and milestones towards sustainability transition in the transport system in Gothenburg; secondly, to communicate unmet needs, and serve as a source of inspiration for current and future business actors to develop possible innovative ideas for products, services and business models in the areas where 'hotspots' – represented by challenges, barriers, and opportunities- are identified in particular; thirdly, to help identify practical-oriented research ideas that could contribute to particularly make the transport system more sustainable; and, finally, this study intends to identify and communicate areas of convergence of

[4] Areas of Advance are to match Chalmers University of Technology scientific excellence to global challenges where a difference can be made. Five of Areas of Advance have received substantial strategic governmental funds; Energy, Materials Science, Nano-science and Nanotechnology, Production, Transport. The other three areas are considered equally important with the potential to address major challenges through scientific excellence: Life Science, Information and Communication Technology, Built Environment. http://www.chalmers.se/en/areas-of-advance/Documents/Areas%20of%20advance%20print.pdf. Accessed on June 2014.

opinions belonging to the three sectors – namely academy, industry, and government- in order to facilitate further dialogue and collaboration between the actors involved in the transport system and other related systems. Therefore, in this thesis the following objectives will be pursued:

- Describe a novel method to find the research questions for a master thesis in order to be able to intervene in a societal issue, giving insights about and results of the execution of the method described.
- Build a conceptual model of the transport system in City of Gothenburg.
- Identify perspectives of stakeholders from academia, government and industry on the challenges, barriers and opportunities for a sustainable transport system in the city of Gothenburg.
- Identify the location of these challenges, barriers and opportunities on the conceptual model built.

1.3 Delimitations

The focus of the present thesis is on the analysis of the established transport system for people and goods, i.e. urban freight transport[5], in the city of Göteborg (in Swedish) or Gothenburg, second largest city of Sweden and located on the west coast of the country, corresponding Västra Götaland region (see *Figure 1.2*). The city has approximately 533,271 inhabitants (SCB, 2014) and is divided into 10 district councils in an area of 450km^2.

Figure 1.2 Gothenburg Location. Source: Google Maps

[5] The definition of 'urban freight transport' used in this thesis is given from Ogden (1992) cited in (Lindholm & Blinge, 2014) as "*...being concerned with the movement of things (as distinct from people) to, from, within and, through urban areas".*

Four months were assigned to develop this master's thesis, the first two were assigned to the execution of the Phase I and the remaining two months to the Phase II, where a study was carried out based on perspectives from stakeholders of the following organizations:

- Academia
  - *Chalmers University of Technology*. Chalmers is a highly progressive university situated in Gothenburg, Sweden. Its goal is to focus on competence, knowledge and collaboration in order to play an important, demonstrable role in social development. Its role has a local, national and global perspective, and the overall goal is to contribute to a genuine conversion of society in accordance with its vision: *Chalmers for a sustainable future* (Chalmers, 2014).

- Industry
  - *UbiGo*. A project that is developed and tested as part of the two-year project Go:smart, headed by Lindholmen Science Park in Gothenburg. The project deals with a fully integrated mobility service, combining the following services: public transport, car-sharing, rental car service, taxi and a bicycle system, all of which utilize the same smart-phone application, and all usage is represented on one invoice every month (Viktoria Swedish ICT, 2013).
  - *Business Region Göteborg*. "Business Region Göteborg AB is a non-profit company that works to strengthen and develop trade and industry in the Gothenburg region. The goal is to contribute to sustainable growth, a high level of employment and diversity in trade and industry in the region" (Business Region Göteborg, 2014).

- Government
  - *Västra Götastadlandsregionen*. *Region Västra Götaland* (in English) is an organization governed by democratically elected politicians. It is tasked with offering good healthcare, dental care and providing the prerequisites for good public health, a rich cultural life, a good environment, jobs, research, education and good communications, providing a foundation for sustainable growth in Västra Götaland (Region Västra Götaland, 2013). Region Västra Götaland is the public transport authority in Västra Götaland, deciding the principles behind how public transport is to be extended and where investments are to be made in order to have the greatest possible impact (Region Västra Götaland, 2014).
  - *Trafikkontoret*. The City of Gothenburg's (Göteborgs Stad) Traffic Office; its mission is to provide effective, safe and sustainable mobility. Main responsibilities are the pedestrian and bike paths, streets and parking in Gothenburg (Göteborgs Stad, 2014).

- *Västtrafik*. Västtrafik is owned by Region Västra Götaland and is responsible for the public transport (tram, bus and boat) in all of Västra Götaland (Västtrafik, 2014).
- *Trafikvervet*. "The Swedish Transport Administration (Trafikverket) is the Government agency responsible for the long-term planning of the transport system. Trafikverket is also in charge of the state road network and national railway network" (Trafikverket, 2013).
- *Political party*. A political party represented in the Local Parliament.

1.4 Outline of the Thesis

The present document is divided in 6 chapters; Chapter 1 is an introduction presenting a general theoretical background, as well as the relevance, intention and delimitation of the thesis; Chapter 2 addresses the first objective by explaining the steps of the Challenge Lab process by giving insights on the execution of the Phase I, whose purpose is to identify how to intervene in the current unsustainable system. Chapter 3 refers to the second, third and fourth objectives by presenting the literature review, the methodology applied and the results obtained during the Phase II, where a project idea was developed. Chapter 4 presents the discussion and the reflections for both the Phase I and II, and Chapter 5 gives the concussions of the study. Finally, Chapter 6 presents some recommendations on how to possibly further use the results of the master thesis.

2 Chapter Two – Challenge Lab process to understand how to intervene in the system

This chapter is going to start with the introduction of the methodology used in the Challenge Lab project to intervene in the transport system in Gothenburg. Following the introduction of the methodology, the process throughout the project will be described. The chapter will end by giving the results of the process of the Phase I.

2.1 Methodology – The Challenge Lab Process

A new methodology called The Challenge Lab Process to intervene in a system that is problematic for society is introduced in this thesis. Furthermore, the methodology is the basis for designing, presenting, and developing this master's thesis work, being used for the first time for this purpose by the students of Chalmers University of Technology belonging to the first generation of the Challenge Lab team.

This methodology is composed of two phases. However, before introducing the content and details of these two phases, it should be expressed that systems perspective implies the thesis' system dynamics thinking perspective, which is adopted to understand how inside-out goes hand in hand with outside-in, and the two together enhance the ability to maximize the outcome from the further process during the Phase I from a systemic view. System dynamics thinking perspective is useful, especially when dealing with the challenges in complex systems and understanding interactions between components of a system (Haraldsson, 2000).

In this regard, in the Phase I, which will be the focus of this chapter, a series of approaches and perspectives relevant for sustainability are introduced (see Fig. X.) in order to help the C-Lab team to "get an overview of and understand the (transport) system (in Gothenburg) from different perspectives in order to identify critical leverage points" (Holmberg, 2014), and find a project idea, what in a traditional thesis would be a research question, for the Phase II. This phase also includes learning and working with supportive tools and methods that will be useful for the next phase. The phase II involves the development of a specific project targeting an issue in society, which is derived from the results of the phase I. It must be noted that this methodology does not include any suggestions on how the Phase II is to be performed. The steps that are described in this section are divided as follows:

- Systems perspective
- Outside-in approach
- Inside-out approach
- Sustainability transition of socio-technical systems
- Interaction with stakeholders on a strategic level
- Design thinking
- Project management

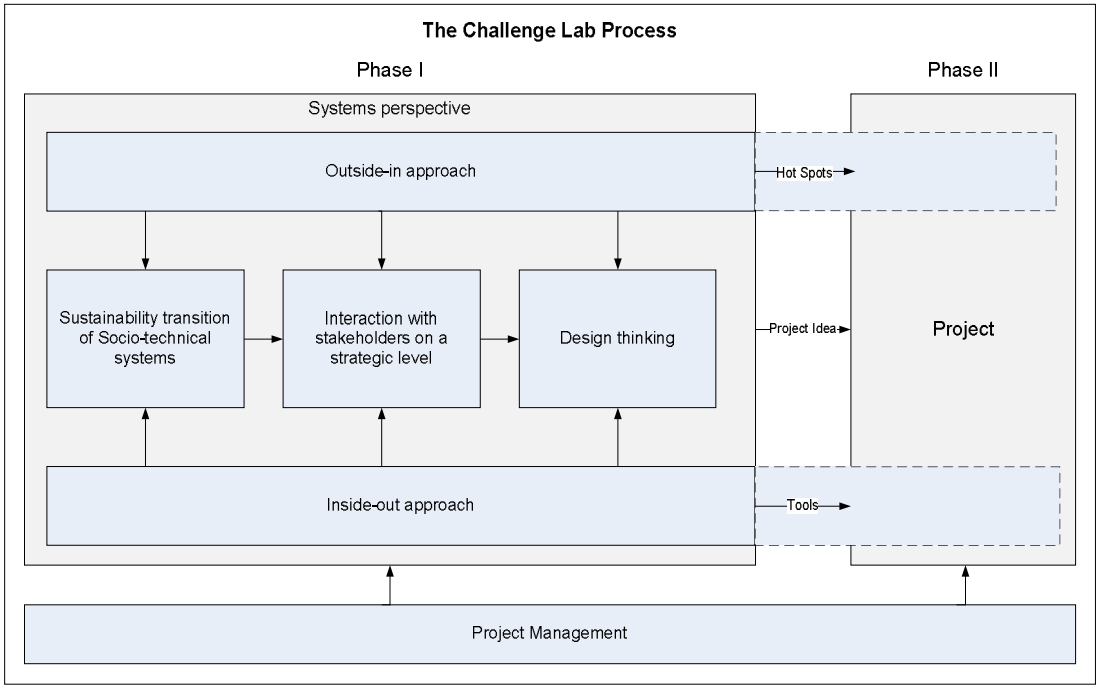

Figure 2.1 The Challenge Lab process

Note that the order of the described approaches in this chapter is not necessarily the order they were executed in reality.

2.1.1 Systems perspective

By systems perspective[6], a holistic thinking and learning approach to coping with issues, e.g. sustainability, stemming from complex and dynamic societal systems is meant. It has been for a long time widely believed that conventional scientific thinking, which is fragmenting and rather mechanistic, cannot solve the current global issues, e.g. sustainability (Hjorth & Bagheri, 2006). This is because the conventional scientific thinking tries to address problems by breaking them into its components, then studies these parts, and finally leads to a conclusion about the whole system (*ibid.*). However, the global challenges are complex and take place in such a global system which is dynamic.

(Abbas & Bell, 1994) defines system as a 'number of components integrated into a complex entity'. Dynamicity of a system comes from the interaction between components of the system. It is this interaction that changes the state of the system over time and, as said by Aristotle, makes ''the whole greater than the sum of its parts''. Quoting Maani and Cavana (2000), Winz (2005) mentions that system dynamics thinking perspective therefore gives the ability to see things as components

[6] It is also called *system dynamics thinking* in this thesis, meaning the way of thinking which is able to understand dynamic interactions between and within systems.

of a whole, of a complex entity by being able to understand interconnections between and within the systems. It is advocated that, in such a complex and large systems as transport, actions that are taken to solve a problem may cause another problem elsewhere (Abbas & Bell, 1994).

(Richmond, 1994) describes system thinking as a paradigm supported by learning methods. According to this, a paradigm consists of vantage point, which is characterized by the term "bi-focal" – that is 'seeing both the forest and the trees'- and of thinking skills which determine one's perception of an issue. (Wolstenholme, 2005) explains that system dynamics thinking help emerge sustainable solutions by challenging existing way of thinking. Likewise, (Radzicki & Trees, 1995) mentions the need for adopting system dynamics thinking perspective to study sustainability, particularly in cities.

2.1.2 Outside-in approach

Global sustainability goals and objectives basically underlie the local sustainability policies and actions made in this regard. This is generally the case in Sweden as well, even though there might be insignificant differences in the local objectives across the country. Generally speaking, the implementation of environmental policies in Europe follows rather a top-down path, which means these policies are made by the EU and national authorities and implemented by regional and local administrations in Sweden (Collier & Liifstedt, 1997).

Outside-in approach enables to understand the challenges in achieving sustainability at all levels, i.e. global, continental (the EU), national, regional, and local levels in a harmony. It further makes it possible to relate the links between the sustainability objectives at respective levels with each other. Given the fact that globalisation is one of the important main drivers of increasing global environmental depletion, the interconnectedness it has brought about between production, consumption, transportation, and communication must be well understood (Kates & Parris, 2003). At this juncture, outside-in approach in the context of the Challenge Lab helps comprehend the link between the global vision that the Challenge Lab project possesses and the local actions taken within the city of Gothenburg.

Outside-in approach that is embraced by the Challenge Lab includes knowledge about the requirements of the global sustainability as well as methods and tools to be used in the process towards the sustainability both at global and local levels. It is aimed at unveiling the current state of the world in terms of sustainability keeping in mind the principles and objectives of sustainable development. Given its capability to overall understanding the requirements of global sustainability as well as strengths and weaknesses of the current situation (Dreborg, 1996), backcasting seems suitable to underlie outside-in perspective to start dealing with the transport and mobility challenge in Gothenburg.

Backcasting is the basis for the outside-in approach. It was introduced by Robinson (1982) as a method to analyze future options of human activities which will help address and be able to avoid environmental and societal problems. Robinson (1982) defined one of the main characteristics of backcasting as the concern on how desirable futures can be reached and alternative solutions for current and prospective problems can be explored, rather than on what kind of futures we are likely to have. However, apart from the definition of backcasting as a method (Robinson, 1982, 1988, 1990, 2003), there occurred different understanding and use of backcasting in the literature. Unlike the use of backcasting as a method, or as a tool (P. J. Vergragt & Quist, 2011), many scholars, e.g. (Carlsson-Kanyama & Dreborg, 2008; Höjer & Mattson, 2000; Dreborg, 1996), incorporated it into their research as an approach. In the context of the Challenge Lab Project, backcasting was applied as an approach rather than a method.

Reminding the unequivocal statement by the UN report on Global Sustainability (Unite Nations Secretary-General's High-level Panel on Global Sustainability, 2012), which is "*...sustainable development is also ensuring that our actions today are consistent with where want to go tomorrow.*", backcasting actually points to this end mentioned in the statement above: the tomorrow we would like to reach. In this regard, Robinson (1990), who introduced backcasting as a method, explains that the start point of this method is actually a particular desirable end-point in the future. On the other hand, Holmberg (1998) considers the starting point of backcasting as the four principles of sustainability – also referred to as sustainability criteria- (Holmberg, Robert, & Eriksson, 1996), which can be used to define a sustainable future. According to these criteria, in a sustainable future; a) concentrations of substances extracted from the earth crust must not systematically increase, b) society must not systematically increase the concentration of substances that they produce, c) ecosystems must not systematically impoverished, and d) basic human needs globally must be met by fair and efficient use of global resources. Therefore, according to Holmberg (1998), backcasting sets out from this point, which is also the starting point for the Challenge Lab project.

It then requires working backwards from that particular desirable future end-point to the present, and then identifies the feasibility of that future as well as the measures that would be required to reach that point (Dreborg, 1996). It is worthwhile to note that backcasting application was initially intended to be a useful method not for planning the future of a company but for exploring different societal choices of sustainable development paths toward the sustainable future (Robinson, 1990). However, the application of backcasting was later expanded to public and private sectors and used by many organizations and corporations (Holmberg, 1998). Therefore, backcasting is particularly useful for strategic long-term planning for achieving the sustainability both in industry and in society (Holmberg & Robèrt, 2000).

In this regard, Dreborg (1996) denotes that backcasting is also considered in seeking for solutions for major societal problems, e.g. challenges faced by society to attain sustainability, which actually require long-term thinking and strategic planning. Backcasting can then be used to suggest alternative solutions for (Robinson, 1988) and implications of different futures (Robinson, 2003).

Furthermore, it is highlighted that backcasting is even more suitable when the problem in question is complex, e.g. unsustainable transport system; the problem may only be solved by a major change, e.g. behavioural change in favour of public transport or bike use; trends that are dominant in the society are actually part of the problem, e.g. perception of increasing social identity by car-ownership; externalities are important, e.g. land use effect of transport system; and there is time long enough to make deliberate choices and decisions, e.g. sustainable transport and mobility by 2035 (Holmberg, 2000; Giurco et al., 2011; Dreborg, 1996; Holmberg, 1998).

Initially, Robinson (1990) introduced the backcasting method describing six steps that comprise of determining objectives, specifying goals, constraints and targets, describing present situation, specifying exogenous variables, undertaking scenario analysis, and undertaking impact analysis, respectively. However, Holmberg (1998) divides backcasting into the following 4 steps:

1. Defining criteria for sustainability
2. Describing present situation in relation to the criteria for sustainability
3. Envisioning future solutions
4. Finding strategies towards sustainability

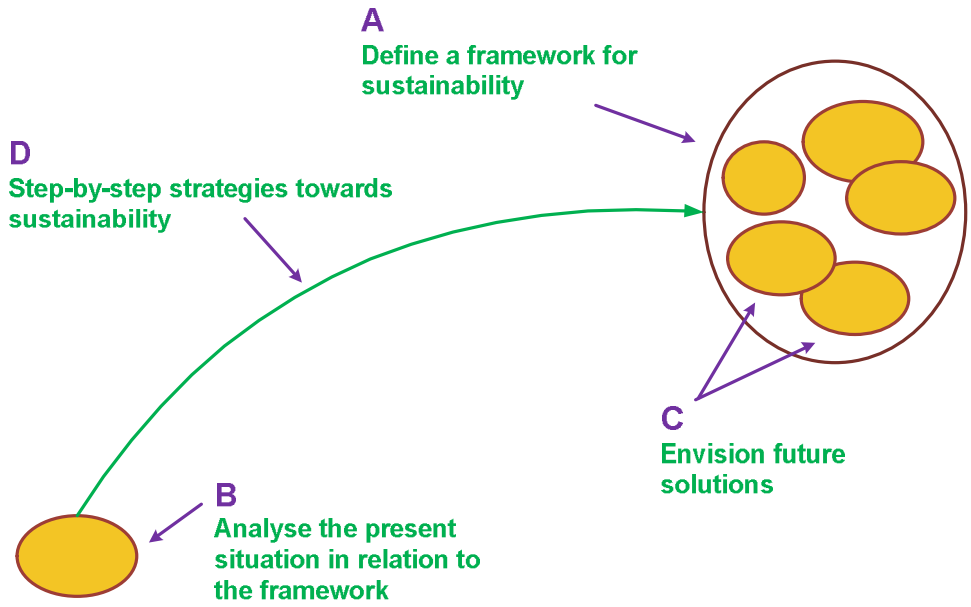

Figure 2.2 The steps in strategic planning for sustainability, based on (Holmberg, 1998)

Even though some forecasting techniques are used in the application of backcasting methodology, as mentioned by Dreborg (1996), it is a useful way of strategic long-term planning which is rather normative than predictive. It must be noted that these techniques are not used to be served in general purpose of backcasting, which is to develop alternative scenarios to reach to a desired future, but to assess the desirability and feasibility of varying scenarios built at the end of the process (J. Robinson, 2003). Furthermore, it would be true to add that backcasting might be seen as a complementary to forecasting rather than a replacement (Robinson, 1982). Additionally, backcasting is an effective methodology to form a ground for engaging stakeholders of a particular problem in the process of planning and with each other, and, thus, for having a common understanding of and vision for a sustainable future.

Now, the four steps forming the backcasting methodology will be described under the following headlines.

Step 1. Defining criteria for sustainability

In this step, criteria for a sustainable future are defined, serving as a starting point to the planning for sustainability process. A better understanding of what involves the demand for sustainability is created within the organization or group of them that aim to generate a plan (Holmberg, 1998).

A tool that can be used in this step is the *sustainability compass* (see *Figure 2.3*), introduced by AtKisson and Hatcher (2001).

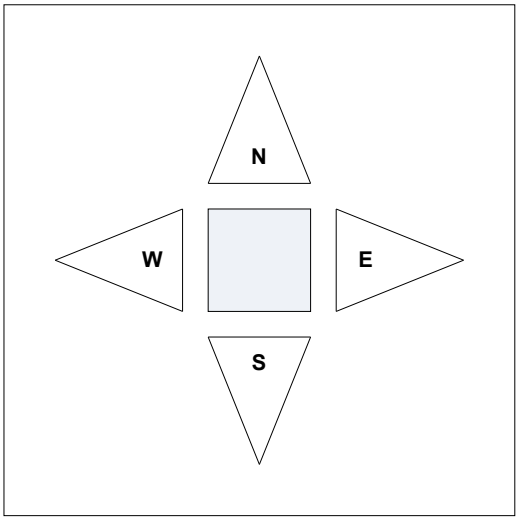

Figure 2.3 Sustainability compass, based on (AtKisson & Hatcher, 2001)

This tool can be used to frame, define, assess and measure progress towards sustainability. It is based in a division of sustainability aspects using the following categories or clusters proposed by AtKisson & Hatcher (2001):

- **N (North) – Nature.** Representing related health and sustainable management

issues of ecosystems, bio-geo-physical cycles, and natural resources.

- **S (South) – Society.** Representing health issues in different system levels: governmental, social and familiar.
- **E (East) – Economy.** Representing how productive, efficient and effective are human efforts in different sectors (e.g. agriculture, energy, manufacturing, services, etc.)
- **W (West) – Well-being.** Representing health, capacity and fulfillment issues of individuals.

Step 2 - Describing present situation in relation to the criteria for sustainability

In the second step of backcasting methodology, the current activities and competences of the system are analyzed; and, as a result, an inventory is created, which will be used in the following steps in order to make realistic scenarios and develop strategies. Therefore, analysis in this step focuses on describing the current products, services, processes and other activities. Afterwards, an identification of those that concur with the principles defined in the first step is performed (Holmberg, 1998).

One tool that can be used in this step is the *double challenge funnel* (see Figure 2.4). It is used to give a clear description of present state of global supply capacity and global demand for natural resources (Holmberg, 1998) and was originated from the concept of resource funnel introduced by (Robèrt, Daly, Hawken, & Holmberg, 1997). Through its illustration (see Figure 2.4), it is easy to understand how the current trends in the global supply and demand shrink the space the humanity can safely sustain his life.

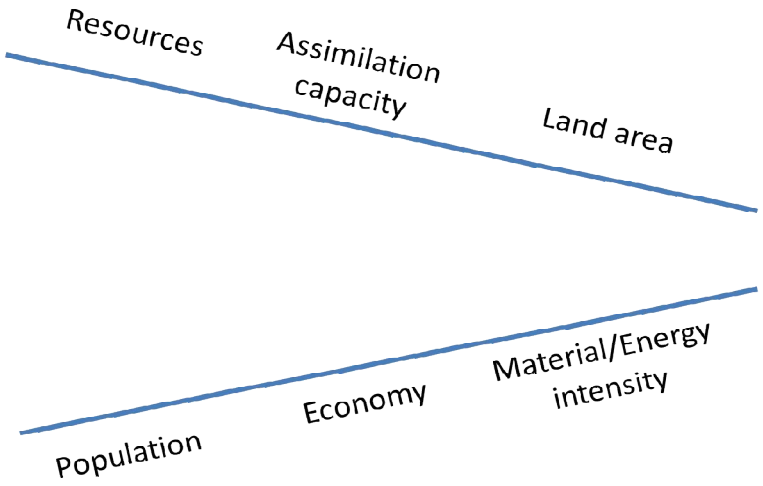

Figure 2.4 The Resource Funnel (adopted from Holmberg, 1998)

The double challenge funnel comprises of the current trends in the Earth's decreasing natural resource supply capacity and in increasing global demand for the resources. In the decreasing edge of the funnel there are *resource depletion, assimilation capacity limits,* and *land use restrictions*; and, in the increasing edge, there are *population increase, economic trends,* and *material/energy intensity*.

Step 3- Envisioning future solutions

This step involves future possibilities to be envisaged, based on the principles identified in the step 1, as well as in the inventory made of the current situation in the step 2 (Holmberg, 1998). The future options do not have to be specified in detail, moreover, Holmberg (1998) mention that thinking in broad terms can help to open the mind to new options.

Step 4- Finding strategies towards sustainability

This last step of the backcasting method is to identify strategies that can link the current situation analyzed with the future (sustainable) situation (Holmberg, 1998). Holmberg (1998) proposes to consider the following points when identifying these strategies:

- Will each measure bring us closer to sustainability?
- Is each measure a flexible platform for the next step towards sustainability?
- Will each measure pay off soon enough?
- Will the measures taken together help society to make changes at a sufficient speed and scale to achieve sustainability without too many losses for humans and other species during the transition?

2.1.3 Inside-out approach

Being different from the conventional master thesis works, the inside-out perspective is presented the Challenge Lab team in order to help the team members better understand their inner world, i.e. attributes that underlie one's personality such as their values, weaknesses, strengths, self-authenticity. To understand one's values and self is vital for achieving organizational sustainable development goals and makes up one of the bases for the inside-out perspective of the methodology. Likewise, the role of individuals' values is crucial in their interaction with society and the nature. Furthermore, one's values system underlies one's consumption behaviours, and even the way of one's life. It is fair to indicate that it is individuals who will determine the success or failure of societies' endeavour towards sustainability (Cavagnaro & Curiel, 2012).

For this purpose, different methods and tools that bring theoretical and practical understanding of the perspective are used. They are categorized into two groups: *Self-leadership for Sustainable Development*, and *Dialogue for Sustainability*. These methods and tools will be presented under the following subtitles.

To adapt to a multi-cultural working environment is a challenging process requiring tolerance and empathy. Likewise, early adaptation of and commitment to a goal by a member of any organization plays an important role in keeping team motivated and bounded to each other (Hussain, Lucas, & Ali, 2004), which leads to the success of the goal. Insights from inside-out perspective and the application of the tools introduced within it significantly contribute to creating a sense of team.

This perspective is further covered within this methodology in order to build trust and a team spirit among the team members who have considerably different cultural, educational and professional backgrounds. The tools used within the inside-out perspective are also useful for pairing up groups for the Phase II of the Challenge Lab process because the team members also get a chance to get to know each other's personalities, and, therefore, to understand how effective and productive one can work with the other.

Self-leadership for Sustainable Development

The self-leadership and leadership tools help get to know of one's self – also in the sense of self-authenticity- and one's values which underlie behaviours that may be driving one for or preventing one from coherently acting in favour of sound interaction with one's surroundings – be it society, be it the nature (Bilsky & Schwartz, 1994). Thus, it is useful for enhancing self-awareness, open-mindedness, tolerance, and empathy in the group, which are the fundamental attributes that will bring effectiveness and productivity during the execution of the different stages of this methodology.

Furthermore, the use of different tools, which will be mentioned in the *process section* of this master's thesis, enables the C-Lab team to explore their self-motivation which is crucial for the success of vision. As Ryan and Deci (2000) indicates based on their self-determination theory:

> *The investigation of people's inherent growth tendencies and innate psychological needs that are the basis for their self-motivation (....); in the real world, motivation is highly valued because of its consequences: Motivation produces.*

Self-leadership tools also enable the C-Lab team to investigate their strengths and give them the ability to think about the 'bright side'. It then brings inspiration and trust among group members, which will function as self-stimulation in case, for example, time constraints are faced. Additionally, Cavagnaro and Curiel (2012:232) notes in their book *The Three Levels of Sustainability*, quoting Kotter (1996:25), *"(...) Leadership ... aligns people with that vision, and inspires them to make it happen despite the obstacles."*

Dialogue for Sustainability

Dialogue tools are important components of this methodology and underlie the basis

of performing the further steps, e.g. *interaction with stakeholders on a strategic level*, and of execution of the phase II. Dialogue tools also serve as an opportunity for using the competences obtained with the self-leadership tools in order to enable generative talks that will broaden relative knowledge within group occur. The main reason to this is the possibility that dialogue brings when exploring the uncertainties and questions that no one has answers to, and then you begin to "think together" (Isaacs, 1999). This means that group members can have an opportunity to learn from each others' thinking through the tools used in dialogue (Sande, 2014)[7].

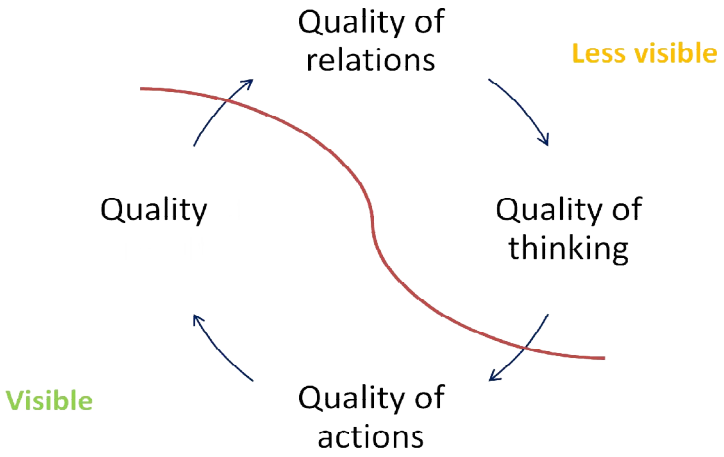

Figure 2.5 Theory of change based on (Sande, 2014)

One important tool for dialogue used in this methodology is active listening, i.e. listening with intention to understand without resistance or interruption. This tool enables the C-Lab team to reflect upon conversation happening between the team members, and, thus, explore underlying causes of problems. As a result, not only group gains some insights and, maybe, even new perspectives from this reflection but also has a better understanding of the core of a challenge. This is mainly because of the fact that learning comes with listening to others (Sandow & Allen, 2005).

In addition to this, dialogue further enhances understanding among group members. Being reinforced by the better understanding of one's inner world obtained with the self-leadership tools, trust is built within group, which then leads to collaboration and better learning and execution of work. Sandow and Allen (2005) notes, in this regard, that in an environment where there is a high level of trust listening enables better understanding, which in return brings strengthened trust leading to enhanced collaboration.

[7] A consultant at a management consultancy company named Preera, Gothenburg, http://www.preera.se/om-oss/kontakt/medarbetare.

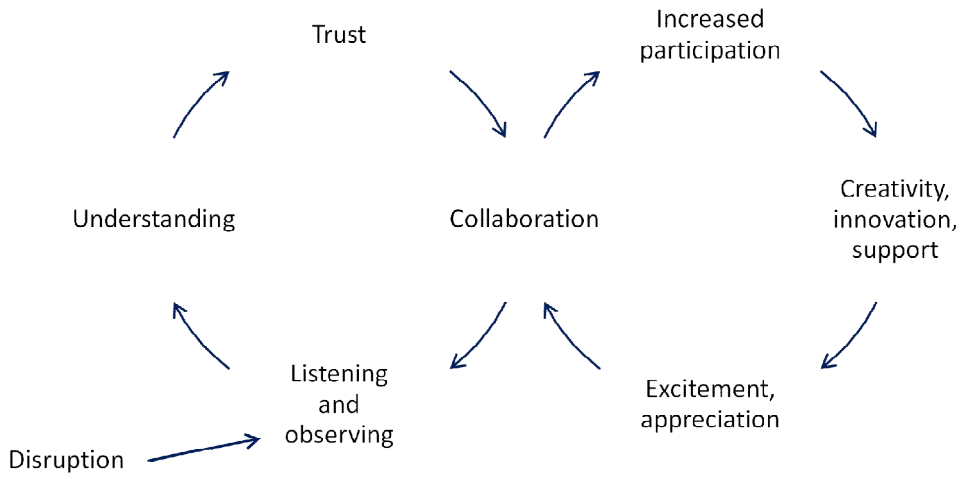

Figure 2.6 Reinforcing circle towards a more resilient organization. Based on (Sandow & Allen, 2005b)

In this regard, Drexhage and Murphy (2010) indicates when referring to the intrinsic need of a possible transition towards sustainability:

> *More sustainable development pathways are needed in both developed and developing countries; which require a level of dialogue, cooperation and, most importantly, trust that simply is not reflected in today's multilateral institutions or regimes.*

2.1.4 Sustainability transition of Socio-technical system

Socio-technical approach to transition – "*a gradual, continuous process of societal change, where the character of society (or of one of its complex subsystems) undergoes structural change"* (Rotmans et. al., 2000 in Joore, 2010)- is used within this step to give understanding of how socio-technical systems, e.g. transport system, functions in society in the existence of norms and laws, and products and services as well as sustainability and climate objectives. Socio-technical approach helps capture interactions within the components of society, e.g. products, services, individuals, organizations, and institutions (Geels, 2012). Through these interactions, changes in one element are triggered by changes in another element within the system (Geels, 2002). Having a multi-level perspective, it is then possible to understand how likely different actors and changes in different levels of society may influence a socio-technical system (Geels, 2012).

Multi-level perspective describes three levels where change in society takes place (Joore, 2010). This means that transition in society towards sustainability is a non-linear process. It includes macro-level, meso-level, and micro-level. The macro-level is the widest context in this perspective and referred to as the *landscape*. For example, climate, culture, societal values and beliefs, urban structure, oil prices, environmental problems may be included in the macro-level.

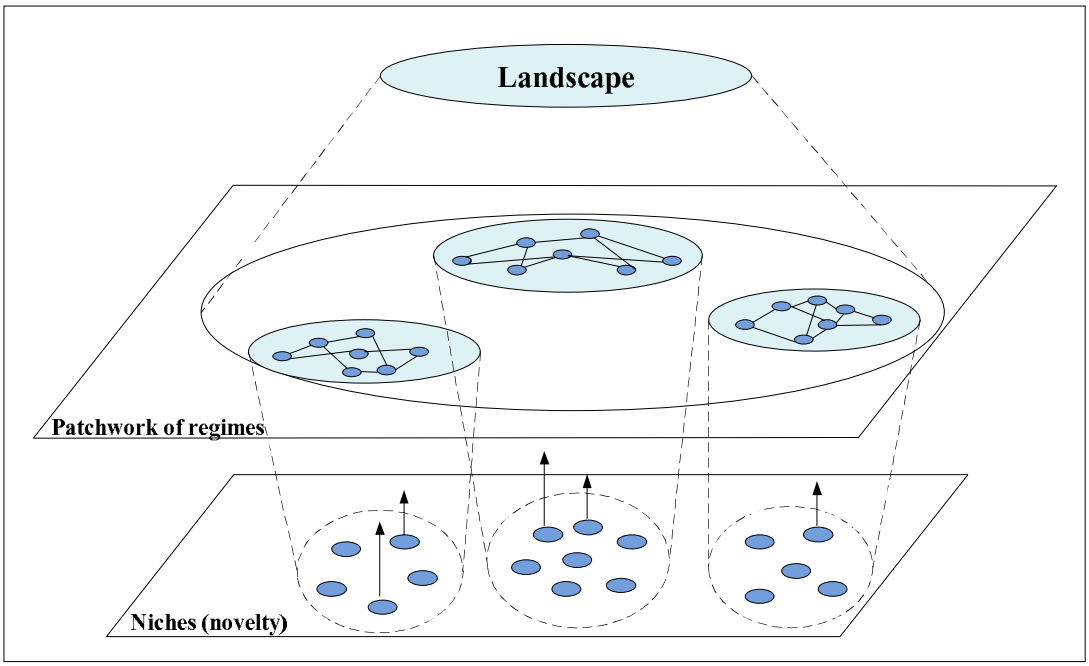

Figure 2.7 Multiple levels as a nested hierarchy, based on (Geels, 2002)

The meso-level is wherein socio-technical systems lie. It is also called as 'regimes'. By quoting the definition of Rip and Kemp (1998), Geels (2002) describes 'regime' as "*the rule-set or grammar embedded in a complex of engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artefacts and persons, ways of defining problems; all of them embedded in institutions and infrastructures*". He notes that changes occur in landscape more slowly in regime, and that changes in landscape may create a 'window of opportunity'. Finally, the micro-level consists of so-called *niches*, where innovation in technology, product, and service, which are experienced at the meso-level, takes place. Niches form an arena for generating innovations and for social-network creations, which will help develop innovations and introduce to regimes (Geels, 2002).

Therefore, through the Challenge Lab methodology, the understanding of interactions between and within these levels makes it possible to answer the question of how technologies bringing a major shift at the meso- and macro-levels can grow in the society. It enables to identify possible barriers such as dominant design, user habits, and technological lock-in that prevents change for sustainable future.

2.1.5 Interaction with stakeholders on a strategic level

The involvement of stakeholders plays a key role in solving global sustainability problems, e.g. unsustainable transport system (van de Kerkhof & Wieczorek, 2005). It is because "a systems change – a transition- occurs through an interactive process (...) between a heterogeneous set of actors who act on the basis of their own vital

interests and expectations" (*ibid.)*. Therefore, the importance of stakeholders in accomplishing sustainable processes is undeniable.

However, the magnitude of challenges faced by societies requires that the stakeholders are not only involved in practical activities but also in fostering strategic thinking, and, thus, increasing generative learning. Senge, (1990) describes as a process that enables understanding of systemic source of problems, leading to creativity for possible solutions. Since stakeholders have practical day-to-day experiences within the ill-structured socio-technical systems, e.g. transport system, they can induce the process of learning-by-doing, which helps "develop theoretical knowledge from practice" (van de Kerkhof & Wieczorek, 2005).

One way of triggering such a process to begin is, possibly through a common meeting area, to enable communication and interaction between those who experience the obstacles of unsustainable systems through practice and those who question and challenge these systems (Jofre & Andersen, n.d.). In such an environment, (P. P. J. Vergragt, Halina, & Brown, 2004) denotes some of the interactions as:

> *Participants re-examine, and possibly change, their initial perspectives on the problem which the particular project seeks to solve, or the societal needs the projects seeks to meet as well as the approaches and solutions; participants examine and place the particular project in a broader context of pursuing a sustainable society; (...) participants change their preferences about the social order and the beliefs about best strategies for achieving them; participants change views on the mutual relationships among the participants relative to the specific project or the broader societal context, including mutual convergence of goals and problem definitions.*

As a result of these exchanges of views, ideas, and knowledge, not only will the stakeholders, who maintain activities based on their varying interests, be able to be questioned regarding the underlying reasons why the system works in the way it works but also the respondents will be inspired as this process can enable them to observe niches to be filled with innovative solutions.

2.1.6 Design thinking

Design thinking is defined by Sato (2009) as "*a systematic approach that optimizes value to customers with benefits to the company",* indicating that could be synonymous with *"customer, user or human-centered design"* or *"integrative thinking"*. Brown (2009) considers that the evolution from *design* to *design thinking* involved a mindset change: from creating just products, to analyzing the way people interact with the products, and then, also analyze how people interact with people. Moreover, Young (2010) considers the following *key themes* as constituting design thinking in practice:

- *Human-centred:* It is people who are the centre of the design process but not

the internal/organizational challenges or technology.

- *Research-based:* Qualitative, ethnographic and observational research techniques are applied to respond to the design challenges.
- *Broader contextual view:* An analysis of the system and context in which the design challenges exist is performed.
- *Collaborative & multi-disciplinary:* Problem-solving includes exploratory and even playful approaches, as well as co-design methods, specially including stakeholders and multi-disciplinary design teams.
- *Iterative delivery & prototyping:* Frequently, iterative project management approaches are used, as well as prototyping, often with rapid feedback loops from end-users, in order to evaluate and evolve ideas and prospective designs.

Joore (2010) attempts to embody design thinking by using a basic cyclic process for design (see *Figure 2.8*) applied in four different system levels (see *Figure 2.9*). When matching those levels with the backcasting approach would signify as follows:

- *Societal system.* A sustainable society.
- *Socio-technical system.* A normative vision of the desired future.
- *Product-service system.* Part of the innovation agenda.
- *Product-technology system.* (Not mentioned, but assumed as part of the innovation agenda as well)

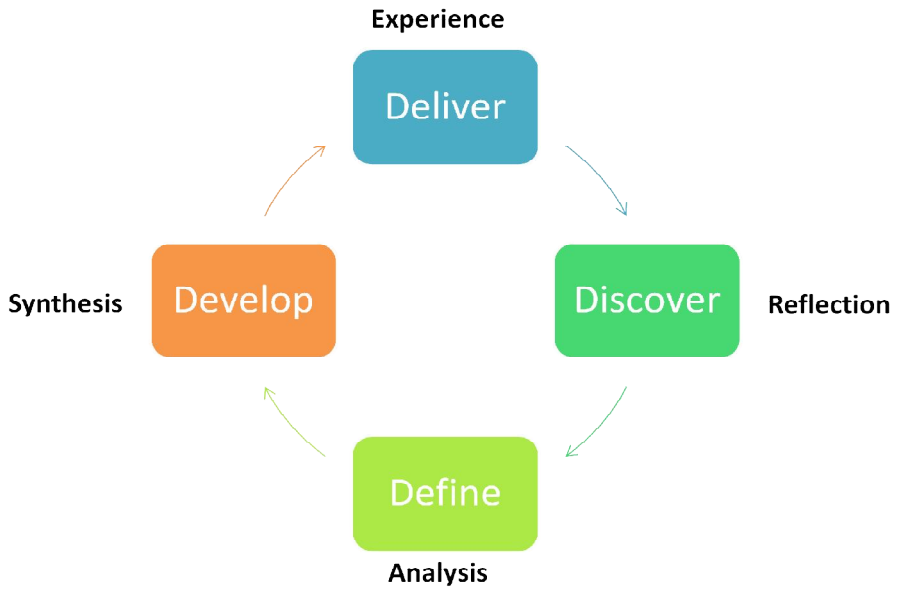

Figure 2.8 Double Diamond based on (Design Council, 2007) presented as a Design Cycle in (Joore, 2010)

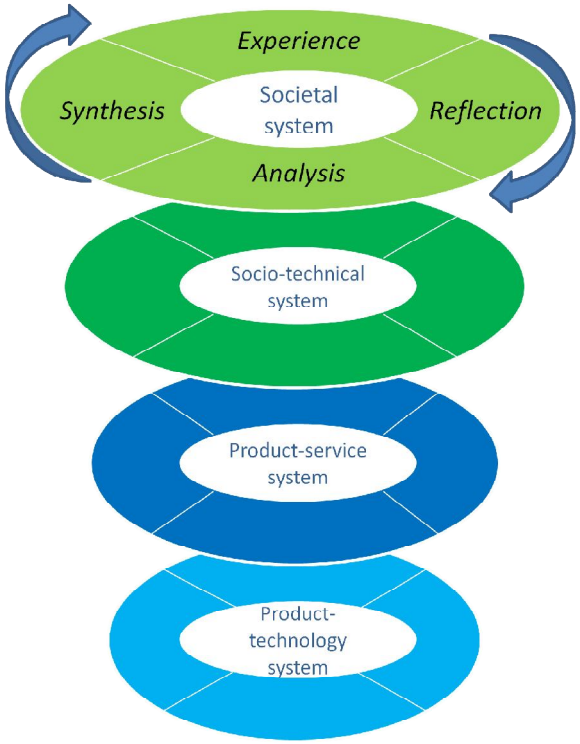

Figure 2.9 Cyclic presentation of potential Multilevel Design Model, based on (Joore, 2010)

2.1.7 Supporting methods – Project management

Considering *project* as "a temporary endeavour undertaken to create a unique product, service, or result" (PMI, 2013) and the present thesis as a project consisting of two phases, there was an identified need for integrating project management tools as a support for the successful achievement of the objectives of each phases. As the *Figure 2.10* shows, the PMBOK Guide from the Project Management Institute (2013) considers the management of a (single phase) project has commonly 5 types of processes included:

- Initiating processes,
- Planning processes,
- Executing processes,
- Monitoring and controlling processes, and
- Closing processes.

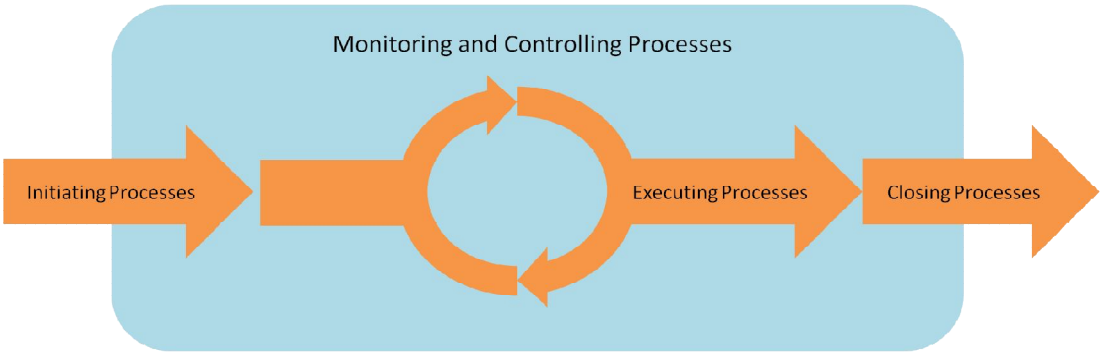

Figure 2.10 Example of a single phase project (PMI, 2013)

In general terms, when developing a project, it is important to identify what activities should be done, when, how and by whom these activities are to be executed in every process. The sense of self-leadership used as a tool within the Challenge Lab implies self-management. The work that was performed in the Challenge Lab does not require a project leader to assure whether the specific activities are executed. Once the activities are defined, the C-Lab team can be considered as a self-organizing team, which is defined by Highsmith (2004)– cited in Hoda et al. (2010)- as *"individuals [that] manage their own workload, shift work among themselves based on need and best fit, and participate in team decision making"*. Therefore a *facilitator* role, instead of a *manager*, similarly to the agile project management approach (Hoda, Noble, & Marshall, 2008), is preferred in the Challenge Lab project.

2.2 Process

This section describes important insights regarding the executed steps in the Phase I, they are presented in concordance to the steps of The Challenge Lab Process described in the previous section (see *Figure 2.1*).

2.2.1 Outside-in approach

In order to identify the collective perception of the team members regarding current challenges in transport and mobility, an exploratory activity using the sustainability compass tool – described in the methodology section- was executed during the first week of the C-Lab project. Four sections were labeled onto a board, according to the areas of the compass (see *Figure 2.11*). Afterwards, each team member wrote different challenges on sticky notes, and presented them to the group by placing the notes in the correspondent area of the board. Some challenges identified in this regard were even placed in the intersection between two areas, i.e. some challenges were considered as encompassing both, say, social and economic areas, as it was not clear for the presenter or for the group where the challenges that they addressed belonged to.

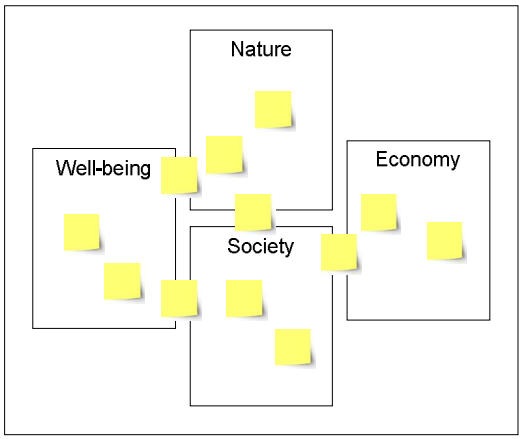

Figure 2.11 Canvas for sustainability compass

Furthermore, with the purpose of easily consulting the work related to this practice, the team shaped a physical working area called *the wall* – inspired by the backcasting approach of the Challenge Lab (see *Figure 2.2*)-, where five sections were labeled (see Table 2.1) to place relevant information for the team members and have it at hand for a diversity of activities (e.g. brainstorming and dialogue sessions with stakeholders). In general, global view was included at both left and right extremes, whereas, in the center, regional and local views were represented.

Table 2.1 Distribution of the working area, "the wall"

Focus level	**Global ← Local → Global**				
Section	*Visualized global trends*	*Map of critical factors*	*Projects*	*Goals and strategies*	*Vision for a sustainable society*
Purpose	Identification of relevant trends related with the declining of resources and ecosystem services, as well as those related with the increasing demand for them.	Understand the main factors influencing the transport system of Gothenburg and their complex interactions.	Identify the successful, ongoing and planned projects in the city of Gothenburg dealing sustainability in transportation and mobility.	Identify plans, targets and strategies at the local, regional, national and EU level	Clarification of the desired future and criteria to evaluate its sustainability.

Now a brief description of the activities performed to fill each section will follow.

Visualized global trends

The identification of relevant trends was performed on teams of two persons each, with the following division of focuses, matching the double challenge funnel sections described in the methodology:

- Resources
- Assimilation capacity
- Land use
- Population
- Economy
- Material/energy intensity

A series of cards was prepared (one card per trend) and placed under the correspondent section. The basic elements included on each card were:

- Title representing clearly what was the trend about

- Graphical representation
- Source of the information

Map of critical factors

The objective of this section was to identify different critical factors for the change or evolution of the current transport system towards a sustainable one, as well as the complex interactions between them. The system dynamics perspective, particularly a causal-loop diagram was identified as a good way for the visual representation of these factors and their interactions.

During the first weeks of the Phase I, many visits from stakeholders from academy, industry, and government, who are dealing with the local transport system, were scheduled (see *Table 2.2*). The visitors explained relevant information to the team members and helped them to have a initial idea on how the local transport system works, the different actors involved, goals and plans at a city and regional level that could impact on how the transport sector develops, etc. From these visits, a list of critical factors was identified by the team members in a round table exercise using the information the stakeholders shared.

Moreover, in order to expand the understanding on the transport needs in the system, the team organized a brainstorming exercise to identify in a board, firstly, the main purposes of transport, divided in the ones for people and the ones for goods; secondly, the underlying causes of the existence of those purposes (by questioning the reasons to each one); and finally, the alternatives for addressing those underlying causes without transportation.

Projects

During the mentioned meetings with stakeholders, the team identified some innovative projects related with sustainable transportation in the city. Moreover, a web research made by the members, helped to identify a few more, as well as their objectives and stakeholders involved. Information cards were made and then placed in the correspondent area with a simple categorization by groups.

Goals and strategies

To be aware of the different goals and strategies dealing with transport and mobility, from the global to the local level, this section of the working area was divided in a matrix composed by the level of focus in one axis and a timescale with the target dates in another (see *Figure 2.12*).

	Year	Year	Year
European Union			
Country level			
Regional level			
Local or city level			

Figure 2.12 Goals and strategies matrix

On the matrix, cards describing a goal and its origin (e.g. program, plan, directive, etc.) were placed by the team members.

Vision for a sustainable society

Firstly, the agreed vision representing a sustainable society by the team was printed and placed on this area, followed by the four principles of sustainability introduced by Holmberg et al. (1996).

After some days of work, the team felt the need of having complementary and more specific criteria to measure sustainability, therefore organized a quick research on relevant criteria, using once more, the sustainability compass canvas as the basis for classification: Nature, Society, Economic and Well-being. Cards with the selected criteria were then placed in each section.

2.2.2 Inside-out approach

A series of workshops and lectures regarding self-leadership and dialogue were organized for the team so that the team could develop their abilities in this regard. The most important tools explained and practiced by the team, in the authors' opinions, are listed below:

- ***Values Map***. An analysis of the personal values and its assigned relevance. An online survey was used to obtain the results, which were lately shared and discussed with other members of the team.
- ***Circle and triangle time.*** Being applicable to many situations, the circle time allows creativity when discussing possible solutions to a problem and involves a respectful listening to every idea; triangle time is the decision making time.
- ***Active listening.*** A special connection can be achieved between team

members when executing this activity; three roles can be taken in the active listening: focus person, observer, and facilitator. The focus person should speak to the observer about a specific topic agreed previously; the observer should listen with presence and preferably in silence, interiorizing what the other person is talking about. The facilitator should listen also with presence, but is not allowed to ask questions or make comments, he/she should be aware of the time remaining to the activity (which should be agreed previously) and make a final summary with remarks of what he observed. A switch of the roles should be organized so everyone takes every role once.

- ***Pearl of the day***. Each person should mention what they consider the best or favorite moment happened during the day (or defined period of time).
- ***Six thinking hats.*** This tool, introduced by De Bono (2000) divides a meeting in different phases, using metaphorically six different hats for each one:
    - *White Hat.* The participants should focus on bringing the hard facts, data and information that is known or needed.
    - *Red Hat.* Everyone pays attention to the feeling, gut instinct and intuition that comes up with a certain decision.
    - *Yellow Hat.* The participants should focus on the benefits an action can bring and why something could work.
    - *Black Hat*. Difficulties and problems that could come up and reasons explaining why something might not work should be mentioned.
    - *Green Hat.* Participants bring creative ways of addressing the difficulties to the table, alternatives, solutions and new ideas.
    - *Blue Hat.* Assures action being taken by focusing on the management of the process and the steps that should be taken further, coming with a specific plan.

2.2.3 Sustainability transition of Socio-technical systems

With the objective of understanding the way that technological transitions happen in society, a lecture with a specialist in the area from academy was arranged. The team members could have a better understanding of the following concepts:

- Socio-technical systems
- Transition of innovations
- Multi-level perspective of transitions
- Valley(s) of death

According to the complexity and dynamism of transitions, the lecturer mentioned that to constantly push the system in the right direction is preferable for planning in advance.

2.2.4 Interaction with stakeholders on a strategic level

In order to learn from practices in the current transport system in Gothenburg, a series

of lectures and meetings were organized with the actors working directly or indirectly in the transformation of the unsustainable transport system in the city (see *Table 2.2*). The sessions normally took from 1 to 2 hours including a final session of questions from the C-Lab team.

Table 2.2 Lectures with stakeholders in the Challenge Lab

	Stakeholder	**Organization**	**Position**	**Topic**
Academy	Magnus Blinge	Chalmers	Vice director of Chalmers Transport Area of Advance	Transport system
	Maria Grahn	Chalmers	Project coordinator at Chalmers	Non-fossil fuels
	Björn Sandén	Chalmers	Professor, Energy and Environment	Transition of Socio-technical systems
	Örjan Söderberg	Chalmers	Head of MSc Programme for Industrial Design Engineering, Design & Human Factors Product and Production development	Design thinking
	Frances Sprei	Chalmers	Assistant Professor	Transport system, FFF strategy
Government	Anna Dubois	Chalmers	Director of Chalmers Transport Area of Advance	FFF strategy
	Thomas B. Johansson	Lund University	Professor Emeritus, Project Leader-FFF	FFF strategy
	Mats Rydehell	Innovationskontor Väst / Chalmers	Innovation Advisor / Project leader, Energy and Environment	Policy documents and strategies
	Sofia Hellberg	Trafikkontoret	Strategic transportation planner	Strategies and plans for transport in the city
	Pernilla Hellström	Miljöförvaltningen	Department of Urban Environment	Strategies and plans for transport in the city

	Stakeholder	Organization	Position	Topic
	Hans Fogerlberg	Västra Götalandsregionen	R&D and innovation policy expert	Strategies and plans for transport in the city
	Jörn Bergström	Västra Götalandsregionen	Kollektivtrafiksekretariatet	Strategies and plans for transport in the city
Industry	Axel Edh	Volvo Cars	Senior Strategic Advisor,	Volvo vision and role in a sustainable transport system
	Per Lanevik	Sunfleet	Founder	Sustainability integration in new businesses

2.2.5 Design thinking

A lecture and a workshop were arranged for the C-Lab team to deepen their understanding of how general and sustainable solutions can be designed and introduced. According to the concept of the multi-level design model, the different levels where innovation could take place were explained by Örjan Söderberg: socio-technical system, product-service system and product-technology system (see *Figure 2.13*).

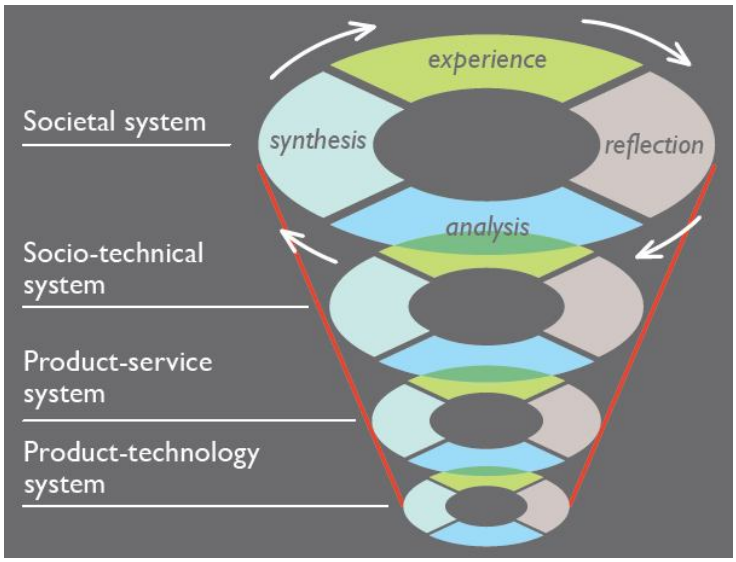

Figure 2.13 Multi-level design model by Söderberg (2014) based on (Joore, 2010)

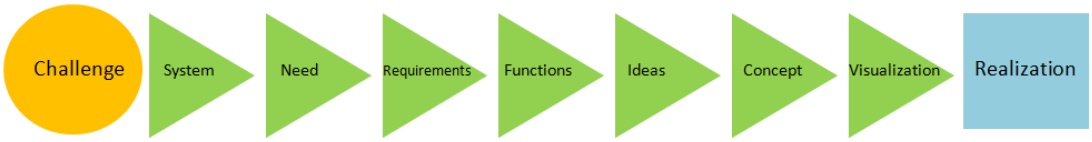

Figure 2.14 Multi-level design methodology by Söderberg (2014)[8]

Afterwards, the multi-level design methodology (see *Figure 2.14*) was presented by Söderberg (2014) to the Challenge Lab team. By this stage, smaller groups of two students[9] were formed according to similar interests to work together in the second phase of the Challenge Lab process. Based on the explained methodology, each group identified the following aspects of their project idea in a matrix composed of the following elements:

- Title / Question
- Link to ongoing activities (in the local context, e.g. projects)
- Stakeholders involved
- Target group (for the use of the outcome)
- Knowledge perspective to apply
- Special and desired requirements (including personal preferences)

The idea description helped refine the scope, and, therefore, the planning process of the Phase II.

Furthermore, a session where the Challenge Lab team identified the travel needs of people and goods was organized. During the session, alternative ways of meeting those needs were discussed. It was also attempted to describe the infrastructure, means of transport, and fuels which could be used to address those needs in the urban context, being Gothenburg in this regard. However, the attempt could not be accomplished due to the time constraints.

2.2.6 Supporting methods - Project Management

With the purpose of helping the Challenge Lab team in organizing and performing the planned and emergent activities, a workshop was arranged with Hanna Tengelin from Preera, a specialist in Project Management. Based on her recommendations, the team decided creating a board where the different activities of the Phase I could be easily identified, as well as their status: planned, in progress, problematic, and completed (see Figure 2.15).

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[8] Örjan Söderberg, Teacher and Head of MSc Programme for Industrial Design Engineering, Design & Human Factors Product and Production Development, 20 Feb 2014, Chalmers University of Technology, Gothenburg, Sweden.

[9] 2 students decided to work individually during the Challenge Lab project.

	Task	In progress	Problematic	Completed
1	Name			
2	Name			
3	Name			
4	Name			
Goal:				

Figure 2.15 Project management board

2.3 Results

2.3.1 Outside-in perspective

The approach adopted to implement to the transport challenge with the system dynamics thinking perspective is backcasting. It should be noted that backcasting was considered as an approach rather than a methodology in this thesis. It is important to underline this fact because we did not practically go through the steps defined by the backcasting methodology but motivated our understanding accordingly. This particularly helped develop ideas around the necessary steps to be taken for the sustainable future of the transport system within the city as well as within the second phase of the master's thesis in this regard.

As one result of the process, the wall (*Figure 2.16*) was created.

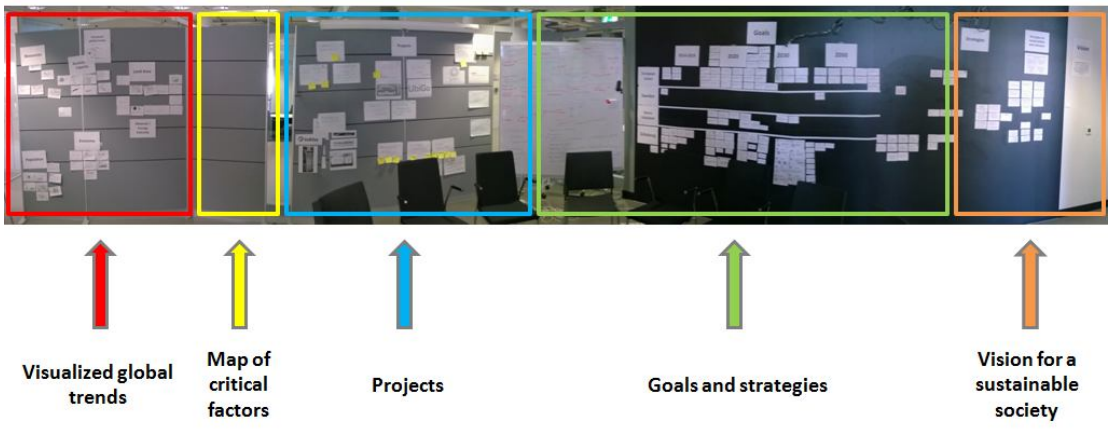

Figure 2.16 The wall created by the Challenge Lab team

To adopt backcasting as an approach further helped narrow the focus on the transport system at the city level in Gothenburg without deviating from our global vision. Another important intention of adopting backcasting as an approach was that the current trends were the main parts of the problem and that there was an urgent need for a major change (Dreborg, 1996).

Inspired by the four system conditions of a sustainable society defined by Holmberg et al. (1996), the vision for the sustainable world was set as '*nearly 10 billion happy people living on the only planet we have in 2050'*. In addition to its widely accepted definition of sustainable development by Brundtland report, the recognition to that there are limits to conventional growth and resource use set by the fixed global supply capacity was given. Therefore, the vision, more precisely, is a sustainable future where the global society is able to meet its own needs within the planetary boundaries giving the future generations enough space in the double challenge funnel to manoeuvre so that they can also meet their needs.

Figure 2.17 Vision and criteria for sustainability on the Challenge Lab wall

Defining criteria for sustainability

According to the described process, the team selected the following criteria to measure sustainability:

Four sustainability principles

According to (Holmberg et al., 1996), in order to become a sustainable society, society must eliminate its contributions to:

1) The systematic increase of concentrations of substances extracted from the Earth's crust;
2) The systematic increase of concentrations of substances produced by society;
3) The systematic physical degradation of nature and natural processes, and
4) Conditions that systematically undermine people's capacity to meet their basic human needs.

Sustainability criteria according to the Sustainability Compass

- **Nature**
  - ***Preservation***. "Development is sustainable if habitants for humans, animals and plants are preserved and consideration is given to future generations in the use of natural resources… The areas of natural importance are to be preserved" (Federal Office for Spatial Development (ARE), 2004).
  - ***Environmental disasters***. "The impact of environmental disasters is to be reduced and environmental risks are only to be accepted to the extent that, even in a worst-case scenario, no permanent damage outlasting one generation would be caused" (Federal Office for Spatial Development (ARE), 2004).
  - ***Emissions & toxic substances***. "Any impact of emissions and toxic substances on the natural environment and human health is to be reduced to a safe level" (Federal Office for Spatial Development (ARE), 2004).

- **Society**
  - ***Health and safety.*** "Human health and safety are to be comprehensively protected and promoted" (Federal Office for Spatial Development (ARE), 2004).
  - ***Education.*** "Education is to be provided, ensuring individual development and identity" (Federal Office for Spatial Development (ARE), 2004).
  - ***Culture.*** "Culture is to be promoted, together with the preservation and development of the social values and resources that constitute social capital" (Federal Office for Spatial Development (ARE), 2004).
  - ***Solidarity.*** "Solidarity is to be promoted within and between generations and also at the global level" (Federal Office for Spatial Development (ARE), 2004).
  - ***Justice***. "Equal rights and legal security are to be guaranteed for all, with particular attention to equal rights for women and men, equal rights and protection for minorities, and respect for human rights" (Federal Office for Spatial Development (ARE), 2004).
  - ***Adaptation.*** "The capacity of actors in the system to influence resilience has to be balanced" (Walker, Holling, Carpenter, & Kinzig, 2004)

- **Economy**
  - ***Income and Employment.*** "Levels of income and employment are to be maintained and increased as required, with due consideration being given to socially and geographically acceptable distribution" (Federal Office for Spatial Development (ARE), 2004).

- ***Productive capital***. "It should be possible for productive capital, based on social and human capital, to be at least maintained and to show qualitative improvement" (Federal Office for Spatial Development (ARE), 2004).
- ***Competitiveness and innovation***. "Economic competitiveness and the capacity for innovation are to be improved" (Federal Office for Spatial Development (ARE), 2004).
- ***Market mechanisms.*** "Pricing should be the primary economic determinant, with due consideration being given to scarcity factors and external costs" (Federal Office for Spatial Development (ARE), 2004).
- ***Public sector.*** "The public sector is not to be managed at the expense of future generations (e.g. debt, failure to preserve assets)" (Federal Office for Spatial Development (ARE), 2004).

- **Well-being**
  - ***Life evaluation.*** The assessment of the "life as a whole" (OECD, 2013) by the individual should be satisfactory.
  - ***Affect.*** Evaluation of personal feelings on how life is experienced (OECD, 2013) should be satisfactory.
  - ***Eudemonia.*** A good psychological functioning or "flourishing**"** (OECD, 2013) related with the realisation of the personal potential should be satisfactory.

Following the definition of the vision, the current trends at the global scale were identified by using the double challenge funnel. Current trends in global supply and demand were visualized by the graphs and tables (see *Figure 2.18*) from the several resources such as Evans, (2010), the World Bank (2014), the United Nations (2014), United Nations Environment Programme (UNEP) (2012b), UNEP (2011), Bringezu et al. (2014). Backcasting approach accompanied by the system dynamics thinking perspective helped connect the global sustainability objectives with the local transport goals and strategies.

The description of present situation in term of sustainability is particularly important in order to capture current societal and technical inefficiencies as well as barriers in reaching the sustainable society and to have an understanding of the current dominant trends that are parts of the problem (Holmberg, 1998). In describing the current situation, the sustainability principles function as a guide that helps ask relevant questions to the system in order to be able to understand how sustainable/unsustainable the system currently works.

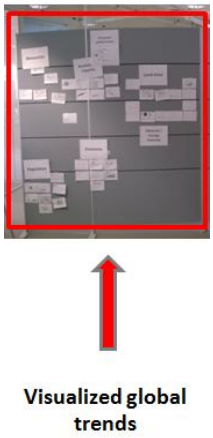

Figure 2.18 Global trends on the Challenge Lab wall

Double challenge funnel

After a long time being in the stable and rather sustainable state, the dynamics of the planet Earth has been changing threatening the humanity with the future that will potentially bring disastrous consequences (Rockström et al., 2009). Anthropogenic activities have been causing a severe impact on the environment influencing the Earth's carrying, or better told, assimilation capacity to keep up with the human socio-economic development at the expense of well-functioning metabolism of the Earth.

The study carried out by Rockström et. al. (2009), in which they introduced the safe operating space for humanity highlighting the planetary boundaries, is one of the renowned studies in regard to understanding where the world has been heading to. Even though it is a very convenient study to show how the key subsystems of the Earth are overstepped by the human-beings, we chose to use the double challenge funnel, i.e. *the resource funnel* which actually captures these boundaries and goes beyond by including such parameters as global population and economic growth and increasing material/energy use. To use the double challenge funnel will make it easier to better visualize this threatening path the human-being has been neglectfully taking into the funnel, in which it becomes more and more difficult to manoeuvre.

Under the following headline, these trends are going to be mentioned in more detail.

Decreasing Global Supply Capacity

Earth's *natural resources, assimilation capacity*, and *land availability* have been in a steady decrease since the humanity entered into the industrial era. In return to this rapid exploitation of the resources, the human pressure on the environment – the ecosystems in particular- has kept increasing exceeding the carrying capacity of the Earth. Even though there are some new socio-technical improvements such as higher awareness towards sustainability, technologies enabling resource substitution and new

business models implementing the sustainability thinking as their core value, the current trends show that several critical global, regional, and local thresholds are either close or have already been overstepped (United Nations Environment Programme, 2012b).

Resource Restriction. One of the most important barriers to the conventional path of growth and conventional way of life is the resource restriction which limits the humanity's capability of sustaining the same lifestyle as it has adopted for decades now. It is strongly underlined by number of studies, e.g. Hall and Day (2014), Brown et al. (2013), Meadows et al. (2004), Rockström et al. (2009), United Nations Environment Programme (2012), Evans (2010), and Giljum et al. (2009), that the amount of natural resources extracted to produce the goods and services to feed the humanity is continuously increasing and, in return, the thresholds in the use of some critical resources have been overstepped. Keeping this in mind, it is fair to say that the natural resources are therefore not used in pursuant of the sustainability principles mentioned by (Holmberg et al., 1996), in particular the 1st and 3rd principles.

One important constraint to resource use stems from resource scarcity. Even though there is now an evidence that the industrialized nations have recently achieved to generate more wealth per unit energy (Hall & Day, 2014), the world annually uses %50 more resources than only a couple of decades ago and it is projected that this use could even increase up to more than %50 comparing to the current use (Giljum et al., 2009). The increasing consumption along with the issue it has created, the climate change, accelerate the problems that are linked to the resource availability and result in degradation of the ecosystems which provide these resources.

Global fresh water reserves are rapidly being depleted (Rockström et. al., 2009). There are still billions of people living in water scarce areas where the water security is highly threatened, especially with more than two folds of increased withdrawal (United Nations Environment Programme, 2012b). Forests are being vanished to provide biomass, e.g. wood, and land, and, according to the European Environment Agency, the world will face a further decline in forest cover, though there are improvements (European Environment Agency, 2010). Biodiversity loss is accelerated by the loss of natural ecosystems causing a great threat to the extinction of many species putting the functionality of ecosystems into a great risk (Giljum et al., 2009).

Assimilation Capacity. Earth's assimilative capacity has also been decreasing mainly due to humanity's increasing resource consumption and material production. Assimilative capacity basically means the Earth's ability of absorbing waste or, better put in the second principles of sustainability (Holmberg et al., 1996), the increasing

concentrations of substances produced by the society without the ecosystems being degraded and losing their ability to regenerate (Cairns, 1994). It is this assimilative capacity that actually sets the limits to unsustainable use of natural resources and brings about the restrictions to generating wastes, e.g. emitting GHGs.

Global warming, for example, is a result of the Earth's atmospheric inability to absorb anymore GHG emissions produced by society. There is now a broad consensus in the academy that the world must keep the surface temperature of the Earth below 2°C comparing to the pre-industrial temperatures (Rockström et al., 2009).

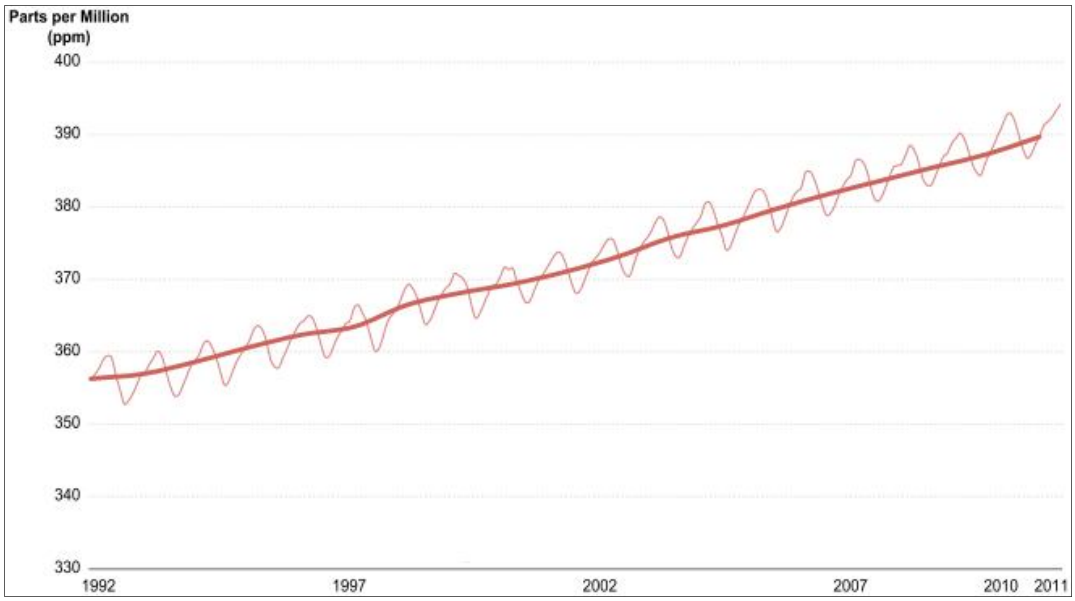

Figure 2.19 Atmospheric CO2 Concentration / Keeling Curve (UNEP, 2011)

Another assimilative restriction is the Earth's terrestrial sinks. Increasing demand for biomass, e.g. forest products, for bio-energy as well as for agricultural yields have led to conversion of forests into lands to be used for forest industry and agriculture resulting in increasing deforestation, which also threatens the habitats of other living-beings. As a result, the Earth's capacity to take up carbon dioxide has decreased in many regions around the world, accelerating the global warming (United Nations Environment Programme, 2012b).

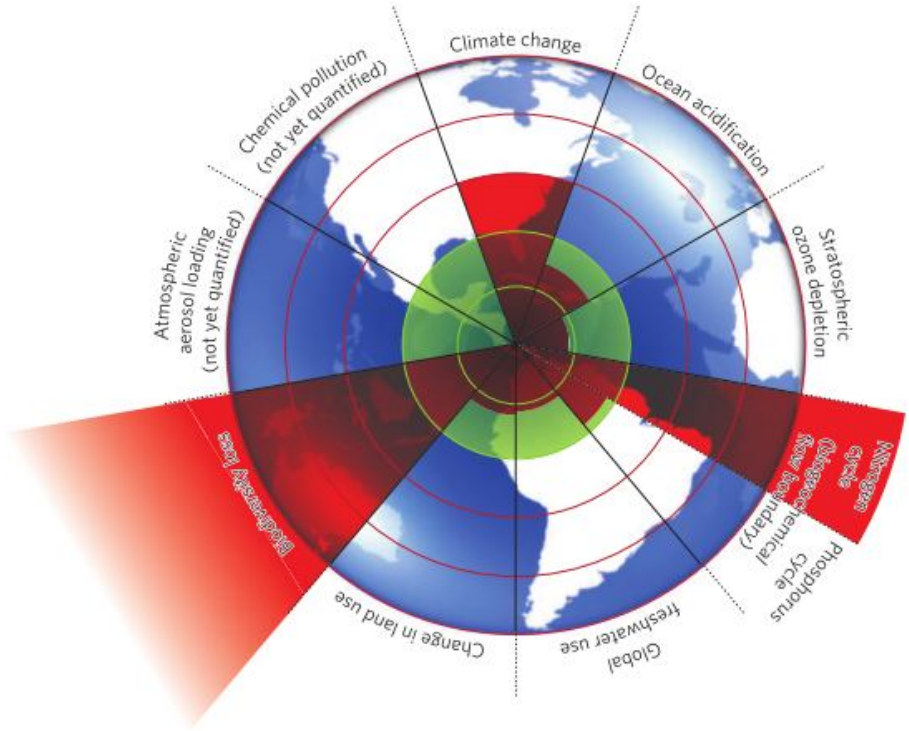

Figure 2.20 Atmospheric CO2 Concentration / Keeling Curve (UNEP, 2011)

In addition to terrestrial sinks, oceans are also under a great pressure due to increasing concentrations of atmospheric pollution, i.e. GHGs. Due to excessive absorption of GHGs by oceans, ocean acidification has already overstepped its capacity to balance between the emission and uptake (Rockström et al. 2009).

Land Area Restriction. Another significant factor restricting the global society to seek for further growth is the availability of land that becomes a scarce resource (Lambin & Meyfroidt, 2011). The pressure on land due to increasing demand for food and raw materials has considerably increased during the past decades. What makes land very special is that it creates reinforcing effect for various other global sub-systems such as biodiversity loss, resource scarcity and global fresh water (Rockström et al. 2009).

Agriculture is the primary user of the available land accounting for in total 33% of the global land cover (Bringezu et al., 2014). Increasing demand for food due to increasing population growth is creating a huge pressure on food production. The past decade witnessed further increase of %11 in land used for crops, and, similarly, of 23% in harvested area (Bringezu et al., 2014). This, in return, causes excessive use of machinery and additional chemicals degrading the soil fertility, further increasing soil pollution (United Nations Environment Programme, 2012b).

It is estimated according to the market projections that, in order to meet global demand for cereals and meat, there need to be an annual additional production of a billion tonne of cereals and 200 million tonnes of meat (Nachtergaele, Bruinsma, Valbo-Jorgensen, & Bartley, 2009). Furthermore, Lambin and Meyfroidt (2011) notes that there will be additional loss of 1.6 to 3.3 Mha per year of prime agricultural land caused by urbanization.

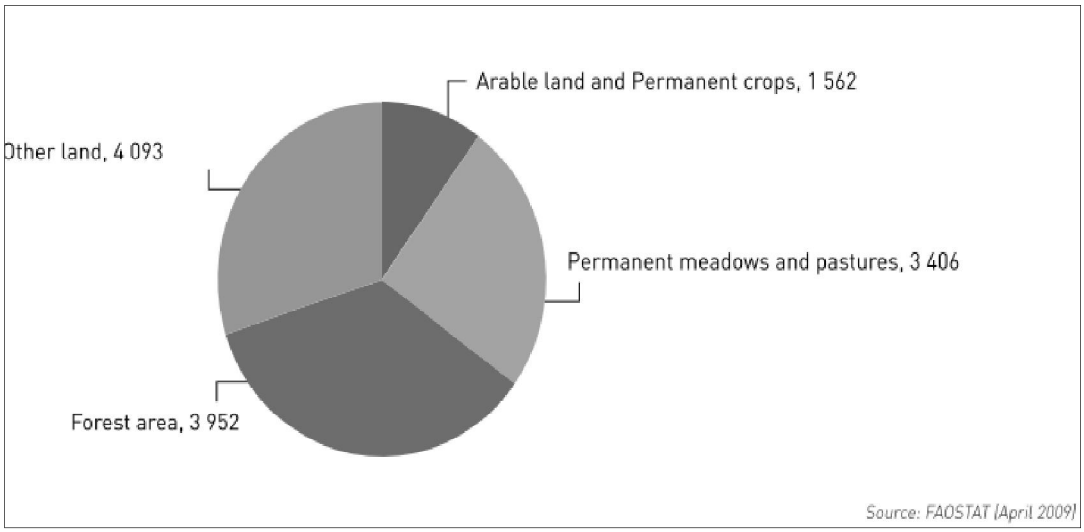

Figure 2.21 World land use and land cover area in 2005 (Mha) (adapted from (Nachtergaele et al., 2009))

Overall, humans degraded approximately 43% of the Earth's surface area as of 1995 (Hooke, Martin-Duque, & Pedraza, 2012). Ellis and Ramankutty (2008) noted that only less than 25% of the Earth's ice-free land area could be considered untouched. Furthermore, Sanderson et al. (2002) mentioned that 83% of this ice-free land area was exposed to direct influence of human-beings.

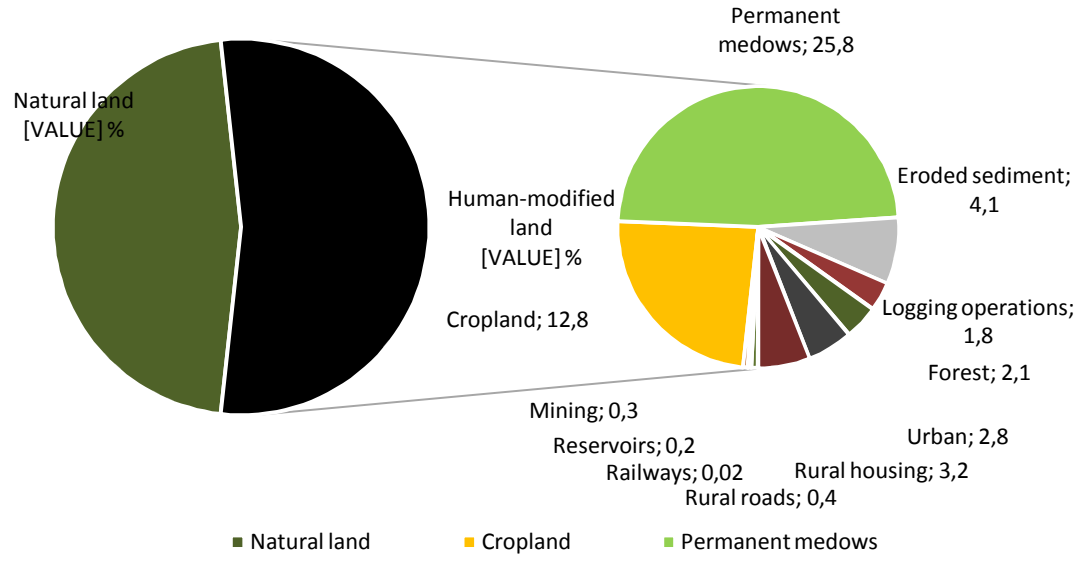

Figure 2.22 Land use as of ca. 2007 based on Hooke et al. (2012)

Increasing Demand for Resources and Ecosystem Services

Global supply of the resources and the services provided by the ecosystems are vital for the humanity to maintain the life on Earth. However, as also mentioned above, there is a great pressure on the ‘’supply side of the equation’’ due to increasing demand from *increasing population*, *growing economy*, and *increasing material and energy intensity*. Even though the demand for natural resources differs from region to region around the world, the humanity's resource consumption has increased some 10 folds over the centuries as the societies have become industrialized changing their lifestyles (Giljum et al., 2009). From 1995 to 2010 the rate of undernourished population to the global population has globally slightly decreased from 14% to 13%; however, the number of people undernourished has unfortunately increased from 788 million to 925 million (United Nations Environment Programme, 2012b). The demand for food, for example, has exceeded the supply seven years between 2000 and 2008 (Evans, 2010). Economies are growing taking more people out of poverty and enabling them to enter the middle class. So is the gap between the rich and the poor. Even though the industrialized countries have in the recent years achieved to produce more wealth per unit of energy, the lifestyles and the consumption behaviours in the political North outweigh this progress causing huge differences in material use between those in the political North and the South.

Population growth. The world population showed an exponential growth since the 20th century (Krausmann et al., 2009) with more than half of the current global population being added during the past decades of the 21st century. The global population has today reached to 7.2 billion as of mid-2013. However, United Nations Department of Economic and Social Affairs (2013) estimated a decline in population in rather developed countries between 2013 and 2050. Nevertheless, it has been further projected that the global population will continue to grow reaching to 8.1 billion by 2025, and increasing to 9.6 billion by 2050, and, eventually, to 10.9 billion in 2100, mainly due to the population increase in developing countries (United Nations Department of Economic and Social Affairs Population Division, 2013). More of this further growth is expected to be in the developing countries with the developed countries having rather stabilized populations. Additionally, the 49 least developed countries (LDCs) still have the fastest growing population in the world, being at 2.3 per cent per year. Although there is an expected slowdown in this rate of increase over the next decades, the LDCs are projected to double their population by mid-century, from 898 million in 2013 to 1.8 billion in 2050, further increasing to 2.9 billion in 2100.

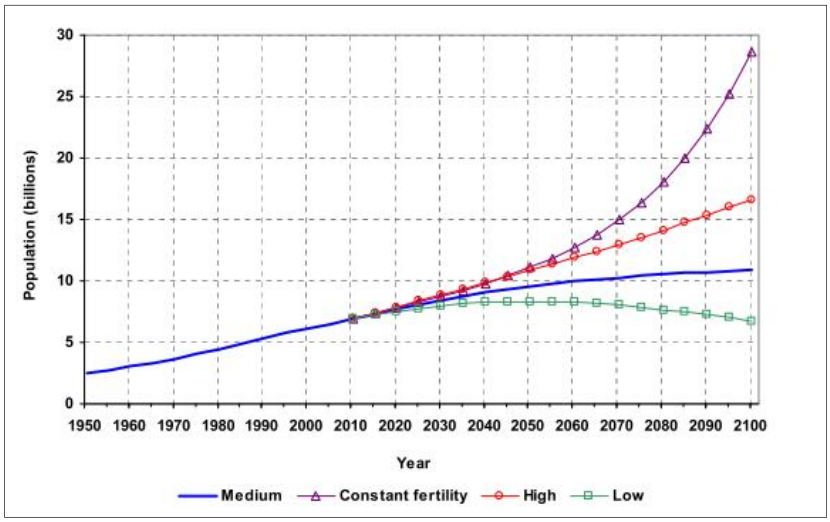

Figure 2.23 World Population Projections, source: Population Division of the Department of Economic and Social Affairs of the United Nations Secratariat, (2013). World Population Prospects: The 2012 Revision Key Findings and Advance Tables. New York: United Nations

Population growth eminently depends on how the future fertility will be. In the medium variant (see *Figure 2.23*), there is a humble, though increasing, decline in global fertility from 2.53 children per woman in 2005-2010 to 2.24 children per woman in 2045-2050 and 1.99 children per woman in 2095-2100. Considerably big share of all of the additional 3.7 billion people from now to 2100 will increase the population of developing countries, which is projected to rise from 5.9 billion in 2013 to 8.2 billion in 2050 and to 9.6 billion in 2100. In contrast, the population of the more developed regions is estimated to show a slight increase by the end of the century. The population in these regions is expected to change minimally, rising from 1.25 billion in 2013 to 1.28 billion in 2100.

Economic growth. Even though the world has been still trying to recover from the 2008's financial crisis, there are now some indications showing that it has started gaining momentum again. The projections on global economy also show the same direction: acceleration of economic growth globally up to 3.2 percent in 2014 from 2.4 percent in 2013 (the World Bank 2014). According to the the United Nations, (2014), this growth will be at a pace of 3.0 and 3.3 per cent in 2014 and 2015, respectively.

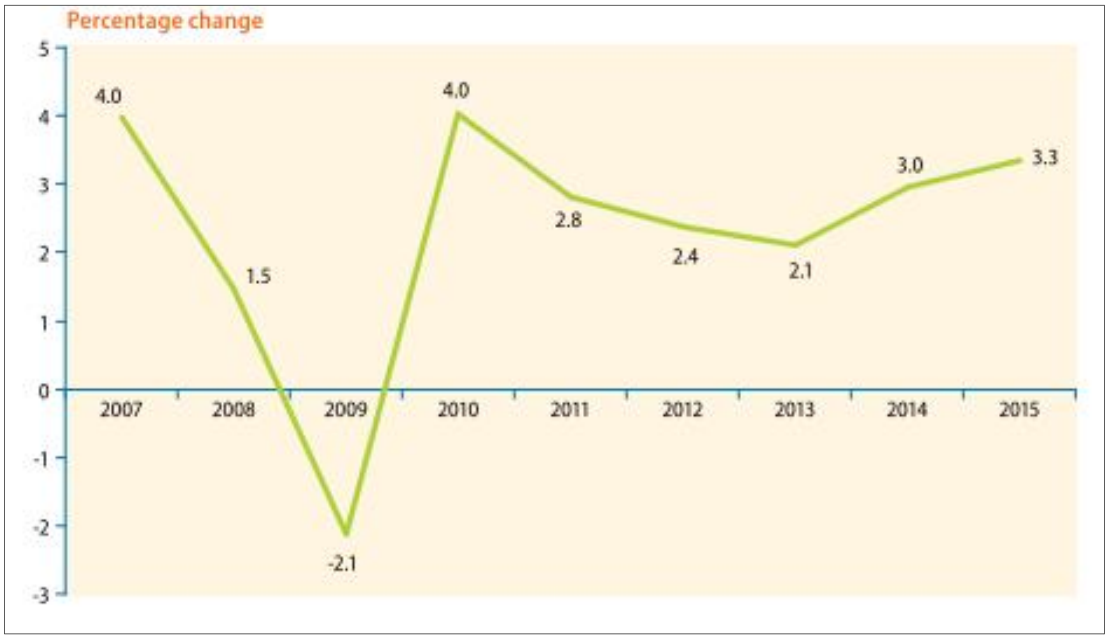

Figure 2.24 Growth of world gross product, 2007-2015 by UN/DESA

Although several emerging economies experienced remarkable slowdown in the past years, they have faced new headwinds during 2013. However, there have recently been some signs showing up: a number of large emerging economies, including Chine, have managed to stop a further slowdown; the euro area finally has a gross domestic product showing a return to growth for the region as a whole. It is evident to say that, in spite of the recent crisis, the economy keeps growing globally. In Western Europe, the rate of growth in the economy is estimated to be by 1.5 and 1.9 in 2014 and 2015, respectively. Even though, the situation in many of the new European Union members in Eastern Europe is not clean-cut, these countries have already shown improvements in the second half of 2013. Similarly, in other developed countries such as the United States, Canada, Australia, and New Zealand, the rate of economic growth is estimated to be ranging between 2.5 and 2.8 in 2014 (the United Nations, 2014).

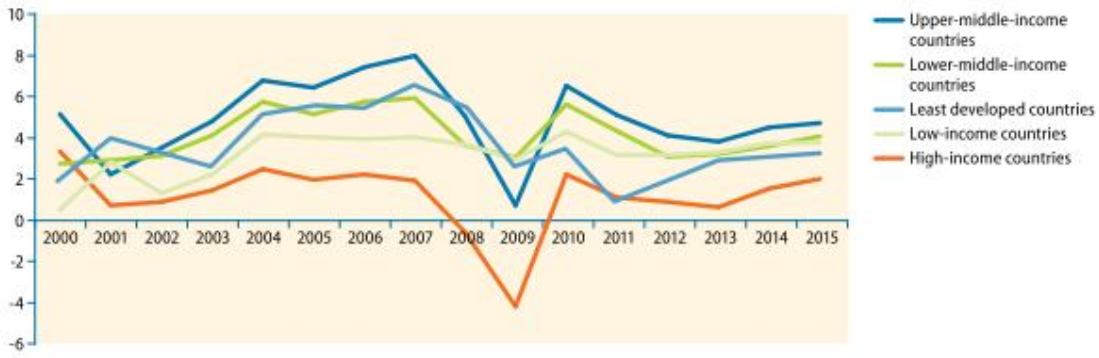

Figure 2.25 Growth of per capita GDP by level of development, 2000-2015. (UN/DESA)

However, while the global economic growth continues, so does increasing income inequality between the rich and the poor. The wealth distribution is in such a tragic situation that almost half of it is gained by the richest one percent of the world population, whereas the other half is shared by the remaining population (Keating et al., 2013).

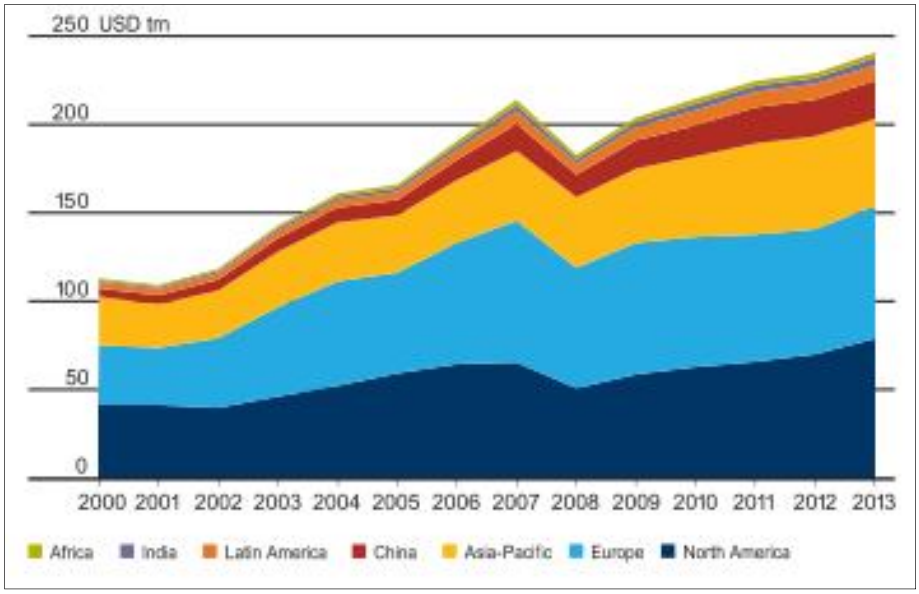

Figure 2.26 Total global wealth 2000-2013, by region (Credit Suisse Global Wealth Databook 2013)

Energy and Material Intensity

The increasing use of energy and material intensity is another trend to take into account while analyzing the actual trends shaping the unsustainable state of the world. Below, *material* and *energy use* are described separately.

Material Use. Over the past decades, especially last 60 years, the world has seen dramatic increase in the amount of extracted material as well as in the demand for raw materials. The amount of materials used by the global society has increased 60% comparing to the amount in 1980 (see *Figure 2.27*) (OECD, 2012a). Undoubtedly, the major drivers of this increase have been the industrialization of developing countries with growing economies as well as the effect of globalization and urbanization. It is estimated that the present material use is more than 62 Gt worldwide and projected to increase up to 100 Gt by 2030 mainly due to increasing population and level of development of emerging economies.

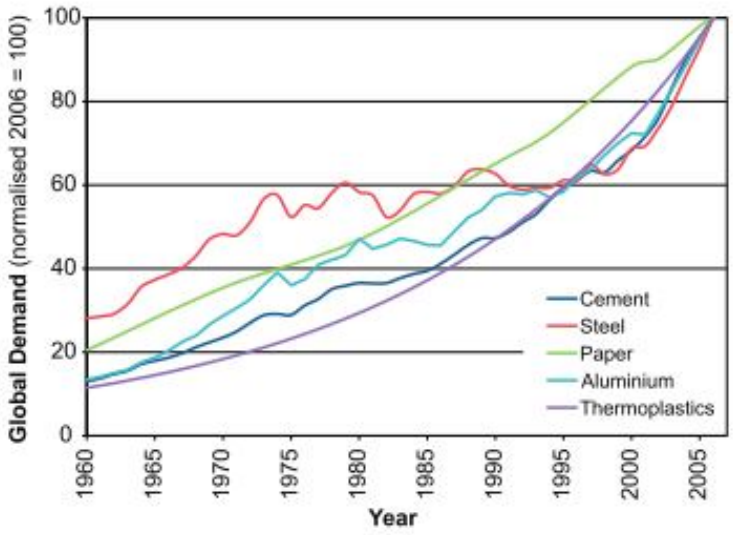

Figure 2.27 Normalised demand for five key materials 1960-2005. (Allwood, Ashby, Gutowski, & Worrell, 2011)

However, just like the disparity in the distribution of wealth, there are considerable discrepancies in material use among the nations. The material use of those living in the developed countries use average four times more than those living in Asia and Africa (Giljum et al., 2009). Even though the material productivity has been improved in developed countries in the recent years, decoupling wealth generation from material use has remained weak.

Energy Use. Energy is certainly one of the most fundamental fuels for accelerating human development. Given the fact that the global material use is immense and keeps growing due to increasing demand and growing economies, energy consumption for producing and transporting these materials have also been in a higher increase than global population. Total global energy consumption has almost doubled in 2011 comparing to the amount in 1973 (International Energy Agency, 2013).

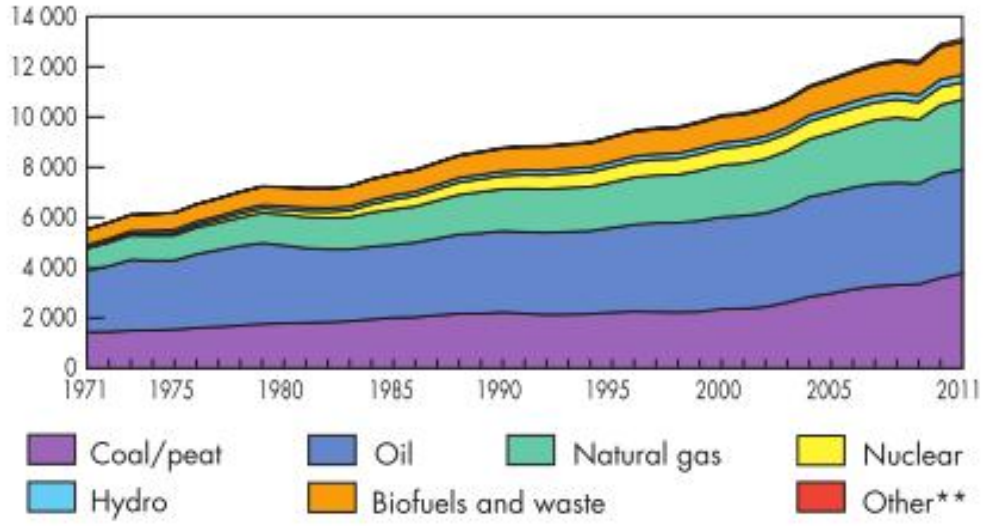

Figure 2.28 World total primary energy supply by fuel (Mtoe) (International Energy Agency, 2013)

While a continuously increasing demand for energy is expected in the future, especially in the low-income countries, there are also great efforts made to increase energy efficiency. For that matter urban areas play a major role in reducing the world's energy consumption since they are responsible for 60% to 80% of the global energy consumption (Kamal-Chaoui & Robert, 2009). The estimations telling that 70% of the world will be living in the urban areas by 2050 point out both great challenges and opportunities (United Nations Human Settlements Programme, 2011). On one hand, urbanization brings about increasing concentration of consumption and production. On the other hand, densely populated urban areas also create a window of opportunity for increasing the energy efficiency globally, and, therefore, making it possible to supply the increasing demand in the future.

Current projects that were thought would bring about the transition towards sustainable transport within Gothenburg were discussed, keeping in mind the local, regional and national strategies for achieving the sustainability in the transport system. The discussion was supported by review of relevant reports about current strategies, policies, and plans regarding transport as well as by the statements of several stakeholders involved in the transport system at local, regional as well as national level. Then, the ongoing projects were connected to the strategies as the steps further towards our vision.

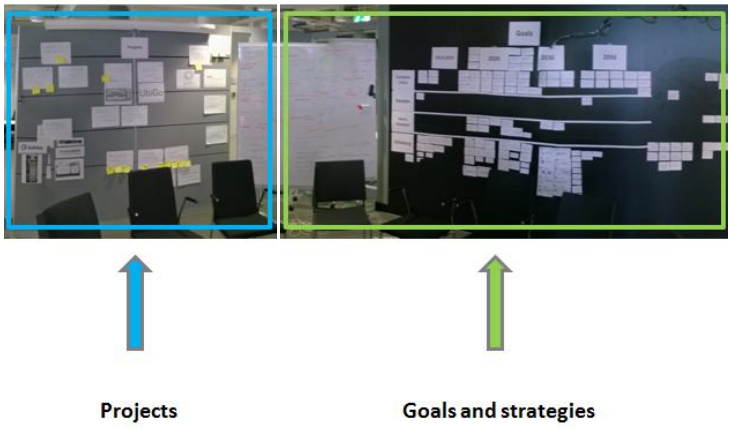

Figure 2.29 Projects, Goals and Strategies on the Challenge Lab wall

Moreover, as part of this step, an analysis of the European and National level programs and regulations is described below.

Undoubtedly, it is a great challenge to achieve the sustainable development when thinking about the complex and dynamic global system which has several complex sub-systems. There are many plans and projects trying to deal with and to bring solutions to the challenges the societies have been facing at both global and national and local level around the world. So is the situation in Sweden and in Gothenburg in particular. Fortunately, the majority of stakeholders visiting the Challenge Lab was aware of the magnitude of challenges and having ambitious and long-term goals in terms of sustainable future of transport in Gothenburg.

The goals set by the national government make up the basis of the regional and local goals, and the national goals align with the objectives set by the European Commission. Therefore, our mention on the goals will be at four different levels: the EU, national, regional, and local. Furthermore, since the challenge that is dealt with is the transport system at the local level, we are going to mention the goals taken into consideration within the Challenge Lab regarding the transport system at respective levels.

Specific plans and goals towards a sustainable transport system

EU level

As a result of the EU's motivation to combat the global climate change, there have been many actions taken by the European Commission related to reducing GHGs emissions produced by the European societies. Various bodies within the European Commission such as DG Environment, DG Mobility and Transport and the European Environmental Agency have so far published many documents regarding the transport and mobility within the EU mentioning further the GHG emissions due to transport across the continent.

The recent publication in this regard was the 7th Environment Action Programme to 2020. There are several points in this action programme regarding the transport within the EU (European Commission, 2014). In this regard, one of the points is under the priority objective of helping cities become more sustainable given the fact that the transport is one of the major activities within the urban areas (Holmes & Pincetl, 2012). Another mention regarding the transport is related to air and noise pollution in the cities becoming denser across the EU.

Furthermore, with the objective of achieving resource-efficient and environmentally-friendly transport for all of its citizens, Horizon 2020 sets clear goals within the transport across the EU, e.g. having CO2-free logistics in cities by 2030 and phasing out conventionally-fuelled cars in cities by 2050 (European Commission, 2013).

National level

Even though the goals set at the national level align with those of the EU level, there are some differences between them. The ambitious objective of Sweden achieving sustainability in transport sector was presented as FFF, meaning fossil-free fleet. Given the fact that there are a lot of efforts made to accomplish this objective by 2030 across the nation, the national goal set by the Swedish Transport Administration is to achieve, at least, a reduction of 80% in the use of fossil fuel for the road transport by 2030 comparing to 2004 (Larsson & Bolin, 2014). Furthermore, the country aims at being neutral in the emission of GHG by 2050, which means the emissions due to transport sector should be close to zero (*ibid.*).

Regional level - Västra Götaland

According to the report *Vision Västra Götaland* (Vision West Götaland), the first goal of the regional administration is that the economy within the boundaries of the region is no longer dependent on fossil energy by 2030. This goal also includes the fossil energy use of the transport sector. Being more specific about the transport sector, the regional administration aims at making public transport more competitive and attractive and sets the goal of making full use of the alternative fuels.

Likewise, *Färdplan 2050* (Roadmap 2050)[10] composed by the West *Götaland Regional Administration also aligns with the national goal defined by FFF.* In addition to this*, Färdplan 2050* further focuses on increasing the share and use of renewable fuels replacing with the fossil fuels. Another report mentioning the goals in

[10] Swedish Environmental Protection Agency to develop the basis of a roadmap for Sweden to produce no net emissions of greenhouse gases by 2050.

this regard is K2020[11]. The two important goals defined in this report are to have more than 40% of journeys within the region by public transport, and therefore, to have journeys in and out of the region by train quadrupled.

Local level - Gothenburg

It is possible to mention two important documents that address the transport challenge at the city level defining clear goals. One of them is *Climate Strategy Program* which aims at achieving 80% reduction of carbon dioxide emissions due to road transport in Gothenburg by 2030 comparing to the amount of emissions in 2010. The other document is the *Traffic Strategy* that sets broader goals for the transport within the city. One important feature of the traffic strategy is that it takes into consideration the urban structure to reduce the travel need, and, thus, the travel demand. It focuses on increasing bike lanes and on improving the existing infrastructure for public transport and freight transport.

It should be finally noted that the local governments in Sweden are to align their policies with the national objectives. Therefore, the goals previously mentioned at the national level are also adopted by the local government of the city of Gothenburg.

In order to identify and classify the main efforts made in the region towards sustainable transport and mobility, the C-Lab team used information gathered in different lectures with stakeholders and made a complementary online research. The categorization and main characteristics of some of the projects identified are shown in *Table 2.3*.

Table 2.3 Some of the ongoing projects related to the transport in Gothenburg

Project	Description	Stakeholders
DriveMe – Self-driving cars for sustainable mobility	Large-scale autonomous driving pilot project in which 100 self-driving Volvo cars will use public roads in everyday driving conditions around the Swedish city of Gothenburg.	Joint initiative between Volvo Car Group, the Swedish Transport Administration, the Swedish Transport Agency, Lindholmen Science Park and the City of Gothenburg. The 'Drive Me' project is endorsed by the Swedish Government.

[11] The K2020 project (http://www.k2020.se/download/18.1e54ec5411db5915e3880002391/1229335391804/K2020_public_transport_development_program.pdf) is a joint action between West Göteland Region (http://www.vgregion.se/en/Vastra-Gotalandsregionen/Home/), the Göteborg Region Association of Local Authorities, the City of Göteborg, Vasttrafik (http://www.vasttrafik.se/#!/en/1/), the National Road Administration, and the National Rail Administration.

Project	Description	Stakeholders
Send-smart	SENDSMART focuses on three types of goods in the city: 1. Goods supply to shops, restaurants etc., also called city logistics 2. Construction transport 3. Transports within waste management and recycling	Partners in the project are Trafikkontoret, AB Volvo, Renova, Schenker Consulting, Chalmers University of Technology, The Swedish Transport Administration, Lindholmen Science Park, Business Region Göteborg, Fraktkedjan, Göteborgs Lastbilscentral, Älvstranden Utveckling, Innerstaden Göteborg, Mistra Urban Futures, Tyréns, NCC, Peab, Svevia.
Go-smart	Go:smart is developing and testing an innovative service that facilitates and rewards sustainable travel in urban environments.	Partners in the project are Lindholmen Science Park, Chalmers University of Technology, Mistra Urban Future, Volvo IT/Commute Greener, Volvo Bussa, Västtrafik AB, Viktoria Swedish AB, Region Västra Götaland, The Swedish transport of Administration, The City of Gothenburg, Move About, Payex Finance, Tyréns, Arby Kommunikation, Vinnova.
Ubigo	There are 70 households in Gothenburg subscribing to a fully integrated mobility service called UbiGo. The service combines Public Transport, car-sharing, rental car service, taxi and a bicycle system, all in one app and all usage on one invoice every month.	Partners in the project are AB Volvo, Commute Greener, Chalmers University of Technology, City of Gothenburg, Västra Götaland Region, Västtrafik, Swedish ICT Viktoria Institute, Tyréns, Swedish Transport Authority, Arby Kommunikation, Mistra Urban Future, Move About, PayEx.
ElectriCity	Commencing in 2015, the electric buses are to run between Johanneberg Science Park adjacent to Chalmers and Lindholmen Science Park in Hisingen. In addition to the electric buses, the cooperation also includes the creation and trial runs of new bus-stop solutions, traffic-routing systems, safety concepts, energy supply and business models.	Partners in the project are Volvo Group, City of Gothenburg, Göteborg Energi, Västtrafik, Lindholmen Science Park, Johanneberg Science Park.

Project	Description	Stakeholders
Hyper Bus	Hyper Bus stands for Hybrid and Plug-in Extended Range Bus system. It's about a concept with entirely new technology that allows the plug-in hybrid to run on battery power longer than earlier models, and about charging stations where it can recharge its batteries in just a few minutes while waiting at the end of the line.	Partners in the project are Business Region Göteborg, Göteborg Energi, City of Gothenburg - Traffic & Public Transport Authority, Volvo Buses, Västtrafik.

2.3.2 Inside-out perspective

Uses of different self-leadership tools helped explore the intrinsic motivations of the individuals at the Challenge Lab and, thus, increased self-awareness of the individuals in an explorative and experiential manner. For example, to draw one's values map enabled the students at the C-Lab to understand their intrinsic drivers for the actions that they take. Through value mapping as shown in Figure 2.30, the C-Lab team identified their values that make up the foundation of their action, their focus at present, and that build their vision.

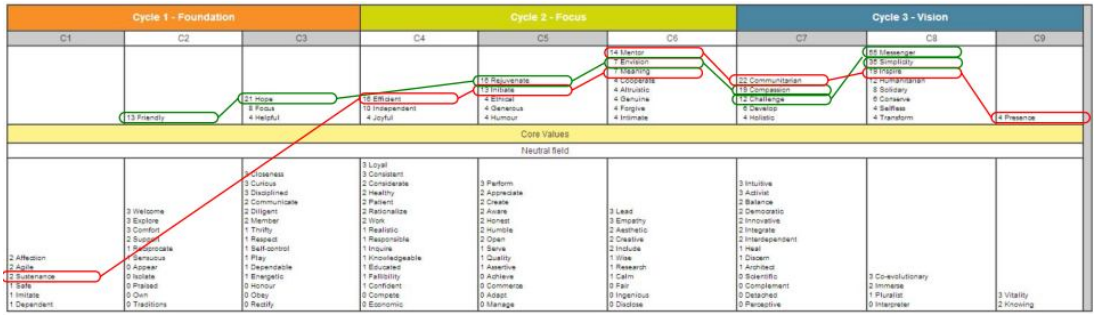

Figure 2.30 Value map example by ValuesOnline Nordic AB, 2014

Self-leadership and dialogue tools used throughout the Phase I of the Challenge Lab gave the team the competence necessary to increase the order of learning from each other and from the interaction with the stakeholders welcomed at the C-Lab. Through story-telling and active listening tools, the team had a chance to reflect on their past experiences, which led them to observe how their values and intrinsic motivations aligned with their past actions. Another important outcome of these practices was the understanding of effectiveness of listening-to-learn and learn-to-listen practices embedded in these tools. This, in turn, enhanced the team's ability to better interact with the stakeholders and to be able to ask strategic questions to grasp the essence of problems faced in the transport system in Gothenburg.

During dialogues within the C-Lab team, the process called 'circular time' enabled

them to share knowledge with and give feedback to each other regarding the work collectively carried out during the first phase particularly. Another complementary process called 'triangle time' then enabled them to make decisions on and, when necessary, division of roles where the collaborative action was needed, e.g. creation of the wall concept. Subsequent to these processes, each student reflected upon the learning of the day in the session called 'the pearl of the day'.

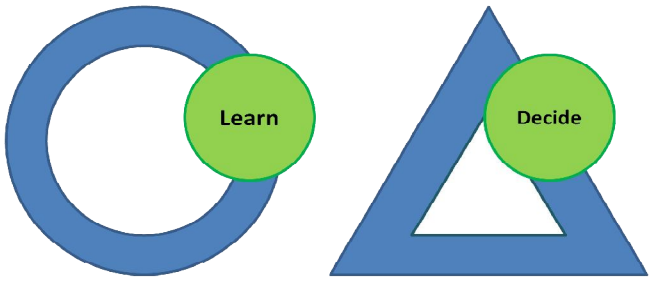

Figure 2.31 Circle and Triangle time (Sande, 2014)

While these tools enabled collective learning through individual thinking and reflecting, 'six thinking hats' presented an ambience where the students experienced thinking together and acting on an issue from different perspectives represented by the six hats. Since the C-Lab team communicated with different stakeholders from academy, industry, and government, this tool enhanced their understanding of different perspectives stemming from different roles taken by those actors.

Overall, an important outcome of the execution of inside-out approach in parallel with outside-in approach was the understanding of the importance of multi-level and multi-actor relations in sustainability transitions. Furthermore, the Phase I process resulted in the identification of a gap to be filled in the current system, which led to the ideation of the study carried out in the second phase. In this regard, another very practical outcome of the Phase I process was that it enabled the authors to identify some key stakeholders, their roles, and relevance for the study carried out in the Phase II.

3 Chapter Three – Stakeholders' Perspectives on Challenges, Barriers, and Opportunities for Sustainability Transition

3.1 Introduction

Transport sector is a 'cog' for social-economical activities in cities and for the wellbeing of societies. However, it is also a major contributor to the global warming. Furthermore, it is Sweden's national objective to reduce GHGs emissions due to transport sector by 95% by 2050 while providing environmentally sustainable, socially equitable, and economically efficient transport services for its citizens (Finnveden & Åkerman, 2014). By the nature of the governance in Sweden, regional and local governments and authorities are also responsible for implementing relative policies that will help achieve the national objectives.

In this regard, as in other cities of the world, there have been also many efforts made in Gothenburg, e.g. alternative fuels, electrification of transport, more efficient vehicle technologies etc., to minimize the effect of transport sector on the city's overall impact on climate change. It is also aimed that these efforts also serve for having a sustainable transport system and a sustainable city eventually. However, it is particularly challenging given the future plans of expansion of the city and the expected growth in population in Gothenburg. Therefore, not only is it enough to try to solve climate related issues but also it is important to address the concerns for potentially increasing demand for transport and mobility in the city. Several different actors[12], for this matter, have been ambitiously trying to achieve the sustainability objectives of transport sector (also see K2020[13]) (Göteborgs Stad, 2012). To this end, the main attempt has been to turn Gothenburg into a test-bed area where new solutions will be sought for to bring about sustainability transition in many key sectors at the urban level (K2020).

During the Challenge Lab Process, different actors working within the transport system were interacted with. It was observed that these actors had rather varying visions of the sustainable future of transport and mobility in Gothenburg with varying approaches for possible solutions. Furthermore, varying challenges and barriers that prevent sustainable transition from taking place as well as opportunities that can

[12] The term 'actor' is treated as 'stakeholder' throughout the chapter 3

[13] The K2020 project (http://www.k2020.se/download/18.1e54ec5411db5915e3880002391/1229335391804/K2020_public_transport_development_program.pdf) is a joint action between West Göteland Region (http://www.vgregion.se/en/Vastra-Gotalandsregionen/Home/), the Göteborg Region Association of Local Authorities, the City of Göteborg, Vasttrafik (http://www.vasttrafik.se/#!/en/1/), the National Road Administration, and the National Rail Administration.

create solutions were mentioned. In an effort to unveil the current situation of the transport system, which is also an important part of the backcasting approach adopted by the Challenge Lab project, and the varying opinions of the stakeholders on the future of transport system in Gothenburg, this chapter describes a study which particularly attempts to:

- Build a conceptual model of the transport system in Gothenburg.
- Identify perspectives of stakeholders from academia, government and industry on the challenges, barriers and opportunities – the "hotspots"- for a sustainable transport system in the city of Gothenburg.
- Identify the location of these challenges, barriers and opportunities on the conceptual model built.

The study also attempts to reveal the lock-ins and windows of opportunities identified, and suggestions made by the stakeholders in the transport system in Gothenburg.

This chapter proceeds as follows. Section 3.2 gives a review of literature on socio-technical system transition towards sustainable transport system in the urban context under the constraints of continuing global warming. Section 3.3 explains the methods used to conduct the study. Following this, the main limitations to the study are given in the section 3.4. Finally, section 3.5 presents the results of the study.

3.2 Literature Review

As mentioned in the introduction, by this study, it was attempted to disclose the current state of the transport and mobility in Gothenburg in terms of challenges, barriers, and opportunities, which are identified based on the empirical data obtained through the interviews with the key stakeholders of the transport system based on the triple helix concept, which may possibly impede or enable transition to sustainable transport and mobility within the city. However, there are only handful studies which addressed transport and mobility in the urban context within the framework of transition theory (Næss & Vogel, 2012). Therefore, transition research approach is adopted to reveal the importance of understanding of the existing unsustainable regimes in terms of challenges, barriers, and opportunities based on multi-stakeholders' perceptions in socio-technical system transition to sustainable transport and mobility in the urban context. Transition research approach combines methods that are linked to a specific research context and questions (Loorbach, 2007).

Although 'transition' concept was mentioned in the 19th century, the term gained momentum after the World Commission of Environment and Development introduced the term 'sustainable development' in 1987 (Lachman, 2013). Domains like energy, agriculture, water, or transport, which enable life in cities, can be described as socio-

technical systems (Markard et al., 2012). Due to increasing concerns related to (un)sustainability of these systems, many scholars confirmed that a transition, i.e. radical change or transformation in system, towards sustainable alternatives for their maintenance is needed (Kemp, 1994; Farla et al., 2010; Loorbach & Rotmans, 2006; Markard et. al., 2012). Developments taking place in different domains can lead to a transition (Rotmans et. al., 2001). Therefore, there have been many studies investigating transition pathways towards a sustainable future. Not surprisingly, one of the common characteristics of these studies is that they express the importance of stakeholder involvement in the transition processes (Frantzeskaki et al., 2011; Geels, 2012; Grünewald, Cockerill, Contestabile, & Pearson, 2012; Köhler et al., 2009; D. A. Loorbach, 2007; D. Loorbach & Rotmans, 2006; McCormick, Anderberg, Coenen, & Neij, 2013; Nykvist & Whitmarsh, 2008).

There have been different approaches that are used in transition studies. Lachman (2013) reveals the more used approaches as *multi-level perspective, strategic niche management, transition management, innovation systems, techno-economic paradigm,* and *socio-economic metabolism.* Geels (2010) mentions constructivist approaches such as *social construction of technology (SCOT), actor-network theory (ANT),* and *constructive technology assessment* suggested by Genus and Coles (2008), and *technological innovation systems (TIS) approach suggested by* (Markard and Truffer, 2008) to be incorporated into the multi-level perspective (MLP) to complement the MLP. Næss & Vogel (2012) subdivided the transition theory into three directions as *socio-technical approach, complex system view,* and *governance perspective* focusing on transition management. Genus and Coles (2008) consider transitions research divided into two constituent branches, being *systems in transition* – this is identical to socio-technical systems approach with the MLP- and *transition management*. (Markard et al., 2012) mentioned four conceptual approaches to transition studies, being *socio-technical regime* being based on evolutionary economics with insights from sociology of technology; *niche concept* from bottom-up perspective*; transition management* combining complex systems theory and governance approaches; and *technological innovation systems* (TIS) going hand in hand with technology development.

Under the light of these varying approaches, two approaches that are used to study transitions towards sustainability are focused. The first one is the transition management (TM) introduced by Rotmans et al. (2001). The second approach is the socio-technical approach, particularly with the multi-level perspective which is an important concept of transition associated with this approach (Næss and Vogel, 2012). One of the main reason to focus on these two approaches is that both of these approaches consider the multi-level perspective as a framework for improving understanding of the concept of transitions in multi-dimensional socio-technical systems (Geels, 2010; Genus and Coles, 2008; Rotmans et al., 2001). The multi-level

perspective is a rather complex perspective, often requiring many qualitative data to investigate a transition. Furthermore, socio-technical regimes being a broad unit of analysis might be considered as a weakness of this perspective (Geels, 2002); however, this does not cause a problem for the present study since its boundaries are already clear being Gothenburg.

Shortly, transition management is a concept that tries to guide processes that will bring about transition at a societal level into a sustainable direction by governing them (Loorbach &Rotmans,2006). It is an approach for studying transitions, which is guided by multi-stakeholder learning process aiming at exploring tangible ways to intervene in big problems (Frantzeskaki et al., 2011). Covering the TM's definitions of many other scholars like Farla et. al., (2010), Shove and Walker (2007), Rotmans et al. (2001), Smith et. al. (2005), Loorbach and Rotmans (2006), Genus and Coles (2008). Lachman (2013) gives a broad definition in this regard:

> *Transition management (TM) is a reflexive and participative governance concept that attempts to manage transformative change (i.e., influence the speed and direction of change) towards sustainable development by combining long-term thinking with short term action (thus complementing conventional policy) through a process of searching, experimenting and learning.*

Due to the existence of lock-ins and path-dependencies in the present regimes, it is not easy to bring about transitions (Geels, 2010). Given the definition above, transition management then stimulates different stakeholders in different domains to interact with each other in order to be able to turn long-term objectives into shot-term practice based on a shared vision stemming from that interaction. In this sense, it is different from 'blueprint' thinking, which tends to follow rather fixed goals towards a vision (Rotmans et al., 2001). In transition management, long-term objectives are followed by obtaining interim goals through backcasting (see *Figure 3.1*) (D. Loorbach & Rotmans, 2006). Loorbach (2007) gives some of the basic characteristics of transition management approach as:

- Having flexible vision – not necessarily-, long-term objectives as a framework for defining short-term goals and actions based on back- and forecasting[14],
- Involving socio-cultural perspective through enabling participation of multi-stakeholders,
- Using the philosophy of learning-by-doing and doing-by-learning,
- Systems –thinking in terms of multi-level, multi-domains, and multi-actors.

[14] (Lachman, 2013) explains this by clarifying it as a continuous reflection on multi-levels.

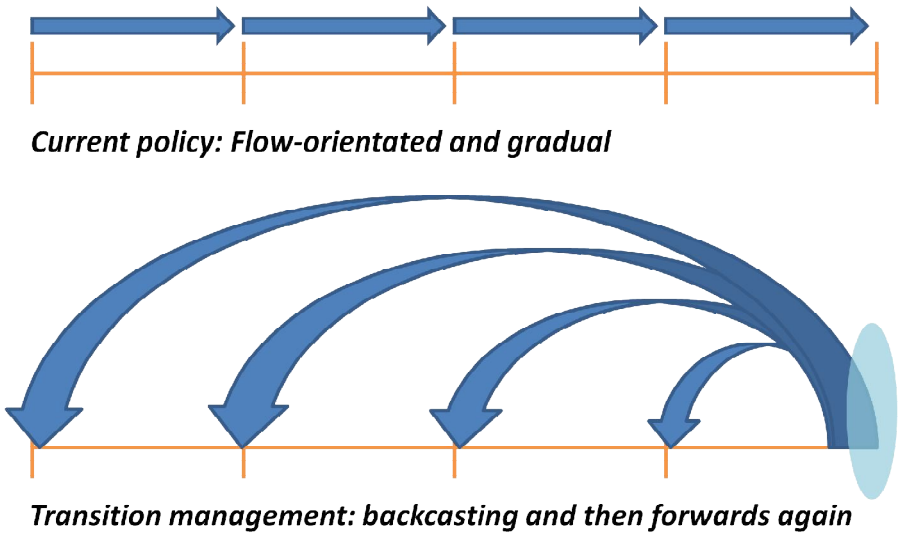

Figure 3.1 Short-term versus long-term policy (adapted from Rotmans et al., 2001)

Transition management is carried out in a cyclical path introduced by Loorbach & Rotmans (2006), which begins with establishing a transition arena that will facilitate the setting of a common vision and transition agenda. The cyclical path follows with executing transition experiments and ends with learning from the process by monitoring and evaluating its execution. Lachman (2013) presented this cyclical path as an execution of transition at three levels which are *strategic, tactical*, and *operational level*. According to this, monitoring and evaluation take place at all levels throughout the process.

As can be seen, transition management is a multi-dimensional goal-seeking process including different stakeholders within a society. Therefore, transition arenas are of great importance (Loorbach & Rotmans, 2006) for transition management in order to create a shared vision and a participatory process (Rotmans et al., 2001). Given these characteristics above, stakeholders' participation and views are one of the most important components of the concept of transition management. (René Kemp, Schot, & Hoogma, 1998) highlights that there is a wide range of factors that present barriers, e.g. inexistence of market for an innovation, to introducing and implementing new environmentally friendly technologies, which impede or slow down transition. The involvement of stakeholders, in this regard, enables a process of social learning (Bagheri & Hjorth, 2006) that results in the ability to understand and address barriers within the transition paths confronted with by the stakeholders, which is an important task for transition management (Farla et al., 2010).

One of the common characteristics of *transition management* and *socio-technical approach* is that they are fed by the interactions between different stakeholders at different levels while bringing about a transition. Geels (2012) describes socio-

technical approach as a broader understanding of transitions towards sustainable development comparing to other approaches. In its understanding of how transitions occurs, socio-technical approach adopts the multi-level perspective (MLP) (Næss & Vogel, 2012).

The multi-level perspective represents an analytical framework to understand transitions to sustainable transport systems, encompassing multiple approaches in order to be able to address interactions between them (Geels, 2012). The MLP, which has been broadly described by scholars like Kemp (1994), Schot et. al. (1994), and Geels (2011), views transitions as the outcomes of developments at multiple level, which are aligning with each other (Geels & Schot, 2007). These levels are described by Geels (2011) as *niche level,* places for radical innovation; *socio-technical regimes*, practices and rules that stabilize existing systems; *socio-technical landscape*, representing macro drivers and barriers to transition (Whitmarsh, 2012).

To this end, Geels (2002) explains that these different levels are heuristic concepts that help understand the complex dynamics of socio-technical transitions. Four characteristics of the multi-level perspective, in this regard, are given by Geels (2012); a) it has a systemic, co-evolutionary approach which enables to understand that transitions are driven by multi-actors and involve developments within the multi-levels; b) it employs non-linear relationships within the three levels; c) it enables radical change to occur while encompassing stability, lock-ins, and resistance to change; d) it adopts an actor-based approach focusing on objectives, perceptions, and actions between, for example, car owners, transport planners, city planners, and citizens, mainly stakeholders of transport system in this example.

Therefore, Geels (2012) suggests that transport research should also take into consideration multiple perspectives in order to be able to understand the complexities of current mobility. It is a relevant suggestion given focus of the socio-technical approach on actions of individuals and groups (Marletto, 2014).

Given the literature on transition management and socio-technical approach with the focus on the multi-level perspective, it is then evident to say that stakeholders are important drivers of transitions in the existing regimes. This is mainly because of the fact that it is social groups – actors embedded in social groups in another sense (Geels, 2004)-, e.g. those in Fig.1, operating within the multi-levels- that create and maintain the functioning of socio-technical systems (Geels, 2004, 2010). According to the multi-level perspective, transitions occur through interactions not only between these social groups but also between processes at the three levels (Geels & Schot, 2007). Through their activities, they either aim to bring creativity and innovation to an element or seek for improving a new element already introduced (Geels, 2002).

However, it should be kept in mind as well that some activities of some stakeholders might be the cause of impediment for transition to sustainability to occur.

Furthermore, Geels (2002) also states that transition can take place when there is a linkage and reinforcement between developments at multiple levels. Notwithstanding stakeholders operating in different environments filling a different niche at the micro level, it is this interdependency and interaction between these stakeholders that enables the existence of linkages between sub-systems (Geels, 2005). Therefore, it is important to understand the challenges that these actors face in the process of transition endeavour and the opportunities they identify. Inherently, challenges and barriers confronted with by stakeholders may be well preventative for such linkages and reinforcement to occur.

In this regard, stakeholders at the urban level may contribute to achieving transitions by, for instance, supporting radical niche projects (Geels, 2012). Given their impact on the global sustainability, e.g. increasing impact on the climate change, urban areas – cities- and sustainability go hand in hand. A major share of issues related to (un)sustainability find their origin in cities (Nevens & Roorda, 2014). However, while cities may be the cause of several global issues, they also present opportunities (Weinstein, 2010) to overcome these issues. Therefore, there has been a focus shift towards cities due to the slow pace of action on societal challenges at regional, national and global levels as well as the local actors' ability to turn agreements into actions. Furthermore, the modern understanding of urban life, which strives for attractive, flexible, and sustainable cities, makes it important to address sustainability transition at the urban level (McCormick et. al., 2013).

In this regard, new forms of communication and dialogue between different stakeholders is required for a sustainable city to become a reality rather than a goal (Banister, 2008). Lindholm (2010) denotes that to address the challenge of achieving sustainable urban transport depends on interaction between stakeholders. However, equally important is to address challenges and barriers that stakeholders face, given the fact that actors are restrained by regulations and societal rules (Geels, 2012), which might also present opportunities as well as barriers.

3.3 Methods

The main objective of the present study is to disclose the current challenges, barriers, and opportunities in the transport system in Gothenburg. Therefore, with a descriptive, exploratory qualitative approach, an empirical research based on the primary data stemming from the opinions of the key stakeholders of the transport system in Gothenburg was performed. The Challenge Lab Process methodology used

in this project helped identify the stakeholders based on the triple helix concept. 21 key stakeholders, including 1 non-governmental organization, that are represented in the triple helix – academia, industry, and government- were identified for the next step which was the data collection. Each of the interviewees have been involved in research on the transport system or held a relevant position in the public or private sector dealing with the transport system.

Following the identification, electronic mails which briefly explained the Challenge Lab, and the purpose of the thesis, were sent out to all 21 stakeholders, with a couple of them being sent twice. In order to have an in-depth understanding of the current state of the transport system, the key stakeholders identified were interviewed based on the standardized open-ended interview method. The interview questions (see Appendix A. Questionnaire for the interviews) were designed to be asked face-to-face and sufficiently open-ended to enable the interviewees feel able to express their opinions within the scope of the interview. According to Turner (2010), this method of interview is rather structured in terms of the framing of questions. The interviewees were asked identical questions; however, the open-endedness of the questions enabled them to fully express their experiences and viewpoints regarding the issue at hand, which is the transport system. The authors were also able to ask probing follow-up questions, thanks to this open-endedness.

The stakeholders were asked 10 questions that were in accordance with the main objective of this study. The interviews were held either at the Lab or at the offices of the interviewees between the 5th of April, 2014 and the 20th of May, 2014. In order to save complete answers of the interviewees to the questions asked, two voice recording equipments were used during the interviews. In addition to the voice recording, the authors also took notes simultaneously using the question sheet printed for each interview. Before each interview started, the steps below were followed:

- Explaining the format of and the purpose of the interview
- Indicating how long the interview on average takes
- Giving the interviewees the contact details in case they want to get in touch later
- Asking them if they had any questions
- Asking whether the use of voice recording equipment was possible

The interviews were also benefited as to co-develop a conceptual model of the transport system in Gothenburg. The initial version of the model, including the elements such as personal and freight transport needs, infrastructure, transport means, and fuels, was inspired by the design thinking step that took place in the Phase I (see Section 2.2.5). Furthermore, the model was improved through the feedback from the interviews held at the Challenge Lab, and the analysis of the data.

The answers of the interviewees were analyzed based on the following steps:

- *Data collection.* The interviews were recorded by voice recording equipment.
- *Transcription and sorting of the data.* A matrix containing the statements of the stakeholders was created on an Excel sheet to facilitate the next steps of the analysis. The following definitions of challenge, barrier, and opportunity were the basis of the sorting:

  Challenge: *"The situation of being faced with something that needs great mental or physical effort in order to be done successfully and therefore tests a person's ability"* Cambridge dictionary

  Barrier: "*Anything that prevents progress or makes it difficult for someone to achieve something*" Macmillan dictionary

  Opportunity: "*A favourable or advantageous circumstance or combination of circumstances*" The Free Dictionary
- *Coding the data*. The statements of the stakeholders were grouped according to their similar content. For the sake of the ease of understanding the results, the groups were named with short titles representing the synthesis of the statements to classify them, e.g. the text in the *challenge* column on *Table 3.2 Main challenges identified*.
- *Categorizing the themes*. Challenges, barriers, and opportunities were categorized according to the depicted conceptual model.

Of 21 stakeholders from the three sectors, i.e. academy, industry, and government, to whom the request for an interview was sent, 10 stakeholders, corresponding to slightly less than 50% of these stakeholders responded our request for an interview positively. This is rather a representing number and demonstration of the successfulness of use of the method, given the time constraints. The distribution of the stakeholders according to the sectors they represented is as follows: 6 from government, 2 from industry, and 2 from academy. Due to their time constraints, 3 of those interviewed stakeholders could not respond all of the interview questions during the interview; therefore, were sent another request to complete the missing interview questions online. The duration of the interviews with these key stakeholders varied and lasted 60 to 110 minutes.

3.4 Limitations of the study

The present study was performed in a time period of only 2 months and is based on the interviews done with 10 stakeholders from the following organizations:

- Academia
  - Chalmers
- Industry
  - UbiGo project

    - Business Region Göteborg
- Government
    - Västra Götastadlandsregionen
    - Göteborgs Stad
    - Trafikkontoret
    - Västtrafik
    - Trafikvervet
    - Political party

3.5 Results

This section presents the identification of the challenges, barriers and opportunities in the transport system of Gothenburg according to the opinion of the different stakeholders interviewed, highlighting the remarkably converging opinions – also referred to as *main opinions*- in this regard. Moreover, the locations of these challenges, barriers, and opportunities are also shown on the conceptual model of the transport system. The interviewees' opinions regarding a common vision of sustainable transport system in Gothenburg are revealed as well.

Furthermore, lock-ins and windows of opportunities in the current transport regime – also referred to as *socio-technical regime*- identified by the stakeholders can be found in the Appendix C. Lock-ins identified and Appendix D. Windows of opportunity identified, respectively. Interestingly, without any questions asked in this regard, the stakeholders gave some suggestions regarding the possible improvements for the current transport system. These suggestions can be found in Appendix E. Suggestions of improvement for the transport system in Gothenburg.

3.5.1 The conceptual model of the transport system

The conceptual model co-developed with the stakeholders, which depicts the different elements of the transport system of Gothenburg (see *Figure 3.2*), is composed of the following elements:

- *Regional development* refers to external projects carried out at the regional level, which have an influence on the entire transport system in the city.
- *Urban planning* implies the activities related to the physical development of the city.
- *Mobility needs* refers to the movement of both people and goods.
- *Transport of people* refers to commuting, leisure, business trips, access to services, and shopping
- *Transport of goods* refers to from store to use, from warehouse or distribution centre to store or use, through Gothenburg, and transportation of waste.
- *Infrastructure* includes the basic physical structure needed to run transport in the city as well as its property, e.g. national, municipal or private.

- *Transport means* refers to the different modes of transport used to perform transportation of people and goods such as walking, bicycle, motorcycle, car, bus, truck, tram, train, ferry, ship, and plane
- *Transport fuels* are the fuels that are used to run the means of transport, e.g. man-power, animal-power, fossil fuels, biofuels, electricity, and hydrogen.
- *Governance* refers to the policies and regulations that shape the transport system in Gothenburg.
- *Management* considers the daily administration of resources such as human, economic, technical, and natural.
- *Innovation and research* includes the emerging projects and researches related to the transport system.

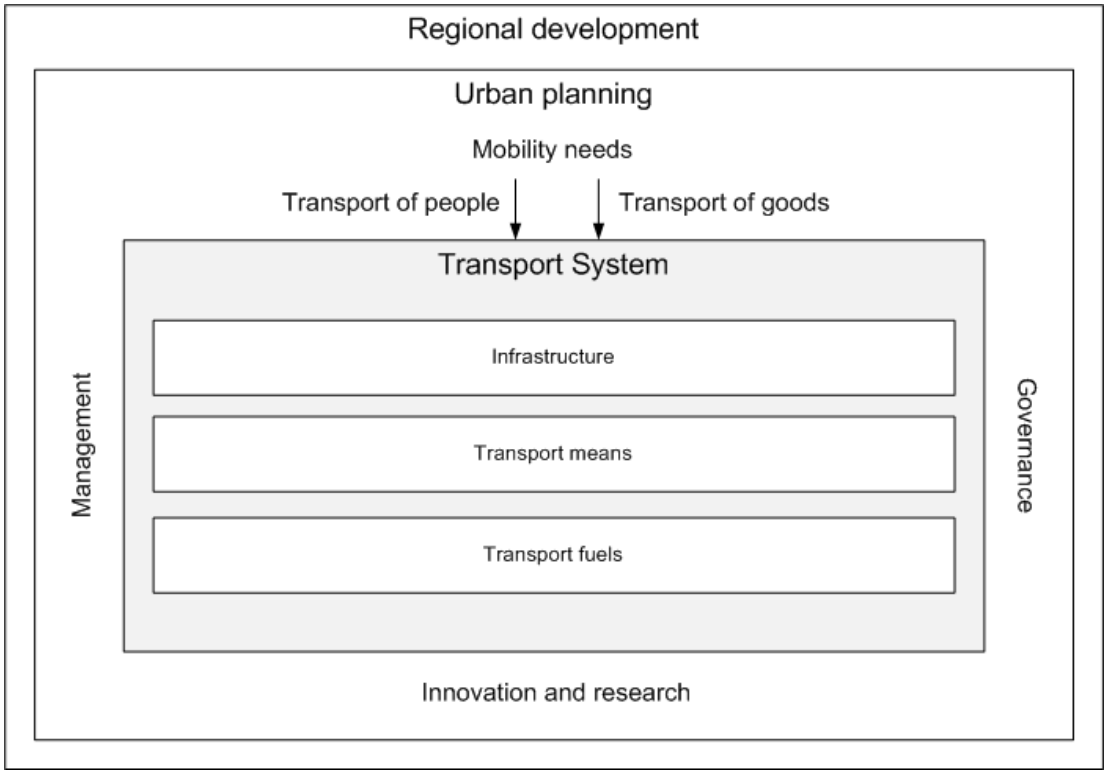

Figure 3.2 Conceptual model of the transport system

3.5.2 Challenges

The stakeholders mentioned varying challenges that they observe in the path towards sustainable transport system. In total, the stakeholders interviewed mentioned 29 challenges in this regard, which can be found in *Table 3.1* (see *Figure 3.3*).

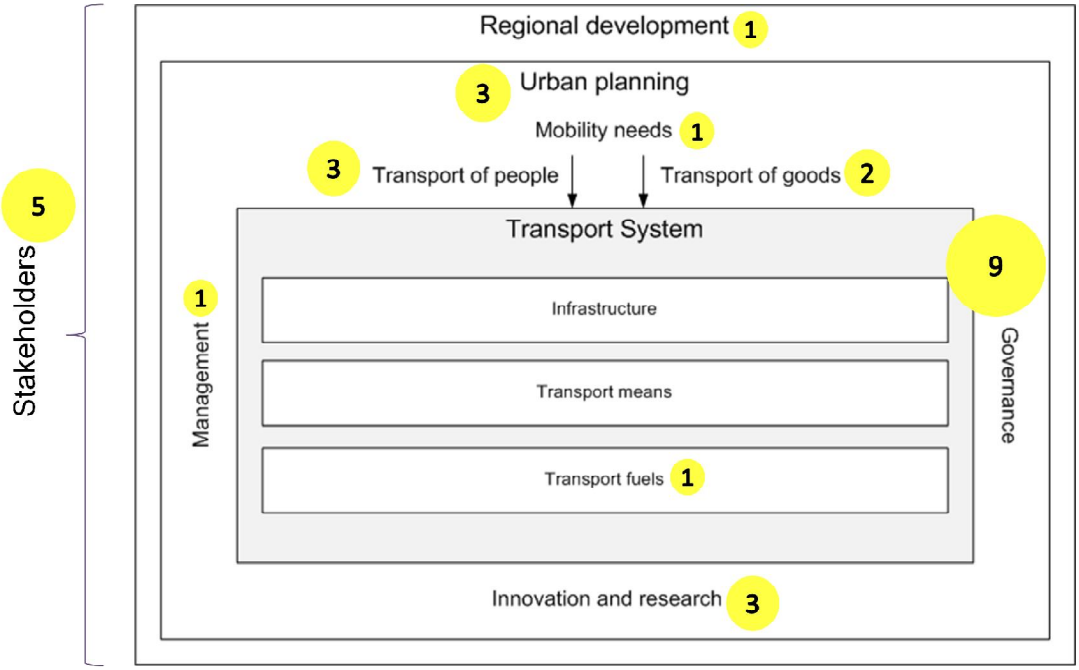

Figure 3.3 Distribution of challenges in the transport system

It was observed that there were challenges identified in both socio-technical landscape, e.g. *build an attractive city,* and socio-technical regime, e.g. *provide a reliable public transport system*, and niche level, e.g. *integration between technical solutions,* according to the multi-level perspective. It is highly possible that these challenges are not the only ones that the stakeholders confront with in their daily work. Of these 29 challenges identified, those that are mentioned by several stakeholders and more conspicuous will be mentioned.

Table 3.1 Challenges identified in the transport system

Category	Challenge	Mentions		
		Academy	Industry	Government
Regional development	Integration of sustainability and systems perspective in different levels of political goals and proposals		1	
Urban planning	Increase the consideration of transport related issues and long term perspective in the city planning process	1		4
	Build an attractive city			1
	Current design of the city and suburbs promote the use of car for personal		1	1

Category	Challenge	Mentions		
		Academy	Industry	Government
	transportation			
Mobility needs	Integration between technical solutions		1	1
Transport of people	Provide an easy-to-use public transport paying system, considering fair fees for users			3
	Manage travel needs of the greatly increase of inhabitants, commuters and visitors in the city			2
	Change in social behavior regarding the ownership and use of cars			1
	Provide a reliable public transport system			1
	Provide mobility for all			1
Transport of goods	Increase awareness in the political arena on the importance of addressing current sustainability issues in the shipping sector	1	1	
	Increase the energy efficiency of freight transport			1
Stakeholders	Combination of business competences for creating solutions		1	
	Common understanding of what is a Sustainable Transport System	1		
	Understanding of the challenges towards sustainable development by the stakeholders	1		

Category	Challenge	Mentions		
		Academy	Industry	Government
	Communication and collaboration between stakeholders towards sustainable development	1	1	4
	Comprehension of the different roles of stakeholders and the need of their existence			1
Transport fuels	Reduction in the use of fossil fuels for transportation			2
Innovation and research	Create the conditions for having the education and research that is needed to address the challenges	1		
	Innovation only happening in specific elements of the system		1	
	Market development of new sustainable technological solutions for being considered as viable	2	1	
Governance	Integration of sustainability perspective in procurement decisions of governmental organizations		1	3
	Effective communication between decision makers and general public regarding the benefits when implementing solutions			2
	Integration of sustainability and systems perspective in different levels of political goals and proposals			2
	Introduction of a sustainability perspective for the design of economic regulations supporting sustainable solutions			2

Category	Challenge	Mentions		
		Academy	Industry	Government
	Change current regulations supporting and/or promoting the use of cars			1
	Getting support from citizens and industry for the sustainable solutions put forward by government			1
	Listen to perspectives from different stakeholders when setting goals and strategies			1
	Political approach of predicting and providing, which is based on short term goals		1	1
	Traduce the strategies and goals to immediate actions to be executed by the stakeholders of the system in their day-by-day work			1
Management	Optimization of the resources in city planning			1

However, some patterns in their answers have also emerged while making the analysis of the interviews. It was then possible to accumulate these salient challenges under the following sub-titles.

Table 3.2 Main challenges identified

Category	Challenge	Academy	Industry	Government	Total of mentions
Stakeholders	Getting stakeholders collaborate	1	1	4	6
Urban planning	Integration of transport planning into the city planning	1		4	5
Transport of people	Providing reliable public transport			3	3

Category	Challenge	Academy	Industry	Government	Total of mentions
Innovation and research	Introducing new technologies	2	1		3

Getting stakeholders collaborate. It would not be wrong to say that the involvement of the stakeholders may also be considered as a barrier to functioning of socio-technical systems. However, it is considered as a challenge in the present study. The main reason to this is that this answer was given by the stakeholders interviewed to the question regarding the challenges that they see in the current transport system. The majority of the stakeholders expressed that it was a challenge to get different stakeholders come together to discuss around issues regarding the (sustainable) future of the transport system, especially in the early stage of decision-making processes. In this regard, by underlining the significance of this challenge, a stakeholder from government remarked:

> *Responsibility for providing mobility is really spread out in so many stakeholders. Urban administration (is taking on the responsibility for) walking, biking, cars in the city, e.g. parking; VGR (is working on) public transport; National Transport Authority (deals with) main road infrastructure and railway infrastructure. All these stakeholders need to work together*

Several stakeholders also mentioned that it is important to address this challenge in order to avoid excluding any perspective while making a decision.

Integration of transport planning into the city planning. There seems to be a cross-sectoral consensus on including transport planning into the planning process of the city as almost all the stakeholders commented. In this regard, an stakeholder from government sector mentioned 'divided planning', meaning that transport efficiency is excluded or seen separated from the city planning. A different stakeholder from industry sector added to this perspective by commenting that not only is a challenge to integrate transport planning in the planning process starting from the beginning, but also the integration of different system, e.g. ICT, business models, infrastructure, city planning.

Providing reliable public transport. Several stakeholders from the government remarked challenges regarding the provision of sound personal and freight transport under the circumstances of an increasing demand for them in the city, although the stakeholders from academy and industry did not mention it. Challenges in this regard were mainly shaped around how to meet the travel needs of and provide sound infrastructure for increasing number of population, how to properly manage the land-

use for increasing housing and for the goals of the city with regard to, for instance, doubling public transport and biking in Gothenburg. In addition to these challenges, following challenging questions regarding increasing demand for transport were posed by those stakeholders who mentioned this challenge: "Who is going to pay for it? Is the region prepared to pay for the doubling of the public transport?". It was also remarked that the increase in population will have a reinforcing effect on this challenge given the fact that the goods providers are to make supply based on demand.

Introducing new technologies. Another challenge identified by several stakeholders from academy, industry, and government was to introduce new systems or technologies that could be alternatives replacing or 'greening' the existing unsustainable socio-technical systems. A few of stakeholders also underlined the challenges of improving current systems by increasing energy efficiency on, for example, road transport in this sense. There are several barriers identified to this challenge, and those will be mentioned under the 'barriers'. A stakeholder from industry mentioned as a challenge the introduction of new business models which will, for example, create alternatives use of existing transport efficiently. Another stakeholder from industry further remarked that the creation of market for innovations in the local (urban) context, which can help bring sustainability transition in the city, was challenging and added:

> *Politicians need to secure that there is a market for the new innovations because sometimes they forget that part, they set a goal or spend a lot of money trying to get companies to innovate (new things) but they don't implement in the public sector the ideas of that innovation, so there's no market for the innovation and it just disappear. They need to work on both things, to guarantee since the beginning that there's a demand for that innovation on the local market. If you don't apply it in the local market, it will not be successful in the global market. For example, (considering) Volvo Buses, they decided to go for electrical buses (referring to the ElectriCity[15] project) or the liquefied methane for goods transportation. The ideal market for them is not in Sweden, there's no demand for those vehicles here (in Gothenburg).*

In addition, the stakeholders from government and academy also commented that it was a challenging task to make other means of transport attractive and, thus, alternative to using a car in the city.

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[15] A new electric bus-service initiative that was launched by the Volvo Group in cooperation with the City of Gothenburg (the Local Government), Göteborg Energi, Vasttrafik, Lindholmen Science Park, and Johanneberg Science Park. http://www.volvogroup.com/group/global/en-gb/_layouts/CWP.Internet.VolvoCom/NewsItem.aspx?News.ItemId=143388&News.Language=en-gb. viewed in 28.05.2014

3.5.3 Barriers

The stakeholders interviewed expressed many barriers both to the challenges they identified and to achieving sustainable transport system in the city in general. In total, the stakeholders interviewed commented 33 barriers that they see precluding the current transport system to be sustainable. These barriers are presented in *Table 3.3*. Furthermore, their distribution on the conceptual model is shown in the *Figure 3.4*. Just like presented under the 'challenges', the dominant, or main, barriers will be mentioned under the following sub-titles. By 'dominant barriers' (see *Table 3.4*) the authors refer to the barriers that were mentioned by several stakeholders, showing a pattern in the answers of the stakeholders.

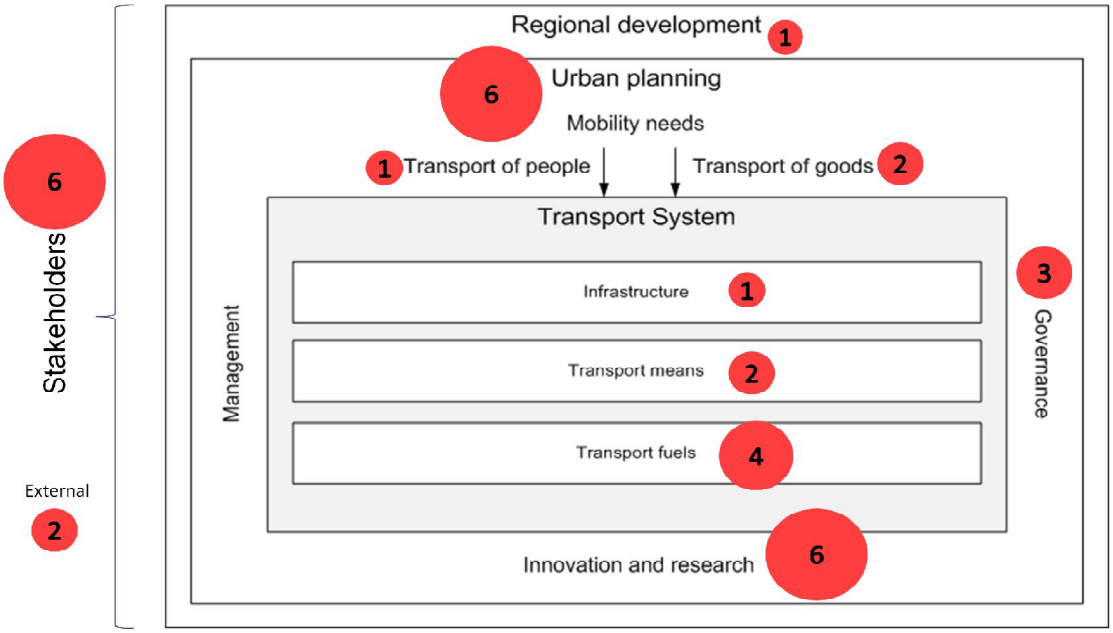

Figure 3.4 Distribution of barriers in the transport system

Table 3.3 Barries identified in the transport system

Category	Barrier	Mentions		
		Academy	Industry	Government
Regional development	Competence for resources between regions			1
Urban planning	Car use is promoted by the design of the city in some areas		1	1
	City planning ideas/projects take a lot of time to be implemented.			1

Category	Barrier	Mentions		
		Academy	Industry	Government
	It takes a long time for ideas and projects to be executed, when they come from city planners		1	1
	Lack of human resources dealing with city planning			1
	Limited space in the city	1		5
	Physical characteristics of the city and its weather limit possible solutions to be implemented			1
Transport of people	There is no effective way of communicating the citizens regarding issues affecting their mobility in the city			1
Transport of goods	Freight transport sector is having a conservative posture and not so much change	1		1
	Sustainable solutions are not being implemented in the shipping sector		1	
Stakeholders	Dialogue between key stakeholders rarely happens		1	2
	Different stakeholders pursuing different goals, having different opinions around the solutions to implement and focus		1	4
	Lack of leadership between organizations to achieve the settled goals by politicians			2
	Lack of understanding and awareness on the problems		2	2
	Resistance of population to change		1	2
Infrastructure	Non existing infrastructure for electrical vehicles	1		
Transport means	Driving and using a car is cheap		1	1

Category	Barrier	Mentions		
		Academy	Industry	Government
	High importance and power of the car industry in the city	1		2
Transport fuels	Biomass majorly used for district heating Use of biofuels is not promising		1	
	Fossil fuels are cheap in comparison to other alternatives	1		
	Resources already invested in certain technologies might limit the consideration of other (even better) alternatives			1
	Use of biofuels is not promising		1	1
Innovation and research	Academia lacks of knowledge on field, day by day problems. Is not currently involved			1
	Future actors in the Sustainable Transport System don't have a voice yet in the discussions	1		
	High focus on solutions that can be provided by local companies	1		
	Innovative sustainable solutions have problems to develop in the local market		2	
	Lack of awareness of new solutions and understanding of the benefits	1		
	Resources for research in academy are limited and require of approval	1		
Governance	Lack of systems perspective		2	1
	Ministry of finance has a lot of power in the decision making, currently having a more traditional development approach			1
	Policy for system change is politically difficult to motivate			1

Category	Barrier	Mentions		
		Academy	Industry	Government
	Political proposals depend on voters opinions and sometimes are not good (or brave) enough to address the challenges	1	1	3
External	Physical characteristics of the city and its weather limit possible solutions to be implemented			1
	Time pressure			1

Limited space in the city. The stakeholders from government and academy indicated that the limited space available for transport was an important barrier to achieving the goals, e.g. doubling public transport, for reaching sustainable transport. In this regard, a stakeholder from government strongly expressed that to provide sound public transport required a lot of space. Similarly, an stakeholder from academy mentioned that the Local Government was "*competing for space in order to increase walking and biking (in the city)*".

Differences in understandings, roles, and goals. The majority of the stakeholders continuously brought up the concerns regarding different stakeholders having different mindsets that lead to different understandings of the challenges. Several stakeholders highlighted that there were different goals and agendas regarding sustainable development in general as well as the transport system among the stakeholders. The stakeholders who mentioned this difference as a barrier made striking comments. For example, by further having a broader perspective a comment made by a stakeholder from government was far-reaching:

> *Science is not (out) in the field. They just say what the problem is and focuses on the opportunities. (...) (Therefore) some politicians think that more transport is needed, that it is good for economy to have more transport; (however), they have not learnt the lesson that more transport is not sustainable, as many scientists agree... (...) Those who deal with economic development are different than those who deal with sustainable development* (modified by the authors). *(The) usual for (the) economic development people are to say to the sustainable development people "keep on with the environmental stuff and we keep up with the core business, do not interfere too much with our business"*

Table 3.4 Main barriers identified

Category	Barrier	Academy	Industry	Government	Total of mentions
Urban planning	Limited space in the city	1		5	6
Stakeholders	Differences in understanding, roles and goals		1	4	5
Governance	Politicians' fear of loss	1	1	3	5
Stakeholders	Lack of understanding and awareness of the problems		2	2	4
Stakeholders	Short sightedness of stakeholders		2	2	4
Stakeholders	Lack of dialogue		1	2	3
Transport means	Power of automotive industry		1	2	3
Transport means	Ease of car use	1		2	3

Politicians' fear of loss. It was mentioned by several stakeholders from government and academy that the dependency of the future of politicians on their voters presented an important barrier to turning goals for sustainable transport into necessary action. The stakeholders pointed out that political proposals depended on the opinions of voters in general and that these proposals are sometimes not good (or brave) enough to address the challenges. A stakeholder from government – a representative of a political party- stated that politicians would not take an action to the ground if there were many citizens not liking an idea that would otherwise be changed by that action, and that this cause politicians to fear of making decisions in favour of that action.

Lack of understanding and awareness of the problems. This barrier was mentioned only by the stakeholders from industry and governments. The stakeholders made striking comments in this regard. A stakeholder stated:

> *People that execute the day-by-day business are not involved in developing strategies (for sustainable transport). They do not understand, they do not care or they do not know how those strategies would impact the daily work. They continue with business as usual. (...) (They think that) environmental problems can be fixed with enough money afterwards.*

Alike, another stakeholder from government remarked:

> *Politicians do not think carbon dioxide is a big problem; (therefore), they do not want to deal with it. They gave the target of reducing carbon-dioxide; (however), they did not meet their own targets. They just block it out. (They think that) Sweden did so much already, (asking) why it should do more than the rest of the world. People (do) not see the climate challenge, and will not see (it) either. The decisions about infrastructure, (for example), are having a direct (impact on the (un)sustainability of the transport system). (They do not understand that) more road infrastructure lead (directly) to more use of cars. They continue investing in infrastructure.*

On the contrary and interestingly, another stakeholder from government indicated, regarding the construction of infrastructure, that more infrastructures, including bridges, even maybe metro, should be built.

Stakeholders' traditional way of thinking about transport planning and executing business was also uttered by several stakeholders as a barrier. A stakeholder pointed out, in this regard, that, for example, companies operating in the freight transport sector are more into traditional way of thinking about the future as they need to make economic gains out of their work.

Short-sightedness of stakeholders. Several stakeholders, including both academy and industry and government, mentioned that there was a lack of long-term, systems thinking perspective, emphasizing the short-sightedness of politicians. According to the stakeholders, politicians' approach to societal issues from a short-term perspective was an important barrier to well-functioning of the transport system as well as socio-technical systems in general. A stakeholder from government said that the politicians changed once in every four years; therefore, they tended to deal with issues having a short-term perspective. Likewise, a stakeholdder from industry emphasized concerns about the political system in this regard, underlining the lack of long-term view of politicians remarking that "*vision is led by 4-year budget; and, elections are not won by visions"*. The stakeholder further mentioned that *"citizens also only saw the immediate cons but missed the benefits of the long-term planning"*. It would be fair to say that this might hinder some actors, especially those taking part in policy-making, from making long-term plans in general.

Another barrier mentioned by several other stakeholders in this regard was the short-sightedness in the sense that the actors in the system in general, including the transport system, was lacking a systems perspective which then, in the opinion of an stakeholder from industry, might cause the actors to miss the interrelation between the transport system and other systems, e.g. the energy system.

Interestingly, a stakeholder from government – a representative of a political party-, on the contrary, stated:

> *Planning for a very long term is not that (useful) because (a lot of improvements) will happen during the way. (Specifically) the rapid development of technology might cause a problem for infrastructure planning. It takes a long time for the ideas to be put in place. For example, the roads that were built in the previous years are not working well now when the city wants to be more walkable.*

Lack of dialogue. Many the stakeholders remarked that the efforts made around reaching to sustainable transport system was lacking dialogue between the actors in the system. Considering the statements of these stakeholders, it was evident that lack of collaboration was a big barrier to the challenge of getting the stakeholders around the same table to discuss about issues regarding (un)sustainability of the transport system.

A stakeholder from government said that those actors who actually had the capability of making a difference seldom sat down and talked together. Additionally, a stakeholder from industry expressed the need for dialogue between the actors, underlining that innovation on specific components of the transport system such as fuels, vehicles, and engines might not be enough. Similarly, a stakeholder from academy also mentioned that the involvement of the stakeholders, e.g. politicians, residents, planners, industry etc., was also needed for freight transport.

Power of automotive industry. There were several stakeholders representing academy, industry, and government who mentioned barriers stemming from the current state of the car manufacturing companies. Of those stakeholders who regarded automotive industry as a barrier, the stakeholders from government expressed the power of car manufacturers associating this with the ability of these companies to create jobs. In this regard, a stakeholder from government stated emphasizing that:

> *Car producers (today) are powerful and lobby to stop the currently sick economical system, and, (thus), the market from changing. Market will change only if the economical system changes. (...) They (meaning the car manufacturing companies) need to be heard because they are big employers (...).*

A stakeholder from industry pointed a value-action gap in the automotive industry remarking that although car manufacturing companies could understand that politicians and city planners (in the city) wanted to increase the share of walking and

biking in the personal transport by focusing on creating a denser city, " (...) *they still want people to use vehicles (as) their job is to sell cars"*.

From academy, a stakeholder mentioned that automotive industry was very short-term oriented, focusing on traditional research, which is mainly on cars. The stakeholder continued expressing concerns regarding R&D activities carried out by automotive industry, stating:

> *(...) Automotive industry in the country has a lot more money (half a billion SEK) for research on transport than the academy has at their disposal. (...) Academy tries to influence that program (referring to traditional research) and challenge it. Since the academy is also involved in research in this regard, this (traditional research) also influences us and has an impact on the city. For example, if they have a lot of researchers investigating diesel, (then) they will have knowledge about diesel.*

The stakeholders having mentioned this barrier seemed to have reached to an agreement on that the automotive industry was having a strong influence on the transport sector/system in the city.

Ease of car use. It was expressed by many stakeholders, including academy, industry, and government together, that it was easy and cheap for people to use car, which make them not to prefer other means of transport. A variety of underlying barriers was mentioned by the stakeholders in this regard. One of these barriers, which was mentioned mainly by the stakeholders from government, was the existence of economic subsidies that is possibly one of the causes lowering the cost of using a car. They also remarked that they "*could not get new technology and biofuels by subsidizing car travel"*. In addition to the economic subsidies, an stakeholder from academy called attention to the cheapness of fossil fuels. The stakeholder said that, currently, the fossil fuels were very cheap to use, which made it difficult for a new technology to compete with the technologies ran on fossil fuels.

Barriers related to ease of car use are not limited to economic reasons. Additionally, urban design was also mentioned by several stakeholders, mainly from government and industry. In this regard, the stakeholders indicated that the city was outspread with residential areas outside of the city and car-dependent. This, in their opinion, made it difficult for the public transport providers to bring residents of these areas the transport service. By attributing this to the stabilized car regime in the city a stakeholder from government stated:

> *Living areas are outspread. (Therefore), it is difficult to serve with the public transport. (On the other hand), it is easier to go everywhere by cars. In Gothenburg, we build cars. It has been in the interest of Volvo and the City, i.e. the Local Government, that people are buying and driving cars. People*

are allowed to live far away from the good public transport. A lot of people are living in places where it is difficult to maintain their lives with the public transport and bicycles...

Interestingly, a specific barrier, though very relevant, was brought up by another stakeholder from government. The stakeholder mentioned that (shopping) malls outside of the city represent an opportunity for people to use their cars.

3.5.4 Opportunities

As of opportunities taking place in the city regarding sustainable transport, the stakeholders uttered 20 opportunities in total which, in their opinion, would have a positive effect on sustainability transition of the transport system. These opportunities and their distribution on the conceptual model are presented in *Table 3.5* and *Figure 3.5*.

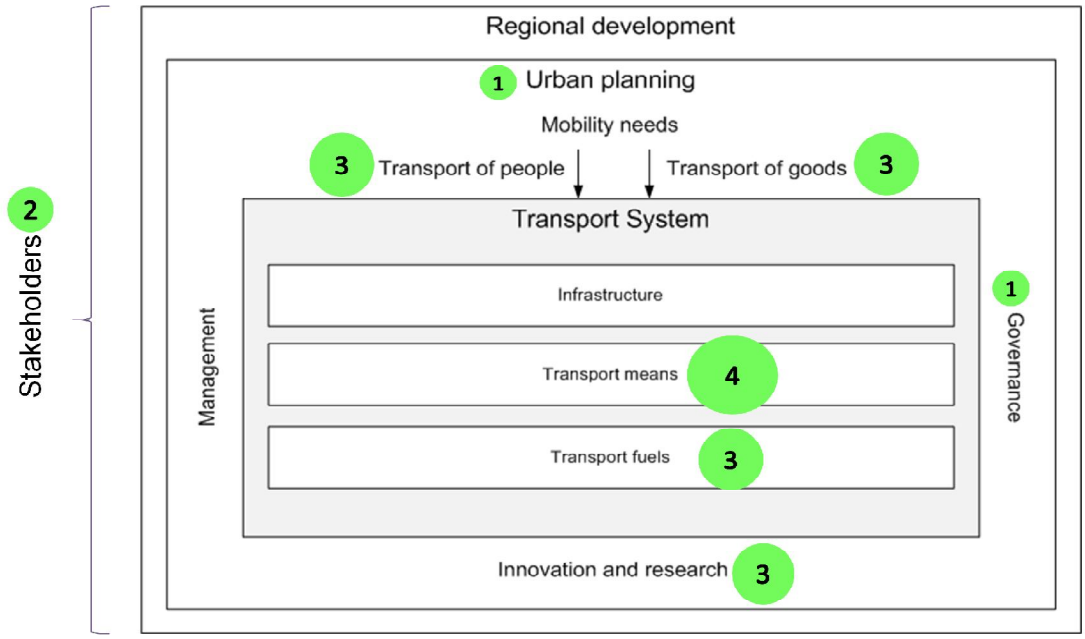

Figure 3.5 Distribution of opportunities in the transport system

Table 3.5 Opportunities identified in the transport system

Category	Enabler	Mentions		
		Academy	Industry	Government
Urban planning	Good strategy for city development (housing, new infrastructure, etc.)	1		

Category	Enabler	Mentions		
		Academy	Industry	Government
Transport of people	Development of electrical buses for the public transport sector		1	1
	Free use of public transport for young people can influence them for not considering using or having a car in the future			1
	Multiple benefits could come from the congestion fee project			1
Transport of goods	Freight transport can be improved by the projects related with the harbor			1
	Good regulations for city distribution and freight transport			1
	Increasing efficiency for city distribution			1
Stakeholders	A sustainable attitude is emerging among population, especially young people. Awareness of the transformation need.	1	1	2
	Collaboration an trust between stakeholders is increasing and improving	2		3
Transport means	Driverless vehicles could connect vehicles and roads in new way	1	2	1
	Existence of good vehicle technology	1		
	Regulations could increase the use of hybrid vehicles			1
	Strong car industry can create new ideas in collaboration			1
Transport fuels	Introduction of subsidies for alternative fuels			1
	Possible demand increase of biofuels			1
	Regulations could increase the production and use of (drop in) biofuels			1
Innovation and research	Academy participating in a more direct and practical way to address challenges	1		2
	Sweden has a tradition of being in the front when it comes to sustainability and innovation		1	1

Category	Enabler	Mentions		
		Academy	Industry	Government
	The city is testing many new technologies and ideas, willing to identify the successful ones and possibly scale them up, adapting them or even rejecting them	1	2	4
Governance	Politicians awareness on the problems is increasing and could lead to better decisions			2

Similar to the previous sections, the opportunities that were mentioned by several stakeholders are going to be shown under this section (see *Table 3.6*).

Table 3.6 Main opportunities identified

Category	Enabler	Academy	Industry	Government	Total of mentions
Innovation and research	City as a test bed	1	2	4	7
Stakeholders	Increasing collaboration and trust	2		3	5
Stakeholders	Behavioral change among young people	1	1	2	4
Transport means	Driverless vehicles	1	2	1	4

City as a test bed. Among the stakeholders there seems to be a broad understanding of the city used as a testing area where different kinds of solutions regarding the (un)sustainable transport system could be tried out. Almost all of the stakehodlers interviewed remarked that the city presented an important opportunity with regard to making transport system sustainable as there were new projects for developing new technologies and ideas being tested in both personal and urban freight transport.

An stakeholder from government indicated that to have the city as a trial ground was ‘a good way of getting new ideas industry, which the Local Government could not otherwise develop’. The stakeholder further mentioned that this presented an opportunity both for being able to try to integrate new technologies for sustainable transport and for evaluating their success before scaling them up and for being able to make more efficient use of the land. In this regard, calling attention to Gothenburg

being a special city accommodating a harbour and strong automotive industry, a stakeholder representing academy also mentioned that to have Gothenburg as a testing city would also enable the stakeholders to make wiser investments and procurements with regard to sustainable transport. A stakeholder from industry highlighted that these new projects would bring decision makers together in a different way to talk and listen to each other.

Increasing collaboration and trust. Half of the interviewees, encompassing all the three stakeholders, i.e. academy, industry, and government, mentioned that the existence of collaboration and trust between the stakeholders as an important opportunity to solve problems and overcome barriers in the transport system in Gothenburg. A stakeholder from government uttered that the collaboration between the Local Government, Västtrafik, and Volvo enabled these actors to collectively develop and test new ideas. A stakeholder from academy indicated that the industry changing its approach from lobbying to negotiating was effective in increasing collaboration between the stakeholders.

Behavioural change among young people. Another opportunity that was brought up by several stakeholders working in academy, industry, and government was the yet emerging attitude towards sustainability among citizens/public, especially among the younger population. A stakeholder said that it was gratifying to see the change in the attitude of young people in this regard, adding, "habits of older generation are not likely to change". A stakeholder from industry mentioned that younger staff working with making the transport system sustainable was a great opportunity for the future of (un)sustainable transport in the city.

Driverless vehicles. Interestingly, several stakeholders mentioned this specific project as an important opportunity for the sustainable future of the transport system in Gothenburg. A stakeholder from industry remarked that "driverless cars could revolutionize the way the mobility was understood". A stakeholder representing academy highlighted that "(several) opportunities could emerge for the micro-level traffic planning, e.g. improving the flows of cars and reducing traffic congestion".

3.5.5 A common understanding and a vision among stakeholders

Among the stakeholders interviewed there was no consensus on the existence of a common vision for a sustainable transport in Gothenburg. This is probably due to the ambiguity of sustainable transport. It is evident from the findings that this ambiguity causes discrepancies in stakeholders' understanding of issues leading to different agendas and ideas for solving problems from different perspectives, which may then result in the absence of systemic view in this regard. For example, only 3 stakeholders gave a clearer understanding of ecological, social, and economical dimensions of

sustainability in the transport system in the city. Another reason to the absence of the consensus in this regard is possibly to a conflict of interest between industry and government in particular. It was mentioned by several[16] stakeholders that, for example, while companies especially in automotive industry want people to use vehicles, politicians and city planners focus on making walking and biking more efficient and attractive by densifying the city. Overall, it is remarkable to note what a stakeholder from the government sector highlighted:

> *Stakeholders, local stakeholders in particular, perceive sustainable transport system as a goal to achieve sustainability in the local context (...). We already know about environmental systems, technology-system dynamics, lock-ins, and trajectory effect which tell us that not all solutions and activities are equally desirable. (However), there seem to be a silent agreement among stakeholders on not discussing these issues (...) since that may bounce back on one's own solution.*

Interestingly, when the stakeholders were asked for their opinion regarding their vision for sustainable transport in the city, those from the government sector mostly mentioned more efficient transport system together underlining the importance of the intermodality in this regard. Of 6 stakeholders from the government only 2 stakeholders commented on integration of personal and urban freight transport. Equally interesting is that the stakeholders from academy and industry indicated their vision in the context of the attractiveness and livability of the city. Furthermore, when the stakeholders were asked regarding the sustainability of the entire transport system in the city, the majority considered only the personal terrestrial transport system in their answers without taking into account the freight transport. An stakeholder from academy remarked "*A sustainable transport system will not be reached if the freight transport is not addressed; and, everybody is caring about the passenger transport*".

[16] By 'several' more at least 3 or more stakeholders were meant in the parts of results, i.e. challenges, barriers, and opportunities; of discussions of Phase II; and of conclusions.

4 Chapter Four – Discussion

Under the following titles, discussions regarding the Phase I and Phase II of the Challenge Lab will be given.

4.1 Phase I

As the first group of students at the Challenge Lab project, the execution of the Phase I was a rewarding experience in the sense that a new methodology was introduced and tried out for the first time within this project. It was a unique methodology firstly and, maybe the most importantly, because it attempted to combine inside-out approach with outside-in approach to understand extrinsic and intrinsic factors that together hamper or bring about a paradigm shift that is needed for sustainability. It was exciting to be among the participants of the first group of students in the Challenge Lab project to try this new methodology and have an opportunity to be actually able to create an impact that will help society be navigated towards sustainability transport system in Gothenburg. Even though there were some stressful moments experienced by the Challenge Lab team due to uncertainty along the process that stems from the fact that it was applied for the first time, the management of this uncertainty came out as another very useful learning experience.

One of the aims of this phase was to identify a way to positively intervene in a system, and, for this purpose, to find research questions or a project idea, also inspired by the interaction with different stakeholders, to be developed in the second phase of the C-Lab project. As a result of the first phase, the teams that were paired up during the Phase I came up with different ideas that were appreciated by many stakeholders trying to deal with the (un)sustainable transport system in the city particularly. Therefore, it must be expressed that the first phase also inspired the authors to study challenges, barriers, and opportunities in the transport system in Gothenburg, encountered by the stakeholders represented in the triple helix.

It was crucial to roughly calculate the necessary time for executing our ideas in the Phase II in order to make a final decision on what project to develop in the Phase II given that the Challenge Lab team was constrained by the limited amount of time because the preparation phase – the Phase I- required some time to be performed. Initially, the authors were inspired by the result of collectively performing the sustainability compass tool, which will be further reflected under “reflections on methods”, to dig deeper into the “soft” or social aspects of the challenge of having a sustainable transport system in the city. This was mainly due to that the majority of the challenges identified by the C-Lab team were placed on the “societal area” of the compass. Therefore, it was considered more important for the authors to carry out a Phase II study related to urban planning and travel behavior in this context. However,

the subject was too broad to be accomplished within the time frame left after the end of the preparation phase.

Some more reflections are expressed below, specifically regarding the experiences with self-leadership, the methods used in the outside-in approach, and the collaboration of the Challenge Lab team with external stakeholders.

Self-Leadership

As the main components of the inside-out approach, several self-leadership tools were executed in a very interesting journey of auto-evaluation and healthy self-criticism combined with the help and opinions of other Challenge Lab students. These tools helped increase the awareness of the C-Lab team about their own personal values, intrinsic drivers and strengths and weaknesses, and even identify new motivation. Aligned with these characteristics, we could also recognize the role with which we were more comfortable to act in a group and develop our emotional intelligence and empathy skills by testing new situations of openness and sharing. These tools were an excellent complement to the C-Lab team's understanding of the systems perspective applied to solve societal challenges, and, thus, to achieve a sustainable development due to the clear awareness of how important the individual level, the power of self-motivation and individual actions are in order to have a positive impact in other spheres of society.

Additionally, dialogue tools proved the authors as well as the C-Lab team how dialogue differs from discussion. With the help of these tools, the authors together with the other students of the Challenge Lab learnt how to turn a conversation into a generative dialogue where participants of the conversation listen to each other without interrupting, which helps them explore underlying parts of other's talk and find out and share new insights in a manner of collective flow. This accelerated double loop learning process within the Challenge Lab. Another useful tool in this regard was "circle-triangle time", where, in circle time, respecting the diversity of academic and cultural backgrounds, the C-Lab team was able to have a dialogue around the topic on the table, which enabled learning among the students, and, in triangle time, they collectively made decisions.

When executing the tools, an increasing feeling of trust emerged in the group, therefore the authors believe that this was a very important aspect for collective and collaborative work that the C-Lab team had during the process. It became a regular practice to share information and ideas between all the students within the Challenge Lab. To get and give constant support and feedback to and from the other students not only improved the individual learnings from the overall process of the Phase I but also created the sensation of a "team spirit". Considering the diverse academic and cultural

backgrounds of the C-Lab team, to have good communication between the students was a key to achieve the creation of team spirit. The active listening tool in this regard was remarkably useful for improving dialogue within the team, and for interacting with stakeholders both in Phase I and II.

The authors believe that the tools that were practiced and the experiences that the authors had during the Challenge Lab project will be of a great help further in professional life regardless the positions the authors might have in an organization or an institution. In any case, the authors also feel the responsibility to share the tools and learned lessons with more people.

Reflections on methods used in the Phase I

The issue and the circumstances under which the issue is to be solved were quite complex. The Challenge Lab took on the challenge of helping bring about sustainability transition in the transport system in Gothenburg by destabilizing the existing regime, which was constrained by the climate change. As the most important part of the outside-in approach, backcasting helped the Challenge Lab team be able to view the sustainable transport challenge from systems perspective. The Challenge Lab team rather applied backcasting as an approach than going through the steps introduced in the backcasting methodology thoroughly. Although the authors had practiced the methodology before, backcasting strengthened their understanding of the importance of local and regional actions in the global context.

In order to better understand the backcasting approach as well as the links between global sustainability and climate objectives and local goals and strategies, the wall concept was used to illustrate the C-Lab team's consideration of the steps of backcasting, and also to enable dialogue within the C-Lab and with the stakeholders welcomed at the C-Lab as it gave the opportunity to present the C-Lab approach. In this regard, the vision of the Challenge Lab for sustainable future of the world was set with the participation of the C-Lab team and placed the rightmost on the wall. To have a clear vision created a sensation of an organizational goal which could be reached only by dedicated and enthusiastic team such as the Challenge Lab team, which was reinforced by the inside-out approach. Along with the this vision in mind, the four system conditions for sustainability introduced by Holmberg et al. (1996) was also kept next to the vision. These system conditions gave clearer understanding of how sustainability would look like in the global context.

The double challenge funnel concept was used to analyze and understand the trends in the global supply capacity and global demand potential. This concept was useful for the Challenge Lab team as well as the authors to observe how the systems were complex and interconnected with each other. It also helped them discern how serious

the transport challenge was considering those trends. The double challenge funnel was also placed as a part of backcasting approach the leftmost on the wall. The Challenge Lab team shared the parts of the funnel for analyzing them collaboratively and collectively. This was an important duty as of working together as a team.

The reason why the backcasting was rather regarded as an overall approach than a methodology in the Challenge Lab was that the step C and D (see *Figure 2.2*) were attempted to be filled by already existing strategies and goals, which do not completely correspond to these steps. These were also replaced on the wall as parts of backcasting approach. The objectives were categorized as continental – the EU level-, national, regional, and local so that it gave the C-Lab team a clear insight of how the objectives and goals are interconnected. The demonstration of the projects that might be considered as probable solutions in this regard helped some of the C-Lab team to be inspired by.

Another tool that helped the Challenge Lab as a team to perform a self-exploratory practice about the understanding of where the major problems regarding sustainability lie was the sustainability compass. The compass showed that, although the students of the Challenge Lab had varying academic backgrounds, their understanding of problems were at closer level. This encouraged some of the C-Lab team whose academic background were quite unrelated to sustainability and inspired the C-Lab team further for the projects studied in the Phase II.

With regard to inspiring for a project idea carried out in the Phase II, design thinking sessions were useful for helping shape the scope of the second phase. Design thinking was based on the concept of multi-level design model consisting of societal, socio-technical, product-service, and product-technology systems. For example, the conceptual model of the transport system in Gothenburg, which was co-developed together with the stakeholders who were interviewed for the subject studied in the second phase of the Challenge Lab, was inspired as a result of these sessions. Design thinking sessions helped the authors identify some of the elements of the model.

In addition to these useful inputs of the Phase I, the authors inherently also encountered some obstacles during the first Challenge Lab journey. Due to the time constraints, the creation of the map of critical factors that reinforce (un)sustainability of the transport system could not be realized, and, therefore, shown in a causal loop diagram, as planned initially.

External Collaboration

For the Challenge Lab team to get insights from those who practically and professionally deal with the transport system in the city since the early stages of the Challenge Lab project was of great importance to have chance to discuss about the transport system. Through the external collaboration with the people in and around the transport system in Gothenburg, the C-Lab team had many hints on what could be relevant or valuable to be obtained from the work carried out within the Challenge Lab, and on how to orient projects towards a practical idea. Therefore, this communication with external actors further helped select and define a scope for the final project idea that was studied in the Phase II.

Overall, the experience that the authors had with external actors and lecturers was useful for navigating towards creating a valuable work for solutions sought to be a remedy for (un)sustainable transport in the city. Nevertheless, regarding the collaborations aiming to bring useful inputs to the team, the authors found some occasions to be improved in the next Challenge Lab project, particularly in the three of those. The first one was about the experience that the Challenge Lab team had with a tool that helps analyze information online and predict some events. This tool was not as useful as expected for the authors as they could not find a real connection to their work studied in the second phase; therefore, the tool was used neither by the authors nor by the Challenge Lab team. The second one was the project management lecture. Although the lecture did help the Challenge Lab team to choose a tool that was used in the following internal activities, it was made use of by the Challenge Lab team. Some follow-up sessions with the same external advisors might probably help with this crucial process, which is important for the two phases. Lastly, when having the idea evaluation lecture, the authors note that there was not a very good connection from the lecturer's material to the group's expectations. In this regard, it might be more interesting and efficient to orient it towards developing a practical exercise according to the objectives of the session.

In general terms, the authors could further suggest some more improvement that might help in the future Challenge Lab projects to be used for developing an idea of master thesis. Starting with the distribution of the workload, which in our case was low during the phase I, but very intensive in the phase II, time management of the entire Challenge Lab process might be improved in the way that it reduces the time pressure to define a project idea or research questions to be studied in the second phase. This can also be improved by assigning more time to the phase II only as some processes happening during the phase I might not be rushed. Moreover, the area designed for executing dialogue sessions might be better benefited by inviting more stakeholders.

Furthermore, the authors note that not so many visitors welcomed at the Challenge Lab were actually paying attention to what was placed on the wall. It must also be noted that the guests that the authors welcomed to have interview for their study in the second phase were more interested in the overall structure and tried to understand the comprehensive approach rather than the specific goals, trends and criteria placed in different sections of the wall. This might possibly be due to the size of the images which were small in the opinions of the authors. Nevertheless, many of those who visited the Challenge Lab and the area mentioned above expressed their interests in the wall as well as its sections – the vision, the double challenge funnel, the projects, the goals and strategies. Last but not least, it might be further helpful to have a defined outline for the written report as it took considerable amount of time for each of the paired-up teams to define their own, mainly due to this new Challenge Lab methodology used to develop a master thesis.

4.2 Phase II

For sustainability transition of the transport as a socio-technical system to become a reality the importance of stakeholders is given in the literature review. In this sense, it is also essential to understand the actual situation of a transport system in terms of challenges, barriers and opportunities for the completion of the backcasting approach. It was evident that, in order to be able to understand, good communication with the stakeholders was required. The Challenge Lab (C-Lab) provided an arena that could enhance the effective communication in this regard.

In the beginning of the Phase II, it was intended to use the opportunity that the Challenge Lab presented as a transition arena to bring several stakeholders representing different sectors to the C-Lab and interview them. Furthermore, it was also an initial intention to co-develop the conceptual model (see *Figure 3.2*) representing the transport system in Gothenburg with the inputs from all the stakeholders during the interviews. However, it was not possible to execute all of the interviews under the settings of the C-Lab – where it was possible to show the stakeholders interviewed the conceptual model (see Appendix B. Presentation of the conceptual model during the interviews at the Challenge Lab – which possibly could otherwise enable the stakeholders to contribute more to developing the conceptual model further.

Unintentionally, the conceptual model was only presented to those stakeholders with whom the interviews were held at the Challenge Lab. In some of the interviews held at the C-Lab, the conceptual model was shown in the middle of the interview, whereas in some others it was shown towards the end of the interview, corresponding to the time when the questions regarding the challenges, barriers, and opportunities were asked. In the cases where the conceptual model was shown at the end of the interview,

the stakeholders were able to add further remarks regarding the entire transport system shown on the model. This is possibly due to the fact that the stakeholders could identify other points that they possibly missed in their answers.

The presentation of the conceptual model (see *Figure 3.2*) included the components of the parts/categories of the transport system, e.g. the transport of people included such components as *commute, leisure, business trips, access to services*, and *shopping* (see Appendix B. Presentation of the conceptual model during the interviews at the Challenge Lab). It was an initial intention to locate the challenges, barriers, and opportunities on the components of these parts because it was expected that the stakeholders would have uttered specific challenges, barriers, and opportunities about these components, e.g. a challenge about specific fuel, a barrier about a specific infrastructure. However, possibly due to the broadness and complexity of the transport system, only a few of the stakeholders pointed out specific concern in this regard.

During the interviews, questions regarding the urgency and importance of the challenges observed by the stakeholders were also asked. The intention in asking about these was to understand whether different stakeholders gave the same priority and importance to the same challenge that they mentioned. However, it was rather difficult to obtain a proper answer regarding this separation, and not all the stakeholders actually answered this question. The reason was perceived as possibly being that the stakeholders presumed that the challenges that they remarked were already given the priority by being mentioned in their answers. It is believed by the authors that some improvements may be done in the interview questions as of its design enhancing its ability to also get relevant information on the urgency and importance of the challenges.

Even though the interviews were based on the standardized questions, the interviews were executed in a manner of dialogue rather than in the question-answer manner. One of the difficulties confronted with by the authors though regarding the interviewing method was that it was difficult to make the coding of the transcriptions obtained from the interviews. This was confirming Creswell (2007) who noted that a difficulty to be identified in the standardized open-ended interview method is about coding the data. By its nature, the coding of the data might have presented subjectivity in the classification of the statements of the stakeholders interviewed, which could otherwise have resulted in less or more classes of challenges, barriers, and opportunities.

During the interviews, active listening tool, which was practiced during the execution of inside-out approach in the Phase I of this thesis, was also performed by the authors in order to enable the stakeholders to express their opinions comfortably and

effectively. Along with this manner, the method used for the interviewing of the stakeholders also enabled them to give answers to the interview questions openly and without them feeling disturbed. The concept of the Challenge Lab, i.e. the role of the Challenge Lab as a transition arena and its importance according to the triple helix concept, which was presented to the stakeholders before the interviews, was also possibly helpful in this regard. The Challenge Lab concept also helped increase the credibility of the authors with regard to the openness interviewees.

Although the main intention of the study, which was to cover the opinions of stakeholders from the actors represented in the triple helix concept, is achieved, both the conceptual model and the results would have been more comprehensive if, at least, there were as many stakeholders from industry and academy as those from government. In this regard, for example, it was not possible to interview a stakeholder representing the automotive industry, which has a considerably strong impact on the transport in Gothenburg as shown in the results. Similarly, the stakeholders interviewed representing the academy were from the Chalmers University of Technology – rather a technical University, which is an important but not the only academic institution in Gothenburg – a non-technical University. To interview the stakeholders from the other academic institutions in the city, e.g. the University of Gothenburg, might have broadened the content of the results as well as the conceptual model.

Likewise, almost all of the stakeholders interviewed were involved in the entire transport system in Gothenburg, i.e. they were not particularly specialised in neither of personal nor urban freight transport. Furthermore, the opinions of some other actors in the value chain, e.g. citizens, freight transport providers etc., are not included. This is mostly due to the time constraints that did not let the authors save more time for interviewing more actors. Additionally, although the stakeholders were asked for expressing their opinions on both personal and urban freight transport, the focus of their answers was more on personal transport. These might have caused that the challenges, barriers and opportunities regarding the urban freight transport are not very well represented on the conceptual model, although those rather well represented on the model might be closely related to the urban freight transport as well.

A lot of the stakeholders interviewed uttered politicians' stance on the sustainable transport issue. It was felt that those stakeholders were holding rather a top-down approach to dealing with the transport system in Gothenburg. However, the literature review showed that a transition arena, where stakeholders together, not only politicians, strategically develops a vision and a roadmap, is needed for the execution of transition management (Lachman, 2013). Furthermore, it was also revealed by the literature review that transition at the landscape level, where macro-political developments takes place, takes decades to occur (Geels & Schot, 2007).

Additionally, results also showed that the stakeholders mentioned only one opportunity regarding the governance, whereas 9 challenges and 4 barriers were pointed out by the stakeholders in this area on the conceptual model. Therefore, given a great recognition to the importance of politicians in the transition path, their stance on the issue should not create a status quo effect on approaching to the challenge of achieving sustainable transport system in the city.

Among the stakeholders, there were varying and contradicting opinions on some topics which were mentioned by several stakeholders by being given different meanings, which were found worth to be discussed herein. In this regard, while the power of the automotive industry was considered as an important barrier to sustainability transition, especially regarding the car dependency; it was also acknowledged how the financial and physical resources of this industry could actually create opportunities in the niche level. For example, the project called "DriveMe" which is initiated by an international corporation in the automotive industry based in Gothenburg is positively welcomed by the stakeholders. However, demand side of the issue must also be taken into account while introducing a new technology, meaning that increasing demand due to increasing population in the city must not outweigh the benefits of a new technology.

Given the mentions regarding the lobbying power of the automotive industry in Sweden, this power might create a reinforcing effect on certain regimes such as car-dependency and further prolong the pre-development or take-off[17] time of a new technology that might hinder the increasing car use or enable the use of alternative fuels. Lobbying is also recognized by the literature (Farla et al., 2010) as an important activity that triggers entrepreneurs and local governments to take actions that will destabilize existing unsustainable regimes. Therefore, a transition is also likely to occur faster in Gothenburg if the automotive industry turns its face in the direction of endeavouring for stimulating a supportive institutional ambience for the transition path.

In addition to the automotive industry, the importance of the urban freight transport sector and of the actors operating in this sector was also acknowledged several stakeholders. It is possible to say that Gothenburg is one of the cities where the need to work for improving the freight transport in terms of sustainability was identified (Lindholm & Blinge, 2014). It was also identified by the present study that there was a change in the attitude of people towards sustainability, particularly among the younger generations; however, the industry, automotive and urban freight transport in

[17] According to transition management, there are for phases for a transition to be adapted. These are pre-development, take-off, acceleration, and stabilization. There might be different barriers in each phase (Farla et al., 2010).

particular, followed the traditional –business-as-usual- thinking about doing business. Furthermore, it is evident that the probable increase in the city's population is also going to increase the demand for urban freight transport. However, there seems to be existing several windows of opportunities in the city in this regard in order for urban freight transport to be directed into the sustainable path. If the mindset of these industries is addressed, as a city being considered as a testing bed, Gothenburg can actually become a frontrunner of sustainable freight transport in Europe, given that freight transport has not been integrated into policy making processes in most cities in the continent (Rodrigue, 2006).

One action that will help start the process that will overcome this problem might be the involvement of the stakeholders of transport industry. Transition is multi-dimensional and multi-sectoral, meaning that it is to occur through the interactions between the actors within the multiple levels. Therefore, dialogue is a must for sustainability transition to become a reality in Gothenburg. There are different opinions on the existence of strong cooperation and collaboration between the stakeholders. Although there seems to be an increasing cooperation among the stakeholders in the transport system in the city, a dialogue cannot be strengthened in the absence of a transition arena which will facilitate the dialogue, which in turn will enhance the effect of this cooperation. The Challenge Lab might in this regard be an objective and transparent facilitator since it bases its efforts for sustainability transition on the students as change agents that are in the same closeness to the actors of the triple helix.

5 Chapter Five – Conclusions

The new methodology introduced with the Challenge Lab project was useful to have a systemic understanding of the dynamics of society. It combined extrinsic knowledge through outside-in approach with intrinsic motivation through inside-out approach, which is actually the especially valuable yet often disregarded side of dealing with the sustainable issues, e.g. climate change. This new methodology presented a unique way of intervening with a societal issue such as (un)sustainable transport system, leading towards designing research questions, in this regard, that, when answered, will somehow influence the existing unsustainable system.

The second phase of the thesis attempted to build a conceptual model that represents the transport system in Gothenburg. Inspired by the design thinking session performed during the first phase of the Challenge Lab project, the conceptual model was co-developed together with the stakeholders that were interviewed. The elements included on the model, from outside to inside, were *stakeholders, regional development, urban planning, governance, management, innovation and research, mobility needs, transport of people, transport of goods, infrastructure, transport means,* and *transport fuels*.

As another objective of the second phase of the master's thesis, 29 challenges, 33 barriers, and 20 opportunities were identified based on the interviews with the stakeholders. According to the main challenges which were mentioned by several stakehodlers, it is founded challenging to bring different stakeholders together around the same table, which will stimulate collaboration. Due to growing population of the city, which increases the need for housing, provision of reliable public transport will also be challenging. Therefore, integration of transport planning into the city planning is essential and presents a great challenge for the stakeholders. Introducing new challenges was another challenge that was underlined by several stakeholders. Immature circumstances for new business models, alternative technologies or new markets to emerge make it a challenging issue for the transport system.

Although the barriers identified do not necessarily correspond to the challenges mentioned by the stakeholders, many of them reinforce those challenges to exist. Differences in understanding, roles, and goals among the stakeholders, lack of dialogue, and of understanding and awareness make it difficult to get stakeholders working together. Likewise, short-sightedness of stakeholders, i.e. having rather short-term oriented thinking without systems perspective, obstructs integration of transport planning into the city planning to be overcome. Similarly, limited space in the city together with the uncertainties in funding the personal transport in case of increasing demand and doubling the trips hinders the public transport to be provided reliably. Additionally, ease of car use, power of the automotive industry, politicians'

fear of loss, i.e. fear of losing their voters, and thus their political power, were also uttered by several stakeholders.

Among the opportunities that were mentioned by the stakeholders are there *city as a test bed, increasing collaboration and trust, behavioural change among young people*, and *driverless vehicles* as the most mentioned opportunities. In this regard, Gothenburg presents an important window of opportunities for experimenting alternative and new ideas, systems, and business models through the learning-by-doing and doing-by-learning practice. This opportunity together with the behavioural change among young people towards sustainability is likely to overcome some barriers that slow down the progress towards sustainability and bring about such a transport system that is more sustainable in the near future. The stakeholders, the politicians in particular, should have enough courage to implement appropriate policies that will accord with this changing attitude of younger generation.

Apart from these, many lock-ins, window of opportunities, and suggestions coming from the stakeholders were obtained through the interviews. The main lock-ins in the transport system in Gothenburg are stemming from not goal-oriented traditional thinking based on forecasting techniques in planning the future of the transport system as well as in planning in general terms. Although there is a shift in attitude of younger generations as stated above, the city's focus on vehicles which is highly possibly due to the historic relevance of automotive industry in the city is another lock-in that hampers regime shift in the transport system. It is fair to say that the city is already having windows of opportunity at the moment considering many projects around the notion of 'city as a test bed'; the West Swedish Agreement[18], which sets high ambitious for making the transport system in the west of Sweden, including Gothenburg, as to reach sustainable and high quality living environment; and The Scandinavian 8 Million City[19], which aims at connecting 4 cities in 3 Scandinavian countries by a high speed rail link.

Some of the suggestions made by the stakeholders closely align with the suggestions of the present study. In order to make some improvements in the city:

- Collaboration and dialogue between the stakeholders should be improved. In this regard, the authors also add that there is a need for a transition arena that

[18] The West Swedish Agreement is a contract between the Swedish Transport Administration, West Goteland Region, Halland Region, Gothenburg City, and the Gothenburg Regional Association of Local Authorities. http://www.vti.se/PageFiles/5454/Workshop%20presentationer/The%20West%20Swedish%20Agreement_Trondheim_12-13%20mars_2013%201.1.pdf. viewed on June 2014.

[19] The Scandinavian 8 Million City project can be found in http://www.8millioncity.com/welcome-onboard.

will help improve the needed dialogue.

- Systems perspective should be included in the planning process in order not to exclude urban freight transport from transport planning, and transport planning from the city planning.
- Academy, industry, and government should intertwine with each other while working on sustainable solutions for the transport system in order to seize the opportunities taking place currently.
- A respectful attention should be also paid to the urban freight transport given the objectives of the city and the region.

It was also an objective of the second phase of the thesis to locate these challenges, barriers, opportunities on the conceptual model. According to this, almost half of the challenges mentioned by the stakeholders are located on 'governance' and 'stakeholders' part of the model. Regarding with the barriers, more than half of them are located in 'urban planning', 'innovation and research', and 'stakeholders'. The distribution of the opportunities identified by the stakeholders was rather diverse on the model. The locating of the challenges, barriers and opportunities can be improved and used to show their further detailed distribution if the model is further developed by also including the sub-components of the elements (see Appendix B. Presentation of the conceptual model during the interviews at the Challenge Lab); and if the interview questions are designed accordingly.

6 Chapter Six – Utilization of the Master's Thesis

In the opinion of the authors, the main use for this master thesis would be to stimulate dialogue between the stakeholders of the transport system in Gothenburg. The findings of the Phase II might create the possibility to unveil opinions that might have otherwise been avoided to be mentioned in the meetings between the stakeholders before. Thus, the findings can be incorporated into the discussions about improving the circumstances both for carrying out actions, strategies, and accomplishing goals regarding the transport system, and for improving the existing decisions in this regard. The authors note that the diversity found between the perspectives of different stakeholders could present the opportunity to develop and implement more robust strategies.

Moreover, the present thesis work can also serve as a source of inspiration for entrepreneurs and companies to incorporate new sustainable solutions into the system to deal with the current challenges (i.e. challenge-driven innovation) and barriers. Furthermore, being also aware of the windows of opportunities currently taking place, the city could bring some advantages grasping the opportunities identified in this study. This might increase Gothenburg's resilience and attractiveness as a city, and turn it into a more sustainable city.

This inspiration can also reach to the academy and help new ideas for challenge-driven practice-oriented education and research topics that might bring about new scientific insights to the literature. Furthermore, the public sector could have some ideas to improve its current organization as well as collaboration with other stakeholders, and to integrate into or reconsider in policy-making which may in turn strengthen the strategies towards sustainability in the transport system.

There are several types of element within transport systems, which are complex, that have been particularly studied in academic transport research, especially about climate change mitigation (Schwanen, Banister, & Anable, 2011). In its research endeavour, academy, in general, has focused more on transport technologies, the price or commodity value of carbon, the 'hard' infrastructure, the 'soft' psyche and behaviour of users, and the institutions governing transport systems to deal with decarbonising the transport system (*ibid.)*. In this regard, the authors suggest that inside out part must not be disregarded in the research endeavour.

Regarding the next generations of the Challenge Lab, the authors believe that this work can present an important guidance when analyzing the current system, and might help the next Challenge Lab team to identify "hotspots" further or the already

identified hotspots to be addressed in the studies that will be carried out within the Challenge Lab.

The future research in this subject might include, being not limited to, identifying the perspectives of other relevant stakeholders in the system:

a) Port of Gothenburg
b) Stakeholders working on urban freight transport
c) Property owners (real state)
d) Other research centers and universities
e) Vehicles manufacturers
f) Sjöfartsverket
g) Citizens
h) Mistra Urban Futures
i) Representatives from oil and natural gas industries
j) People working with procurement in the public sector
k) Innerstaden Göteborg

Some of them were identified by the interviewees. Based on this, a more comprehensive analysis can be made to reveal what might possibly hamper the sustainability transition in the transport system in Gothenburg.

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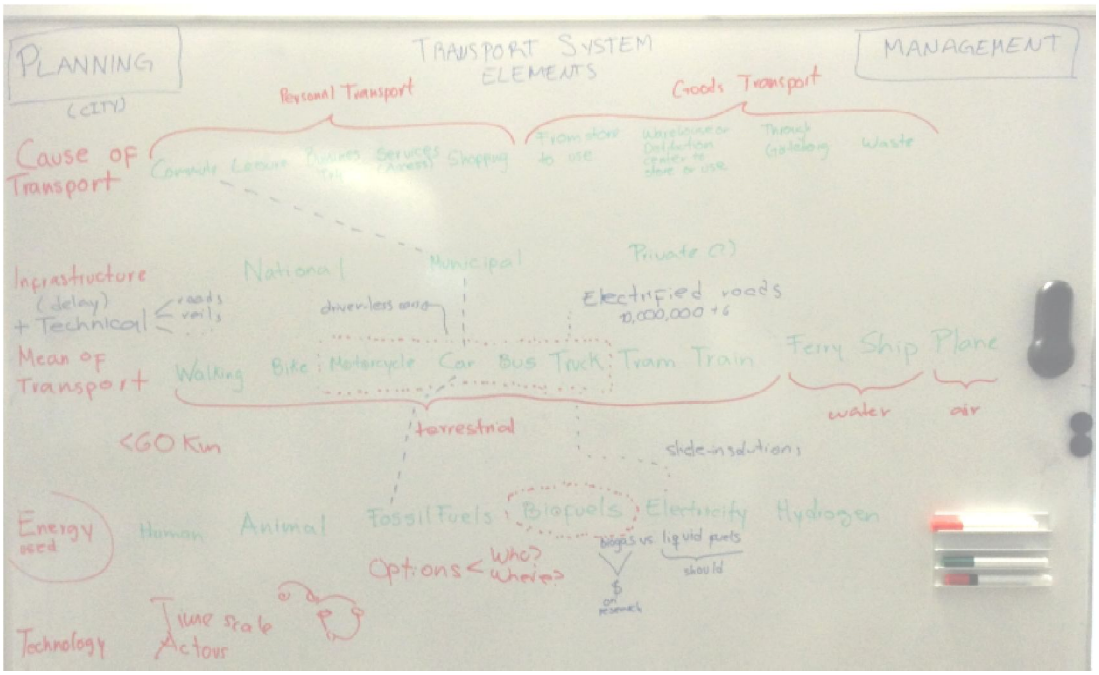
8 Appendixes

8.1 Appendix A. Questionnaire for the interviews

1. Do you think there is a common understanding between the stakeholders on what is needed to address in order to have a Sustainable Transport System in Gothenburg?
2. How does a 'Sustainable Transport System (STS)' look like to you? (e.g. your vision for STS, your understanding of STS)
3. When do you think this vision should be reached?
4. Which are the main challenges for the vision to be reached?
5. Have you identified/observed any lock-in/path-dependency within the system?
6. In your opinion:
   a) Which are the main barriers to overcoming these challenges? (e.g. in barriers for changes to happen, to start the transition)?
   b) Where in the system are these barriers located?
   c) Who is/should be involved in dealing with these barriers?
   d) What are the causes for the existence of these barriers in the local context?
   e) What are the impacts these barriers will have at the city level in case they are not addressed?
7. In your opinion,
   f) Which are the main enablers you could identify in the current system that could help in the transition towards sustainability? (Opportunities like new business models, policies, technology, projects, etc...)
   g) Where in the system are these enablers located?
   h) Who is involved?
   i) What are the causes for the existence of these enablers in the local context?
   j) What are the potential impacts these enablers could have at the city level?
8. Do you identify any window of opportunity in the short term when changes could happen?
9. How does/could your organization contribute to have a Sustainable Transport System, given the identified challenges and given the function of your organization? (Is possible to point out the challenges, barriers and enablers already mentioned)
10. Which other stakeholders are important for the transition of the transport system towards sustainability?

8.2 Appendix B. Presentation of the conceptual model during the interviews at the Challenge Lab



8.3 Appendix C. Lock-ins identified

The table below shows the lock-ins identified in the transport system of Gothenburg by the stakeholders interviewed.

Lock-in	Academy	Industry	Government	Total of mentions
Use of forecasting for planning		1	2	3
Identified generalized opinion - "Tram system should stay, is the part of the city soul"			3	3
Too much focus on vehicles' development due to the historic relevance of the automotive industry (including buses and trucks) for the city	1	1		2
Is taken as a fact that buyers need the products as soon as possible - this option could be or not of value for the consumer, the impact of choosing one (fast) distribution option or the other (slower) could be significantly different			1	1
Car ownership			1	1
Identified generalized opinion - "Every inhabitant of a building should have a parking space"			1	1
Focus on specialization and improvement in transport means and not on its integration - Not remembering they are just "means"			1	1
Identified generalized opinion - "There are not real problems with the current system (car based)"		1		1
River city project - parts near the big river are cold, windy and dark. There are waterfronts in the city center (canals) that could be cozier and easier to reach with public transport			1	1
Traditional planning approach on how to use the space in the city			1	1

Lock-in	Academy	Industry	Government	Total of mentions
Traditional planning approach of predict and provide/ not goal oriented			1	1
Work between organizations (different levels working on different goals)			1	1

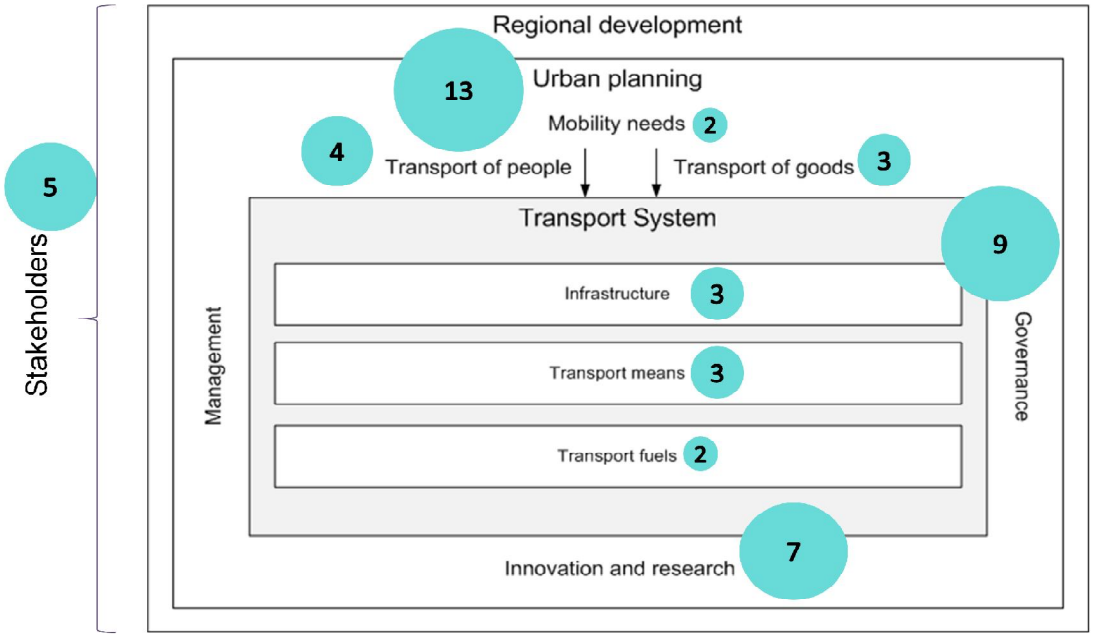
8.4 Appendix D. Windows of opportunity identified

The table below shows the windows of opportunity identified for Gothenburg city by the stakeholders interviewed.

Window of opportunity	Academy	Industry	Government	Total of mentions
Currently in a window of opportunity		2	5	7
Coming political elections	1		1	2
If West Swedish Package continues	1		1	2
Development of the River city project		1		1
Development of the Dry harbor project			1	1
Development of the Environmental zone project			1	1
If a high speed train is built		1		1
If climate change affecting the city			1	1
If green chemistry is further developed		1		1
If online shopping trend increases			1	1
If public has a good opinion regarding FFF commission	1			1
If social mindset is challenged regarding current traveling behavior		1		1
If systems perspective is integrated in planning			1	1
If the 8 million city develops			1	1
If the regional authorities give more resources for increasing and improving public transport			1	1
Increasing imports of food			1	1
Resources and projects around Horizon 2020		1		1

8.5 Appendix E. Suggestions of improvement for the transport system in Gothenburg

The distribution of the suggestions made by the interviewed stakeholders can be appreciated in the figure below:



A total of 51 suggestions of improvement were obtained, the list can be consulted in the table below.

Category	Suggestion	Academy	Industry	Government	Total of mentions
Stakeholders	Improve collaboration and dialogue between different stakeholders	1	1	2	4
Governance	Increase the confidence and commitment of politicians when introducing proposals	1		3	4
Stakeholders	Communicate arguments clearly between stakeholders		1	2	3
Urban planning	Evaluate the use of the urban space in different levels (under and over the ground)	1		2	3
Transport of people	Improve conditions for the use of transport means different than cars (walking, bicycling and public transport)	1	1	1	3

Category	Suggestion	Academy	Industry	Government	Total of mentions
Urban planning	Integrate a systems perspective for city planning	1	1	1	3
Urban planning	Consider having good spots for public transport when planning building projects	1		1	2
Stakeholders	Increase the involvement of academia in the discussions regarding a Sustainable Transport System		1	1	2
Governance	Integrate bonus-malus systems to change and regulate the fuel market without promoting the use of cars	1		1	2
Urban planning	Make less convenient to own and use a car	1		1	2
Governance	Promote a change in social behavior		1	1	2
Innovation and research	Academy should participate in a more direct and practical way to address challenges			1	1
Urban planning	Accept and implement projects regarding city planning in a faster way			1	1
Mobility needs	Analyze the trips individuals make in the city (from A to B and from Monday to Sunday		1		1
Mobility needs	Assure the needed services by people exist in the proximities of their living area	1			1
Transport fuels	Change the use of biomass for district heating to biofuels production. Use surplus of energy coming from industry instead.		1		1
Innovation and research	Combine different specialties in academy and collaborate with other stakeholders for the co-creation of solutions addressing the challenges	1			1

Category	Suggestion	Academy	Industry	Government	Total of mentions
Transport of goods	Consider sustainability impact for plans regarding shipping industry and the harbor			1	1
Urban planning	Consider the safety risks related with the tram system and people using bicycles when deciding to conserve it or not	1			1
Transport of people	Consider the sustainability impact of doubling public transport trips			1	1
Innovation and research	Considering technical solutions to address different types of transportation			1	1
Urban planning	Create a denser city		1		1
Transport means	Develop infrastructure for electric vehicles	1			1
Infrastructure	Develop railway infrastructure for goods transportation		1		1
Transport of goods	Discuss the possibility of using the current railway infrastructure for goods transportation to reduce the heavy trucks traffic in the city		1		1
Stakeholders	Engage the different stakeholders of projects since the early stages			1	1
Infrastructure	Evaluate the infrastructure needs for new technical solutions to be placed			1	1
Transport fuels	Evaluate the use of biogas and liquefied methane in the shipping industry		1		1
Innovation and research	Evolve to a more practical oriented research		1		1
Governance	Faster transition could be achieved if the system changes within			1	1

Category	Suggestion	Academy	Industry	Government	Total of mentions
Urban planning	For the upcoming building projects in the city, the number of parking spaces should be less than the number of apartments.			1	1
Stakeholders	Increase connection and understanding between business and academia		1		1
Transport means	Increase the costs related with driving a car			1	1
Urban planning	Increase the priority for bicycles and public transport in crossings			1	1
Infrastructure	Instead of building more bridges, use the connections by ferry			1	1
Governance	Integrate a leadership figure to implement more efficiently the strategies and projects in the city			1	1
Governance	Integrate a sustainable perspective for public procurement		1		1
Governance	Integrate external costs (environmental damages) to the prices in the market			1	1
Innovation and research	Invest on research for new technologies	1			1
Transport means	Limit car trips			1	1
Urban planning	Limit parking spaces in new building projects			1	1
Governance	Look for solutions implemented in other countries to solve similar issues than the ones the city is facing. Learn from their experiences		1		1
Transport of goods	More silent waste vehicles are needed			1	1
Urban planning	Optimize the space in the city for other means of	1			1

Category	Suggestion	Academy	Industry	Government	Total of mentions
	transport but cars (walking, bicycling and public transport)				
Transport of people	Optimize the space in the city for other means of transport but cars (walking, bicycling and public transport)			1	1
Transport of people	Promote the car sharing	1			1
Urban planning	Raise the use of bicycles 3 times more than the current use			1	1
Urban planning	Restrict the space for cars in the roads and parking lots			1	1
Innovation and research	Support innovative projects related with a STS with public funding		1		1
Governance	When evaluating and pursuing the implementation of innovative technologies, consider infrastructure development needed, as well as the local market development, to increase the possibilities of success	1			1
Innovation and research	When evaluating and pursuing the implementation of innovative technologies, consider infrastructure development needed, as well as the local market development, to increase the possibilities of success		1		1