

PLANNING FOR MOBILITY, A CITIZEN PERSPECTIVE. -A CASE STUDY OF VEJEN MUNICIPALITY



Master thesis, Sustainable Cities, Aalborg-University-Copenhagen

AUTHORS:
CHRISTIAN TARSTRUP
ANDERS SKJØTT

SUPERVISOR:
JACOB NORVIG LARSEN

DEADLINE:
8TH OF JUNE 2018

Study program and semester: Sustainable Cities, 4th semester.

Project title: Planning for mobility, a citizen perspective

Project period: 1st of February 2018 – 8th of June 2018

Semester topic: Master thesis

Aalborg University Copenhagen
A.C. Meyers Vænge 15
2450 Copenhagen SV

Secretary: Janni Rise Frellesen
Tel: 99402535
E-mail: jrl@plan.aau.dk

Supervisor(s):

Jacob Norvig Larsen

Group members:

Anders Skjøtt
20133596

Christian Tarstrup
20136316

Number of pages:

104 excluding appendixes

Number of Characters:

229.429 with spacing, including
bibliography.

Abstract:

In this project, the role of congestion, and how to increase mobility was investigated by using the four-step principle, which is a principle for how to plan transport. Vejen Municipality in Region Syddanmark was used as a case area, and the problem formulation was as follows:

Under which circumstances can the four-step principle be used, as a tool to prioritize planning, and utilize the potential of the four steps, in terms of transport?

To investigate this, four scenarios for future transport in Vejen Municipality were created, which each corresponded to a step in the four-step principle. To define the planning paradigm plans related to transport in Vejen Municipality were analyzed. Lastly, to investigate users, social practice theory was used. The empirical foundation consisted of a survey, which was carried out with 287 respondents, two expert interviews and two focus group interviews.

It was concluded that many of the proposed initiatives could be used in Denmark. However, there are challenges regarding which levels of government that should be the primary developer of the initiatives, and under what circumstances the four-step principle could be realized.

Table of Contents

Chapter 1. Introduction.....	1
1.1. Denmark.....	1
1.1.1. <i>Growth in vehicles numbers</i>	2
1.1.2. <i>Congestion</i>	3
1.1.3. <i>Infrastructure</i>	4
1.2. Four-step principle.....	5
1.2.1. <i>Why the four-step principle?</i>	6
1.3. Political context of infrastructural planning	8
1.4. Findings.....	8
Chapter 2. Problem formulation.....	9
Chapter 3. Methodology	10
3.1. Project structure	10
3.2. Research design & approach.....	12
3.2.1. <i>What was done?</i>	12
3.3. Case selection	13
3.4. State of the art analysis	14
3.5. Survey	14
3.6. Interviews with planners.....	14
3.6.1. <i>Interview with Vejen Municipality</i>	15
3.6.2. <i>Interview with Region Syddanmark.</i>	15
3.7. Focus group interviews.....	15
3.7.1. <i>Creating a group</i>	16
3.7.2. <i>Carrying out the interview</i>	16
3.7.3. <i>What was done</i>	16
3.8. What can we say about the case?	17
Chapter 4. State of the art review.....	18
4.1. Defining congestion	18
4.1.1. <i>Projekt Trængsel</i>	18
4.1.2. <i>Commission of Infrastructure</i>	19
4.1.3. <i>Commission of Congestion</i>	20
4.1.4. <i>Definition of congestion in this project</i>	21
4.2. Transport planning in Denmark - tools and planning hierarchy.....	21
4.3. Commuting and mode transport in Denmark.....	21
4.3.1. <i>State actors</i>	22

4.3.2.	<i>Non -government organizations</i>	22
4.3.3.	<i>Contribution</i>	22
4.3.4.	<i>Behavior and mode of transport</i>	23
4.3.5.	<i>State actors</i>	23
4.3.6.	<i>Contribution</i>	23
4.4.	<i>Findings</i>	23
Chapter 5.	<i>Theory</i>	24
5.1.	<i>Plan analysis</i>	24
5.1.1.	<i>Corrective Planning</i>	24
5.1.2.	<i>Prognostic Planning</i>	24
5.1.3.	<i>Programmatic Planning</i>	25
5.2.	<i>Users</i>	25
5.2.1.	<i>Social practice theory</i>	26
5.2.2.	<i>Changing practice</i>	27
5.3.	<i>Scenario introduction</i>	27
5.3.1.	<i>Scenario building</i>	28
5.3.2.	<i>Backcasting approach</i>	28
5.3.3.	<i>Types of scenario building</i>	29
5.3.4.	<i>Scenario building in this project</i>	29
5.4.	<i>Joint theoretical framework</i>	30
5.5.	<i>Findings</i>	31
Chapter 6.	<i>Case introduction: Vejten Municipality</i>	32
6.1.	<i>Vejten Municipality</i>	32
6.2.	<i>Infrastructure</i>	33
6.2.1.	<i>Political action</i>	34
6.3.	<i>Public transport</i>	35
6.3.1.	<i>Public Transport in Region Syddanmark</i>	36
6.4.	<i>Findings</i>	39
Chapter 7.	<i>Plan analysis</i>	40
7.1.	<i>Introduction to plans</i>	40
7.1.1.	<i>Vejten Municipal plan</i>	40
7.1.2.	<i>Joint municipal plan for The Triangle Region</i>	40
7.1.3.	<i>The Regional development plan for Region South Denmark</i>	41
7.2.	<i>Analysis of each plan</i>	41
7.2.1.	<i>Vejten Municipal plan</i>	41

7.2.2.	<i>Joint municipal plan for The Triangle Region</i>	<i>42</i>
7.2.3.	<i>The Regional development plan for Region South Denmark</i>	<i>43</i>
7.3.	How are planning paradigms influencing planning in Vejen Municipality?	44
7.4.	Findings	45
Chapter 8.	Users of the transport system	46
8.1.	Survey	46
8.2.	Survey results	46
8.2.1.	<i>Short distance travellers</i>	<i>47</i>
8.2.2.	<i>Long distance travellers</i>	<i>48</i>
8.2.3.	<i>Respondents with no access to a car</i>	<i>49</i>
8.2.4.	<i>Cyclist with access to a car</i>	<i>49</i>
8.3.	Focus group interviews	50
8.3.1.	<i>Focus group one</i>	<i>50</i>
8.3.2.	<i>Focus group two</i>	<i>51</i>
8.4.	Findings	52
Chapter 9.	Scenarios	53
9.1.	Creating the scenarios	53
9.2.	Initiatives	56
9.2.1.	<i>Step 1 initiatives, influencing behavior</i>	<i>56</i>
9.2.2.	<i>Step 2 initiatives, effective use</i>	<i>58</i>
9.2.3.	<i>Step 3 initiatives, improved infrastructure</i>	<i>60</i>
9.2.4.	<i>Step 4 initiatives, building new infrastructure</i>	<i>62</i>
9.3.	Scenarios	62
9.3.1.	<i>Scenario I: Behavioral change</i>	<i>63</i>
9.3.2.	<i>Scenario II: ITS and Behavioral change.</i>	<i>66</i>
9.3.3.	<i>Scenario III: Scenario I and II combined with expanding infrastructure</i>	<i>70</i>
9.3.4.	<i>Scenario IV: New infrastructure combined with Scenario I and Scenario II .</i>	<i>72</i>
9.4.	Findings	75
Chapter 10.	Desirability	76
10.1.	Scenario I	76
10.1.1.	<i>Carpooling</i>	<i>76</i>
10.1.2.	<i>Workplace initiatives</i>	<i>78</i>
10.1.3.	<i>Taxation</i>	<i>79</i>
10.1.4.	<i>Conclusion Scenario I</i>	<i>79</i>
10.2.	Scenario II	80

10.2.1.	<i>MaaS</i>	80
10.2.2.	<i>ITS</i>	81
10.2.3.	<i>Real-time data</i>	81
10.2.4.	<i>Conclusion Scenario II</i>	82
10.3.	Scenario III.....	82
10.3.1.	<i>Expansion of current infrastructure</i>	83
10.3.2.	<i>Conclusion Scenario III</i>	83
10.4.	Scenario IV	84
10.4.1.	<i>Conclusion Scenario IV</i>	85
10.5.	The four-step principle.....	85
10.6.	Findings	86
Chapter 11.	Discussion.....	87
11.1.	Political aspect	87
11.1.1.	<i>Why new highways?</i>	88
11.1.2.	<i>Tools for decision-making</i>	89
11.2.	Actors and institutions	90
11.3.	Social practice theory	91
Chapter 12.	Conclusion	93
12.1.	Planning Paradigms	93
12.2.	Attitude towards the four-step principle	93
12.3.	Long-term planning	94
12.4.	In conclusion	94
Chapter 13.	Recommendations and future research.....	95
13.1.	Recommendations	95
13.1.1.	<i>Rethinking bus planning</i>	95
13.1.2.	<i>Using ITS</i>	95
13.1.3.	<i>Creating an arena for change</i>	95
13.1.4.	<i>Co-creation</i>	95
13.2.	Future research.....	96
13.2.1.	<i>Assessment of infrastructure projects</i>	96
13.2.2.	<i>Highways as public-private partnerships</i>	96
13.2.3.	<i>New tools for regional planning</i>	97
Chapter 14.	Bibliography	98

Appendix list

Appendix 1 – Focus group one transcript

Appendix 2 – Focus group two transcript

Appendix 3 – Interview with Erik Ørskov – Region Syddanmark

Appendix 4 – Interview with Hans Peter Christensen – Vejle Municipality

Appendix 5 – Focus group interviewguide

Appendix 6 – Interviewguide Region Syddanmark

Appendix 7 – Interviewguide Vejle Municipality

Appendix 8 – Survey

Appendix 9 – Survey results

Chapter 1. Introduction

The issue of congestion is widely increasing at both the European and global level, with hundreds of cities experiencing challenges with the rapid increase in car numbers. TomTom, an organization monitoring global transport development trends, concludes in their latest indexing, that developing countries that are experiencing economic growth, simultaneously have a significant increase in car numbers (TomTom 2017), supported by Figure 1.

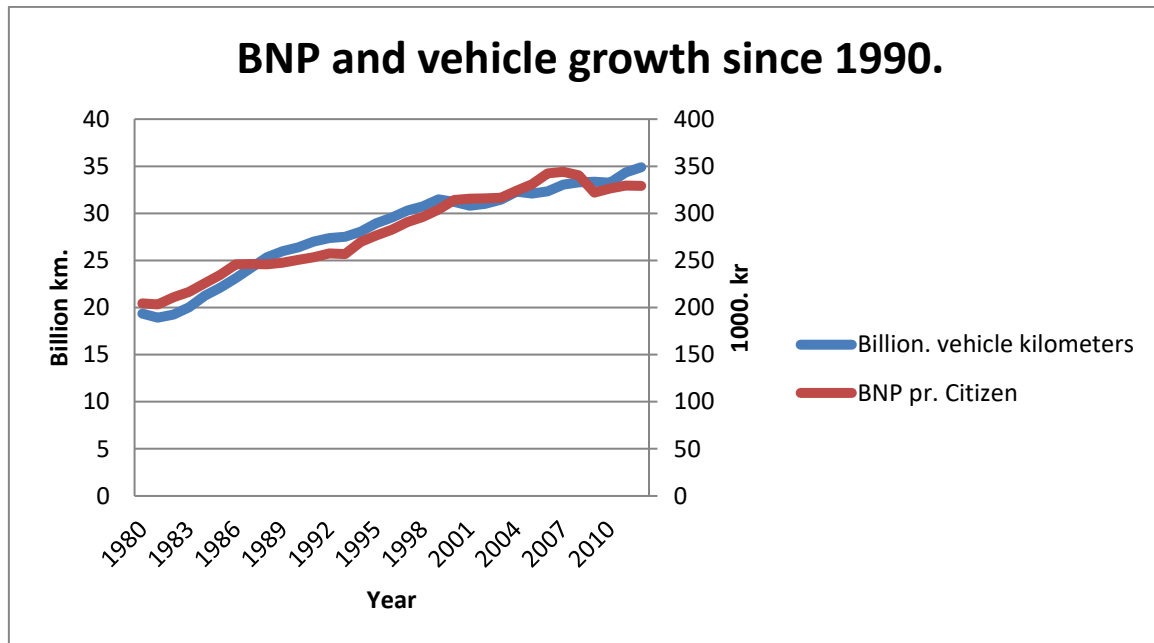


Figure 1. The relation between BNP growth, and increases in vehicle kilometers (Statistics Denmark n.db)

Both for drivers caught on congested roads, and for citizens living near congested roads it results in loss of time. In addition, regularly exposure to highly congested roads has a negative influence on peoples health, due to the emitted particles from the vehicles. Vehicle noise can lead to sleep loss and high blood pressure, and the light from vehicles can interrupt sleep (Narwal 2016). Furthermore, the stop-and-go traffic from congested roads lead to an increased CO_2 emission from the cars during acceleration and deceleration. Free flow is therefore not only advantageous in terms of travel time, but also environmentally. In relation hereto, a study found that emissions could be reduced by up to 20%, if cars are traveling at an optimal speed, without stop-and-go-traffic, because the vehicles will be driving more kilometers per liter of fuel (Barth, Boriboonsomsin 2010).

1.1. Denmark

Denmark is experiencing an increase in vehicle numbers and congestion levels are rising and this chapter will take an economic perspective to analyze the development trend in Denmark. The chapter covers the growth in car numbers, congested roads, and car infrastructure and introduces a planning approach for future planning. The approach will be applied later in the project.

1.1.1. Growth in vehicles numbers

The economic impact of congestion on highways was investigated by The Danish Federation of Motorists, to be used as an argument as to why more money should be invested in increasing road capacity in the national traffic corridor. The investigation estimated the value of the time wasted by the drivers stuck in queues to be worth 8.5 billion DKK per year (Federation of Danish Motorists 2013), creating the foundation for investigating how to reduce congestion. The growth in vehicle numbers in Denmark has been very significant, with a growth in the number of new cars of 44%, in the period between 2010-2017, based on available data from Statistics Denmark (Statistics Denmark 2018), see Table 1.

Totals	2010	2017	% development
Total new cars	153.614	221.488	44%
Total new buses	852	1294	52%
Total new trucks and vans	190.022	404.070	113%

Table 1. The number of new cars, buses, trucks and vans in Denmark in 2010 compared to the number of new cars, buses, trucks and vans 2017 (Statistics Denmark 2018).

In the period the population has also grown, which could explain some of the new cars however, the growth in cars is significantly bigger than the population growth, see Figure 2.

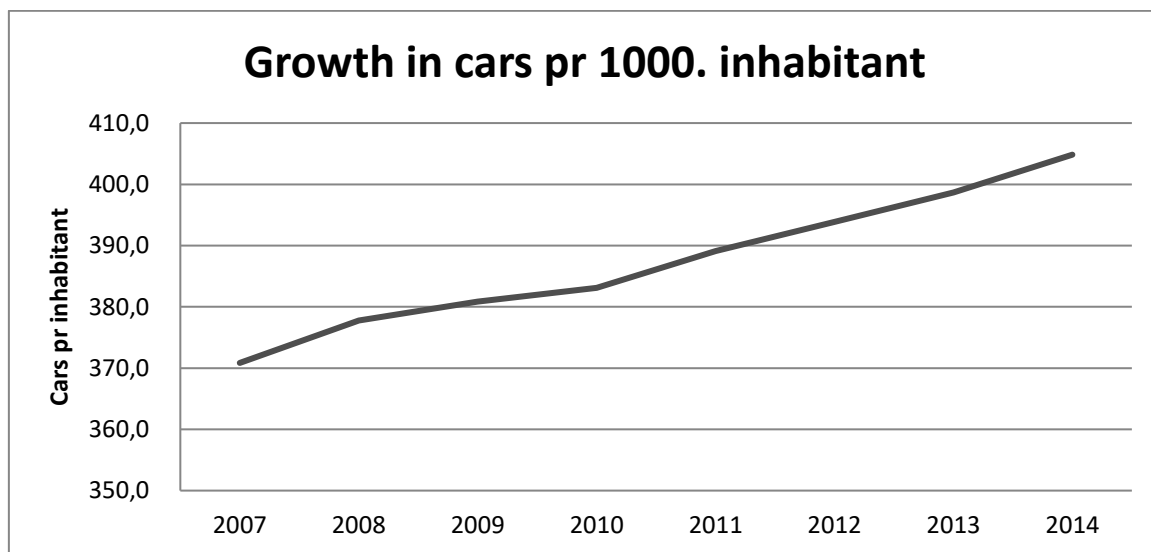


Figure 2. Cars per 1000. inhabitants (The Danish Road Directorate 2017b).

This increase happened despite a political effort to promote a modal shift towards public transport through different political packages. In 2009 the green transport agreement was implemented with a budget of 60 billion DKK earmarked for improving public transport (Danish Ministry of Transport, Building and Housing 2009). Likewise, in 2012 a political program was implemented with a budget of one million DKK per year, to reduce ticket prices for public transport and improve its facilities (Danish Ministry of Transport, Building and Housing 2012). Denmark also has considerable

taxes on cars, and they are frequently changed both in terms of how cars are taxed, and the tax levels themselves. Currently cars fueled by either diesel or gasoline have a tax of 85% of the value up to 185.00 kr. and 150% for the remaining value. In 2016 the tax level was 102% of the value up to 82.800 kr. and 150% for the remaining value (Danish Ministry of Taxation n.d.a, Danish Ministry of Taxation n.d.b).

1.1.2. Congestion

Congestion is increasing all over Denmark, but mostly in The Capital Region, and as the region has almost three times as many jobs as the neighboring region, Region Sjælland, and a much higher population density, traffic is significant in the region (Statistics Denmark 2017). Congestion is also centered primarily around this region, as traffic numbers show that the five most used highways in Denmark are all located in The Capital Region, see Table 2.

Road stretch	Annual daily users
Køge bugt motorvejen	127.000
Motorring 3	120.000
Amager motorvejen	111.000
Holbæk motorvejen	100.000
Helsingør motorvejen	85.000

Table 2. The five most used highways based on annual daily users in Denmark (The Danish Road Directorate 2017b).

However, this is not to say that congestion is only a problem in The Capital Region. Traffic growth is also happening at a national level, even if the congestion levels are not as significant as in The Capital Region. To illustrate this, Figure xx shows the traffic growth on the national road network, and it can be seen that several locations are experiencing traffic growth of more than 30%.

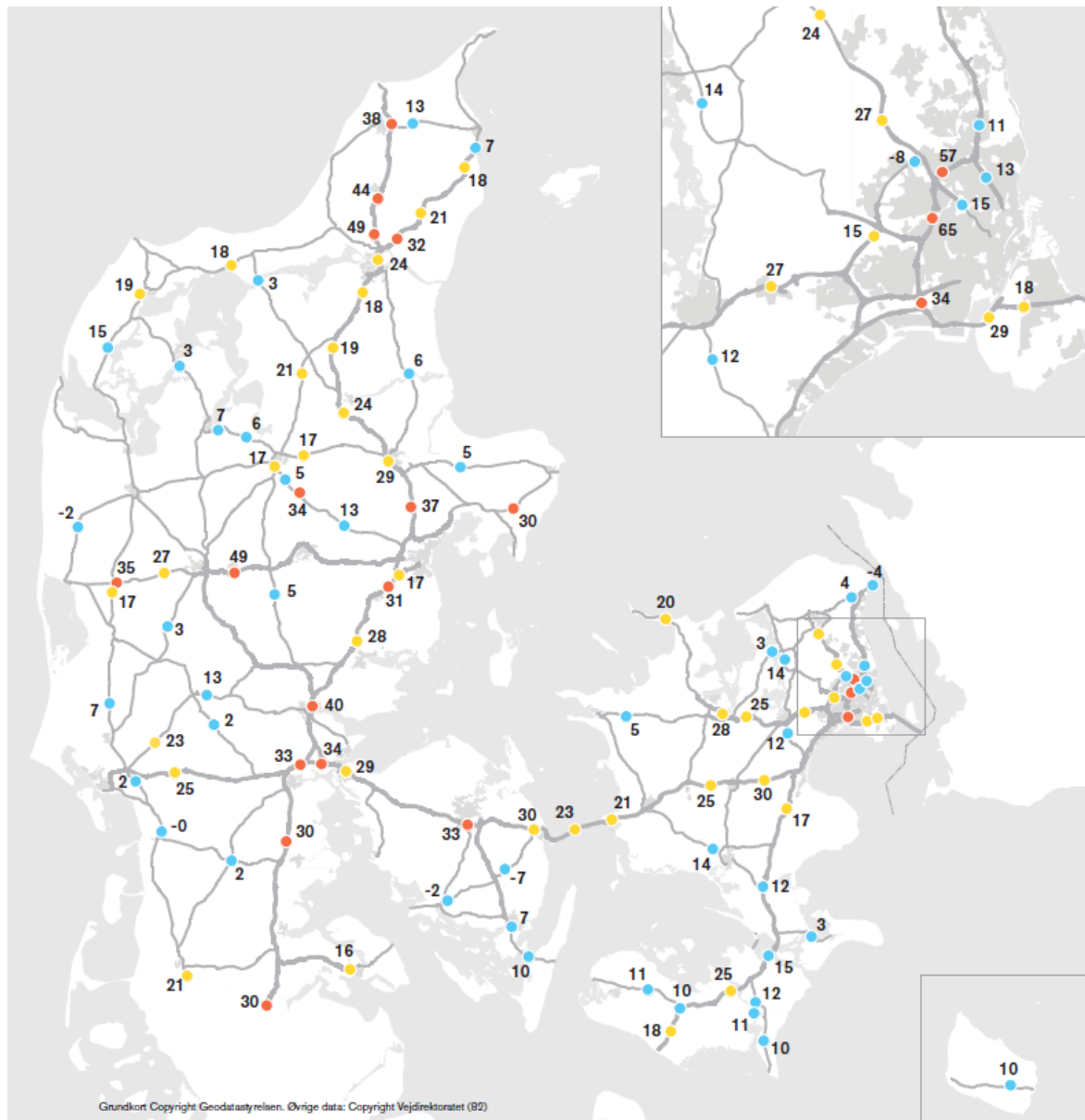


Figure 3. Traffic growth on the national road net in Denmark from 2006-2016. (The Danish Road Directorate 2017b, page 15)

Many areas with high growth rates in traffic are also areas that have had new highways built, or existing highways expanded to accommodate the challenge of increasing traffic.

1.1.3. Infrastructure

With a point of departure in Figure 3, three congested areas can be identified, The Capital Region, the area around Fredericia and Kolding, and near Vejle Fjord. For this project, The Triangle Region is the most relevant because the sixth and seventh most congested highways are located there, both in near proximity to each other. These are Østjyske motorvej with 82.000 daily users and Sønderjyske Motorvej with 80.000 daily users in 2017. This is because it was decided to investigate traffic development and congestion outside The Capital Region, and this area has the most congested highways, outside The Capital Region.



Figure 4. The sixth (Østjyske Motorvej, E45) and seventh (Sønderjyske Motorvej, E45j) most used highway in Denmark, marked with red. Own production. GIS data from: (Danish Geodata Agency 2018)

These two highways have had an increase in traffic of more than 100% during the past 20 years and it is estimated that this will continue, resulting in increased congestion levels, especially near Kolding and Vejle. They are marked on Figure 4 and are identified as hot spots with high levels of congestion and high risk of increased congestion if no actions are taken (The Danish Road Directorate 2016c).

1.2. Four-step principle.

When it comes to reducing the number of cars and the level of congestion, two general approaches can be taken, to either reduce the number of trips or reduce the travelled distance per vehicle. This can be done in a variety of ways, but an overall planning approach to do so is implemented in Sweden, and it relies on a four-step principle approach.

The four-step principle contains, as the name suggests, four-steps, which influences the transport system at different levels, see Figure 5.

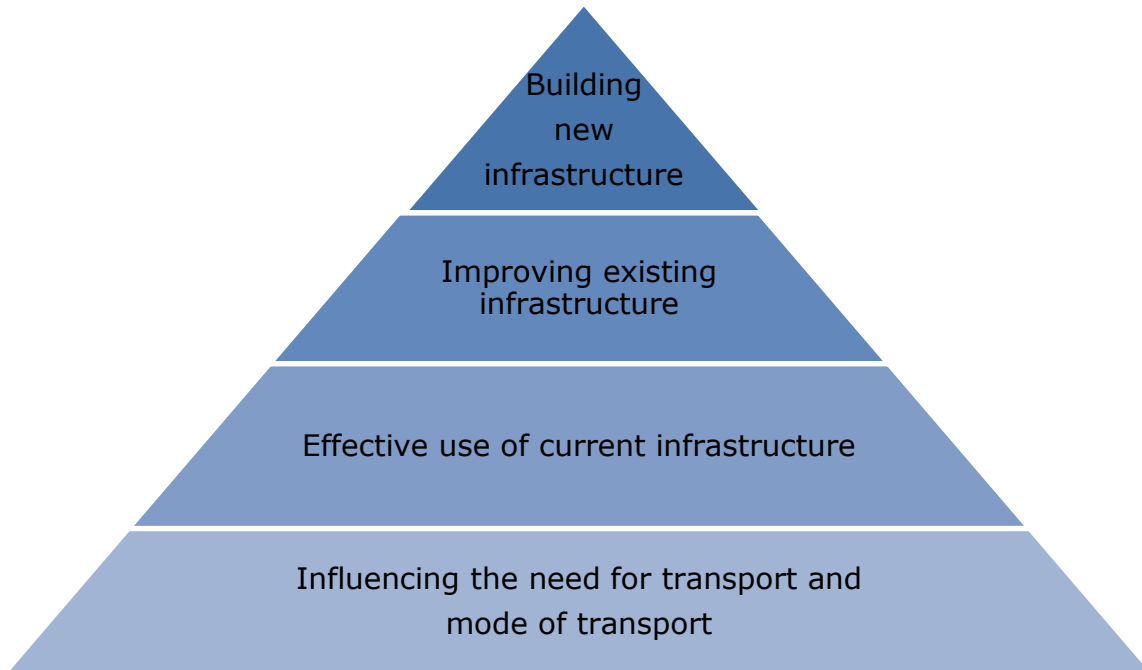


Figure 5. The four-step principle. The suggested approach is having the most initiatives in the bottom categories, and a decreasing number of initiatives, the higher up the pyramid planners get. Own production

The idea of the principle is, that planners should have more initiatives influencing the bottom category, and fewer initiatives as one moves up through the pyramid. Following this structure, the figure is further explained from the bottom and up.

- *1st step - Influencing the need for transport and mode of transport*

The first step is to try to change citizens behavior, and thereby decreasing their need for transportation.

- *2nd step – Effective use of current infrastructure*

The second step is to introduce means that will make better use of the current infrastructure, e.g. traffic lights changing based on real-time data.

- *3rd step - Improving existing infrastructure*

The third step is to improve current infrastructure, for example by building wider roads

- *4th step - Building new infrastructure.*

The last step is to build new infrastructure to increase the capacity of the road net.

1.2.1. Why the four-step principle?

By using the idea of the four-step principle, a city or region can limit its use of resources, because initiatives at step one and step two are not as expensive as expanding- or building infrastructure. The four-step principle thereby intends to reduce the need for new infrastructure, by utilizing the potential of step one and step two to reduce the number of trips and the distance travelled per vehicle.

Furthermore, as sustainability is becoming a more and more recognized topic for citizens, municipalities and countries worldwide, all levels of government will at some

point have to adapt their current strategies to become more sustainable. An adaption, which has to take place through all branches of society. The four-step principle as an approach can work towards sustainability by its focus on more efficient use of existing infrastructure and changing user behavior towards more efficient transport alternatives. In short, for the three aspects of sustainability, economic, environmental and social, the four-step principle could be beneficial in the following ways:

- *Economic – Reducing the need for expansions and road constructions by influencing user behavior that potentially can lead to a reduction of vehicles and travelled kilometers per vehicle.*
- *Environmental – First and foremost the resources required for roads are significant. It is for example estimated that it pollutes 1030 tons of CO₂ per kilometer highway being built (Pihl, Efla 2008). Furthermore, a more efficient use of existing infrastructure could be realized through better flow speeds, which can reduce CO₂ emissions from driving cars by up to 20% (Narwal 2016).*
- *Social – By increasing mobility through new initiatives people with previously low mobility could experience an increase in personal mobility.*

A consideration which was mentioned in a thesis from 2006 regarding the usage of the four-step principle is how the steps relate to each other. Measures in step one and step two will typically have a significantly longer period of implementation before its effects can be observed, and will require a more continuous effort because it is targeted at behavioral changes. On the contrary, the cost of implementation is relatively low. Measures in step three and step four have a more direct implementation process, which to some extent is "just" an environmental impact assessment, and the effect of the construction can be observed almost immediately. On the contrary, it is very expensive (Sellebjerg, Strøjer Lyster 2006).

The potential of this principle was analyzed in a Swedish rapport from SIKA (Swedish Institute of Communication). The report found that despite the intentions of limiting resource use, the principle was no more than a "hideout". Options from all four steps of the approach were taken into account, but when it came to decision-making, the main conclusions were still to either expand current infrastructure or build new infrastructure, thereby skipping step one and step two, which is a challenge for the principle (SIKA 2005).

In a Danish context, the city of Odense published a plan for mobility last year, in which they presented a plan for how investment in mobility should be prioritized. The plan was based on the four-step principle. The city of Aarhus is also using a similar model, when working with transport and infrastructure. (City of Odense 2017) (Aarhus Municipality 2012). In their plans the focus regarding each step was to change behavior, use infrastructure more efficiently among other things. But, since the plans were just recently implemented, is it too early to say what effects the application of the principle has been.

1.3. Political context of infrastructural planning

As argued in Chapter 1.1.1 *Growth in vehicles numbers*, politics play a central part in the development of a nation and the regulation of cars through taxes is one example hereof. The changing tax levels also shows the conflict between the two primary ideologies in Denmark. In terms of infrastructure planning, and perhaps more accurately, infrastructure funding, a similar conflict is found. This conflict has its foundation in the argument that infrastructure is a driver for growth and societal development, and of course because of the big investments required to build new infrastructure (DI Analyze n.d).

The development trend in terms of infrastructure, though highly depends on the parties in office.

Currently, the liberal parties of Denmark are in office, and the Danish Minister of Transport stated in a speech in 2017, that he wants to dramatically increase investments in road infrastructure, rather than in railways in the coming years (Birk Olesen 2018). Previously when more socialistic parties were in office, they on the contrary decided to invest two thirds of the total infrastructure budget into rail infrastructure and public transport (Danish Ministry of Transport, Building and Housing 2009).

Historically infrastructure has also been a subject for political deals in Denmark, meaning that parties have agreed to certain programs or packages (in other areas), as a tradeoff to get support to their own agendas, for example in terms of building new highways. This can be politicians promising local voters better infrastructure as a part of their campaign or similar.

An example hereof can be found in terms of public transport, with the suggested railway from Vejle to Billund, which is primarily driven by DF (Dansk Folkeparti) (Siggaard, Skovgaard 2018). A preliminary investigation found that the suggested train alignment would cost 50 million DKK to operate per year, that it would only support a relatively small passenger group, and that it sums up to a total economic cost of 1,4 billion DKK for society (Nielsen, Fosgerau 2014). Despite that, the project was politically decided to be investigated and it will be handed for a political process during the summer 2018 (Banedanmark 2018).

1.4. Findings

From the introduction, the following findings were identified:

- *Car ownership has been steadily increasing in Denmark.*
- *The traffic corridors around The Capital Region and The Triangle Region are experiencing increasing levels of congestion.*
- *The four-step principle is a planning principle that has its appliance in transport planning, with a higher level of attention towards user behavior than other transport planning tools.*

Chapter 2. Problem formulation

Congestion and car ownership are generally increasing in the world, and the same trends are showing in Denmark. Danish congestion in 2013 cost society 8,5 billion DKK (Federation of Danish Motorists 2013), creating the need to investigate what can be done to reduce congestion. It was found that the largest increase in traffic is happening on highways, which means that the capacity of the Danish highways is a part of the problem. From the Swedish four-step principle a second perspective was added, the user behavior. A change in user-behavior can free up road capacity, through initiatives that influences users' mode of transport and need for transport.

To investigate what can be done using the four-step principle in terms of transport and planning the problem formulation is as follows:

Under which circumstances can the four-step principle be used, as a tool to prioritize planning and utilize the potential of the four steps, in terms of transport?

To investigate the problem formulation, the following sub-questions were included in the scope of the project.

- *Which planning paradigms characterize municipal transport planning and what influences it?*
- *What are the attitude from planners and citizens with regards to the four-step principle?*
- *How can a long-term target of increased mobility be planned for in a municipality?*

These were included because the sub-questions provided the knowledge required to be able to meaningfully answer the research question from the problem formulation.

The question about municipal planning provided knowledge regarding what circumstances needed to be met, in a planning context, to use the four-step principle. Furthermore, it helped to determine the extent of the potential of prioritized planning and the role of the planner in such a system.

Investigating how to increase mobility also supported the examination of circumstances, and as a part of the process of developing scenarios and paths to realize them, barriers to realizing the four-step principle were also identified.

Determining attitude of citizens and planners provided perspectives not previously investigated in transport studies and were required to argue for the utilization of the potential of the scenarios. It furthermore helped to discuss desirability, both with planners and citizens.

Chapter 3. Methodology

The purpose of this chapter is to present the methods used to investigate the problem formulation and argue for why the research design was chosen. This is done by introducing reflections regarding the case selection, interviews, and scenario building.

3.1. Project structure

The overall elements of the project are categorized into the following:

- *An introduction of the transport system, its capacity, and the role of congestion.*
- *Problem formulation.*
- *An introduction to the approach taken to investigate the problem formulation.*
- *A state of the art review to map relevant existing knowledge regarding the investigated field regarding congestion and traffic planning.*
- *An introduction of the theories chosen to investigate the field.*
- *A case description and analysis of the context in terms of planning and user types.*
- *Scenario development used to investigate alternative modes of transport and transport system, with an emphasis on the users. The scenarios were built based on the ideas of the four-step principle.*
- *A discussion of the role of politics in transport planning, the role of decision-making tools, and the role of public-private collaborations. Lastly the findings are discussed.*
- *The conclusion.*
- *Recommendations and future research perspectives.*

The project structure is also visualized in Figure 6, to help the reader navigate the project.

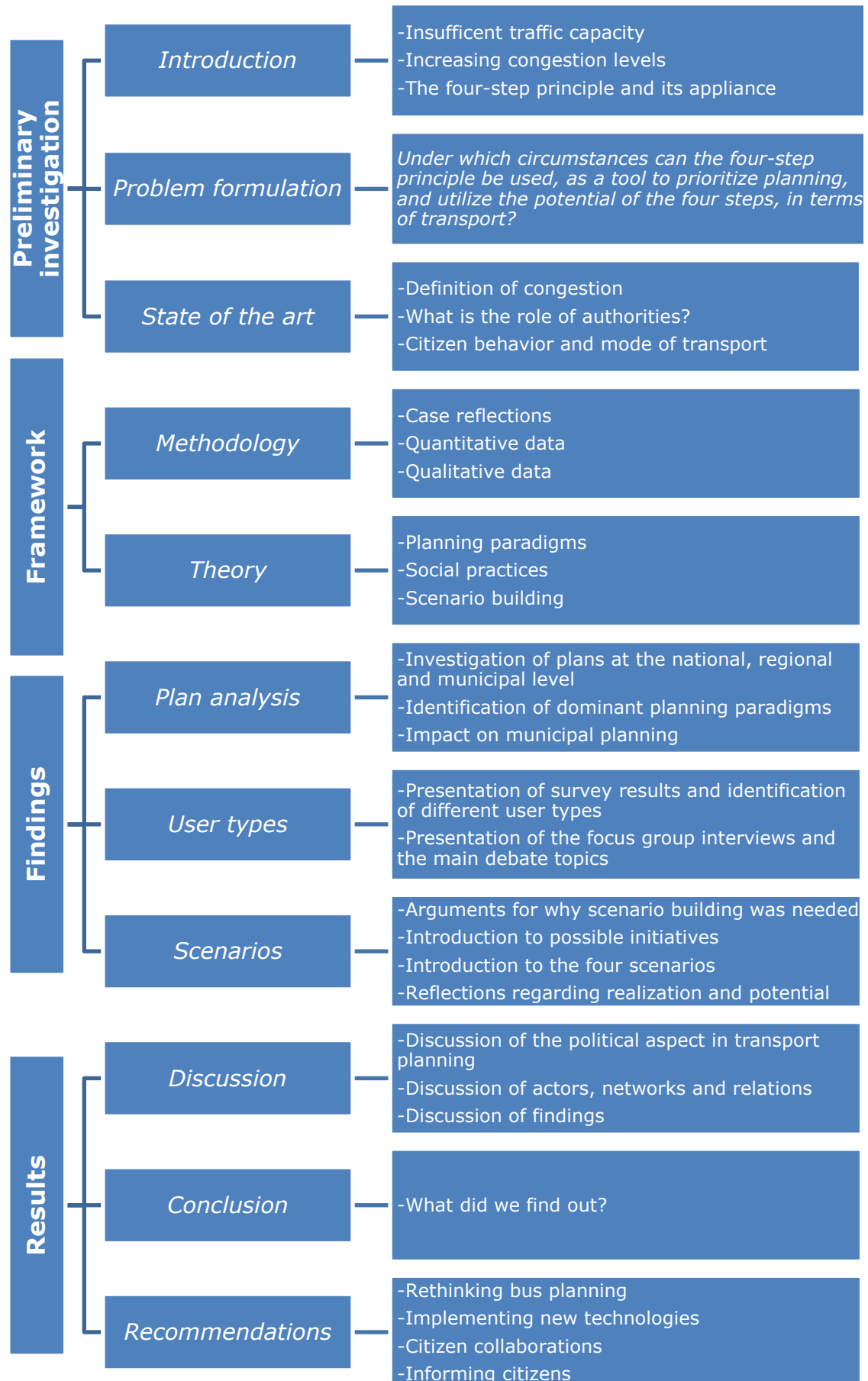


Figure 6. Overview of the project. Own production

3.2. *Research design & approach*

To investigate the problem formulation, it was chosen, to have a research design, which was structured as a case study. The purpose of such a research design was to allow the researcher to investigate a case area thoroughly, by providing the opportunity to investigate a contemporary issue in depth. The contemporary case was an investigation of transport behavior and attitude towards new transport solutions in Vejen Municipality.

By investigating an issue in depth, a researcher can put him or herself above the rules and norms of the field and disregard the business-as-usual approach, when trying to identify a solution to the discovered issue. In doing so, the investigators achieve the required context-dependent knowledge to become experts within the case area and obtain a significant knowledge of local conditions and context (Flyvbjerg 2010, De Vaus 2001).

Related to the research design is also the approach we took as researchers, in order to gain insight into the case. There was a high level of participation in the case area between researcher and respondents. The purpose was to uncover aspects that were not identified in the literature. The approach used small-scale theorizing, to examine specific problems for the case area and uncover context-dependent knowledge through interaction. This was carried out by having open interview situations with citizens using focus group interviews, and with planners by having semi-structured interviews.

3.2.1. *What was done?*

A literature review was carried out to identify general development trends and to uncover existing knowledge relevant to the scope of this project, see chapter xx. Based on these findings, a survey was created to test the preliminary findings. The survey was structured as a "check-box" survey, in which the respondents responded by checking boxes with predefined answers, based on the findings we wanted to test.

Based on the survey results, the first case-oriented knowledge was produced, which led to an identification of two types of travellers in the case area, long-distance travellers and short-distance travellers.

To have a qualitative discussion about the quantitative results keeping an emphasis on the user-perspective, focus group interviews were held with respondents. During these interviews, the two types of drivers were identified by their differences and routines. In this way the quantitative data worked as an input tool, to begin a qualitative processing, where the tendencies and results from the survey, were elaborated by the respondents.

Likewise, interviews were also held with local planners to test the results and uncover context-dependent knowledge regarding planning practices.

The process is summed up in Figure 7

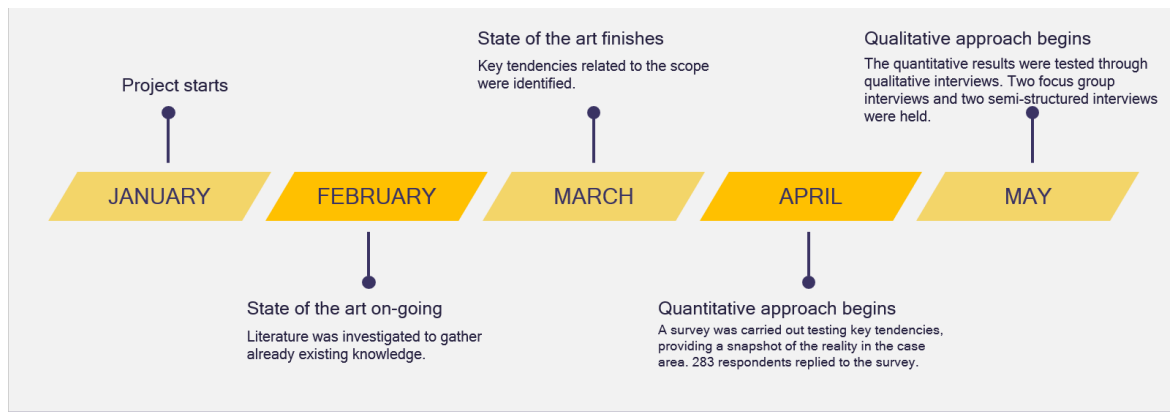


Figure 7. Methodology timeline. Own production.

3.3. Case selection

The case selection was based on an information-oriented-strategy, in which the researchers chose a case based on an expectation of the information it could provide. By doing so, the researcher could be confident that information was possible to obtain, despite having a relatively small data collection pool. This context-dependent knowledge could then, after its operationalization, be used to identify solutions (Flyvbjerg 2010). Furthermore, the case was categorized as a critical case because based on the definition of congestion, there is no objective congestion in the municipality, but yet citizens in the case area found congestion to be an issue. What made the case interesting for this project was to see if people who do not experience objective congestion, could be influenced to change behavior to reduce congestion. If this is the case, that users not experiencing objective congestion would change behavior to reduce their experience, then it was assumed likely, that users experiencing objective congestion likewise could be influenced.

In terms of the value of narrow case studies, questions have been raised in literature, such as it being biased towards verification and that it is not suited for testing hypotheses, which calls for caution when using this approach.

The value of a case study is the context-dependent knowledge. Obtaining this knowledge allows the researcher to elevate from the general rules of the field and proceed to become an expert within an area. Having general rules to apply to a case, and then from those results argue that it is the one truth, should not be the purpose of a case study. The purpose is rather to identify solutions within the context. The logic of general rules applies to classic science studies, but when studying society and human behavior no broad set of rules applies, and the future behavior can therefore not be predicted by a broad set of rules. This logic makes context knowledge a more reliable source of information to base future predictions upon because they follow context-shaped observations.

Lastly, the case study has the power of the example, meaning that one's thesis can be observed, investigated and tested in the case area (Flyvbjerg 2010).

The case introduction can be found in Chapter 6 *Case introduction: Vejen Municipality*.

3.4. *State of the art analysis*

The purpose of the state of the art analysis was to investigate existing literature and investigate studies examining similar issues, as a part of becoming experts within the context being analyzed. The benefit was that it allowed for more insightful questions to be identified, and to learn from other researcher's approaches, and how their research designs shaped their investigations.

Furthermore, the goal was to examine the relationship between planning, the transport system and its users, which was done using the following four questions:

- *What is congestion and when does it occur?*
- *What is the latest knowledge regarding citizen behavior in terms of transport, and what is the status of the Danish transport system?*
- *Do any regions or municipalities have any experiences with the four-step principle in a Danish context?*
- *What are the responsibilities of the Danish road authorities?*

The state of the art can be found in Chapter 4 *State of the art review*

3.5. *Survey*

A survey was carried out based on the state of art findings to test the discovered tendencies in the case area. The quantitative approach created a snapshot of the real word, which enabled the test of the preliminary findings, primarily in the mode of transport, car dependence and car usage in the municipality. The survey also worked as a tool to establish contact with the respondents and it created a contact platform, which was used to reach out to potential focus group participants.

The results of the survey are introduced and investigated in Chapter 8 *Users of the transport system*.

The survey was created using the findings from both the introduction and the state of the art, to test, if similar trends were present in the case area. The core elements of the survey was the users' modes of transport and experience of congestion.

It was decided to distribute the survey to as many as possible, with the only condition that the participants had to live in Vejen Municipality. It was distributed by taking contact to the chairpersons of 19 local councils in the municipality by either phone or e-mail, asking if they were willing to distribute it in their network. 14 chairpersons agreed to share the survey, which resulted in 287 completed surveys.

3.6. *Interviews with planners*

Besides the literature review and the survey, interviews with planners were carried out. The reason is that interviews can provide new aspects to consider from the planners point of view. It can also reveal more subjective opinions, which perhaps are not published, but still relevant to consider when finding solutions. To achieve this, the interviews were carried out using a semi-structured interview form, where a more informal interview situation was created. The informal situation allowed two-way

dialog between the interviewer and the respondent and gave the interviewer opportunity to ask questions outside the interview guide. This was preferred, rather than having a strict interview situation, steered by the interview guide (Kvale, Brinkmann 2015), because it was required that the respondents reflected upon the challenges they encountered, and how they experienced them. The interviewer was aware of this during the interview, and the semi-structured interview form allowed this, through the open dialogue situation.

The interview guides can be found in Appendix 6 and Appendix 7.

As a note regarding the interviews, they were carried out in Danish, because everyone involved were Danes, and to keep an accurate replication of the interviews, the transcripts were therefore done in Danish (Kvale, Brinkmann 2015). Quotes used in the project, are translated.

The transcripts can be found in Appendix 3 and Appendix 4.

3.6.1. *Interview with Vejen Municipality*

To collect local knowledge regarding the case area, and include a local planner's point of view, an interview was held with Hans Peter Christensen, who is managing consultant in the planning department in Vejen Municipality. He is responsible for waste, agriculture, transport and interdisciplinary cases and has as a result hereof first-hand experience with local planning in the municipality, and a wide knowledge regarding the municipality, their current plans and their future plans. Furthermore, he contributed with his expertise and knowledge in a discussion about both the four-step principle and the scenarios.

3.6.2. *Interview with Region Syddanmark.*

As a representative for Region Syddanmark, Erik Ørskov was interviewed. He is a senior consultant working with mobility and infrastructure. The interview focused on mobility perspectives and the role of the region, in terms of developing infrastructure in the region. Compared to Hans Peter Christensen, the purpose of this interview was not to obtain local knowledge, but to discuss the potential of inter-municipal planning and wider collaborations within the region. Furthermore, like Hans Peter Christensen, his experience also made him relevant to interview, for a discussion of the four-step principle and the scenarios.

3.7. *Focus group interviews*

The idea of a focus group interview is to create a situation in which the participants are interacting with each other, rather than taking turns answering the question of the interviewer. The purpose of this interaction is to make the participants reflect upon their behavior, and how their everyday practices are shaping their day-to-day routines. This allows the interviewer to observe their engagement and opinion, and their arguing can indicate how committed they are to their practices' (Halkier 2008).

In this interaction, there can though be a situation in which a level of social control can occur. This could be if a member, or even an opinion, achieve a level of power and agreement in the group. Does this occur, it can exclude atypical practices from

being revealed and they will be lost for the interviewer. For this context, focus group interviews are not a tool to necessarily identify practices or opinions of all the members, but rather a tool to identify a general opinion of the assembled group. If an atypical practice is identified it can be beneficial to have some sort of follow up dialogue with the respondent, to get a better insight into the practice (Halkier 2008).

3.7.1. *Creating a group*

In terms of assembling a focus group, there are, like with any other interview, considerations to make beforehand. First, the focus group should be as relevant and heterogeneous as possible, for the interaction between participants to flow. Does a group have too many similar respondents it is more likely for a social control to occur from this group of respondents, which can intimidate the other respondents from explaining their "opposing" practices. On the contrary, a group should not be completely in opposition to each other, because it can create a tension during the interview, which creates an uncomfortable interview situation for the respondents, thereby limiting the interaction (Halkier 2008).

The size of the group is likewise relevant to consider. A smaller group is vulnerable to respondents canceling, but it creates an interview situation where practices can be investigated deeper, whereas a larger group is not that vulnerable to a respondent canceling, but the investigation of practices will be at the group level. Lastly, the location of the interview is relevant. Hosting the interview at a public space sets a more formal tone for the interview, whereas meeting in a more personal space can set a more casual tone. As the interview progresses and the respondents get more familiar with each other, the setting though has a declining impact (Halkier 2008).

3.7.2. *Carrying out the interview*

For the focus group interview, it is beneficial to be two people performing the interview, because the primary interviewer will be occupied by steering the conversation and working as a moderator, the second interviewer is to assist in steering the interview and noting interactions, which the moderator possibly overlooks. Both interviews were carried out with the two researchers present.

Also, to start the interview, it can be advantageous to have a few short rounds of more broad questions, where all participants are "forced" to speak, to make them comfortable with participating. Hereafter some rather simple questions should follow before the interview enters its more core questions. The purpose is again to set a comfortable interview situation for the respondents (Halkier 2008).

The results of the focus group interviews can be found in Chapter 8 *Users of the transport system*, transcripts in Appendix 1 and Appendix 2, and the interview guide in Appendix 5.

3.7.3. *What was done*

After having established contact with possible participants through the survey, selected respondents were contacted by phone to plan the interview. The following planning was done using an online platform, on which the participants could check when they could attend an interview, based on eight predefined meeting times,

decided by the project group. The selection of participants was done in accordance with the approach described by Bente Halkier, with a goal of creating three groups consisting of 10 survey respondents, five short distance travellers and five long distance travellers.

The identification of these short distance- and long distance travellers for the three groups were likewise done in a manner so the participants had; different experiences of congestion, and were mixed in terms of gender, to try and create three heterogeneous groups.

The result of this process led to 17 respondents participating in the online planning, out of which it was possible to invite 15 respondents to two focus group interviews. When the day came, the first interview had five participants and the second interview had six participants. Despite last-minute cancellations, both focus group interviews had respondents with various experiences of congestion, which was the critical element in the focus group interviews.

In terms of carrying out the interviews, a central public building was used to host the interviews, to make it as easily accessible as possible for the participants. The interviews began with a short round of introductions and simple questions regarding their attitudes to transport and congestion before the interview entered its core elements. During this time, the participants were challenged to reflect upon their practices, and challenge each other's practices. To do so, scenarios were presented to provide a talking point for the participants, which also worked as a tool to challenge their existing practices and have them reflect about them. Furthermore, the scenario discussion worked as a way to discuss the desirability of the scenarios, with potential future users.

The scenarios are introduced in Chapter 9 *Scenarios* and further analyzed in terms of desirability in Chapter 10 *Desirability*.

3.8. *What can we say about the case?*

As a final remark, it is important to know that the interviews with the planners, and focus group participants, and the way it was structured, led to them presenting their personal opinion on some points. This means that if another researcher carried out similar interviews, using the same interview guides, the results could vary, due to the context of the interviews.

In terms of the survey, it was due to its size of almost 300 respondents representative for the identified commuters groups, and similar results would have been found if it was carried out by different researchers, which the questionnaire results from the state of the art confirms, as they have similar results and similar questions.

For the qualitative methods, it is difficult to argue for what and whom it represents because of the reason mentioned above. To accommodate this, the results of the interviews were compared with each other and with the quantitative results throughout the analysis.

Flyvbjerg says that in many cases it is a misunderstanding that a case cannot be used to generalize. He says that cases can be used to generalize if the selection of a case is based on a selection strategy (Flyvbjerg 2010).

Chapter 4. State of the art review

To understand what has previously been done within the field of transport planning, especially in Denmark, a state of the art review was done to obtain an understanding, of what knowledge that already exists.

The purpose of the review was to take a critical approach to the newest knowledge and identify how this project can contribute to developing the field of transport planning.

In the review, articles from primarily higher learning facilities and ministerial reports are investigated.

A review of the term congestion and its development is carried out. The purpose is to define congestion within the scope of this project.

The reason is that traffic development has changed the meaning of congestion in a Danish context. Several attempts have been made to define congestion in this context and these are introduced in the following paragraphs.

4.1. Defining congestion

The first attempt was made in 2000, where a project had the purpose of creating a definition of congestion and how to measure it.

4.1.1. Projekt Trængsel

In a collaboration consisting of six transport actors, the project started in 2000 and finished in 2004. Its primary research area was The Capital Region of Denmark.

During this four-year period, the project team collected data and carried out a literature review of 130 papers regarding congestion. In the literature review, it was found that most studies avoid a clear definition of congestion, and focus on the effects of congestion. Studies that do define congestion don't have the same definition. (Dansk Erhverv, FDM & DTL 2012, Copenhagen Municipality et al. 2004). Based on their own data and the literature review, the project team made their own definition, which was as follows:

"Congestion is an expression of the harms, drivers impose on each other in terms of reduced freedom to move, when they are in the traffic system." -(Copenhagen Municipality et al. 2004, page 6)

To measure the level of congestion a series of indicators was used to group the roads. The indicators were for highways speed and density and for cities, only speed was used, see Table 3 and Table 4.

Indicator set for measuring congestion on highways		
Congestion level	Speed	Density
None	Above 80% of the free flow speed	Below 20% of the maximal density
Starting	Near 80% of the free flow speed	Between 20%-33% of the maximal density
Significant	Between 40-80% of the free flow speed	Between 33%-60% of the maximal density
Critical	Below 40% of the free flow speed	Above 60% of the maximal density

Table 3. Indicators for measuring the level of congestion on highways. Source: (Dansk Erhverv, FDM & DTL 2012, Copenhagen Municipality et al. 2004)

Indicator set for measuring congestion in cities	
Congestion level	Speed
None	Above 80% of the free flow speed
Starting	Near 80% of the free flow speed
Significant	Between 40-80% of the free flow speed
Critical	Below 40% of the free flow speed

Table 4. Indicators for measuring the level of congestion in cities. Source: (Dansk Erhverv, FDM & DTL 2012, Copenhagen Municipality et al. 2004)

The reason for not using density as an indicator in cities is, that density in cities is highly influenced by traffic lights and therefore the density indicator was not found fit for measuring congestion (Dansk Erhverv, FDM & DTL 2012, Copenhagen Municipality et al. 2004).

Reviewing the definition and its applicability eight years after showed that the definition of indicators was also quite wide. For a driver not to be influenced by congestion with this definition, a driver would have to always be able to drive the free flow speed of the road on the highway and always be first at a red light in the city, which is a utopia (Dansk Erhverv, FDM & DTL 2012).

4.1.2. Commission of Infrastructure

In 2006 a Commission of Infrastructure was established to investigate future infrastructure needs within transportation and to develop strategies to handle future challenges within the transport sector, including congestion (Commission of Infrastructure 2008).

Due to their assignment of investigating future challenges, the indicators from "Projekt Trængsel" which measures current congestion levels, were not fit. To use them would require a significant work in terms of creating accurate transport models to predict future traffic, before the indicators would be applicable (Rosenstand, Olsen 2014). This meant, that they had to redefine congestion indicators.

The Commission of Infrastructure investigated the national traffic development and identified that areas near The Capital Region, Western Fyn, and The Triangle Region had insufficient road capacity, which lead to congestion. Therefore their approach was to compare the actual traffic with the capacity of the roads and use the ratio between the two to determine a critical level. The liability level on a stretch of road was defined as the traffic share of the capacity (Commission of Infrastructure 2008). With this approach, the commission defined congestion using the liability level, as presented in Table 5.

Congestion level	Liability level	Effect
None	Below 70%	No impact on drivers
Starting	Between 70-80%	70% leads to reduced maneuverability and minor speed reductions
Significant	Between 80-95%	Results in speed reductions between 10-25 km/h for highways
Critical congestion	Above 95%	Results in speed reductions between 25-30 km/h, for highways, with risks of stop-and-go traffic.

Table 5. The relationship between the liability level and congestion level and its effect on drivers.

Source: (Commission of Infrastructure 2008)

4.1.3. Commission of Congestion

The Commission of Congestion, a commission under the Danish Ministry of Transport, investigated congestion and solutions in The Capital Region of Denmark. Due to the above-mentioned publications, this commission also modified the definition of congestion. The definition from "Projekt Trængsel" was investigated by the Technical University of Denmark (DTU)-transport, and the primary issue with the definition of congestion was that relatively few cars could be enough to generate congestion (DTU Transport 2012b).

Therefore the Commission of Congestion and DTU-transport began a collaboration with the same aim as the aim from "Projekt Trængsel", to create a definition of congestion that secures a homogeneous understanding (and use) of the term. Furthermore, the collaboration identified which levels of congestion were acceptable and which were not.

Furthermore, it was the goal of the collaboration that the definition would work across more transport modes than cars (DTU Transport 2012b).

The modified definition was as follows:

"Congestion is an expression of the harms, drivers impose on each other in terms of reduced freedom to move, as a result of interacting with the traffic quantity and the capacity of the traffic system" (DTU Transport 2012a, page 2).

The 2012-definition of congestion provides a high level of attention to the capacity of the system and traffic quantity, concluding that congestion can be reduced by either increasing the capacity of the infrastructure or by reducing the total amount of trips.

It was argued that a complete removal of congestion should not be a goal, because the cost would outweigh the benefits. Congestion should only be reduced if travel times can be reduced to a level, which justifies the costs. Congestion can be “allowed” in areas where it is of least harm to the overall traffic (DTU Transport 2012a).

4.1.4. *Definition of congestion in this project*

Based on the above investigations, this project will use the definition from 2012, to analyze the transport system in both in terms of quantity and capacity.

Definition of congestion

“Congestion is an expression of the harms, drivers impose on each other in terms of reduced freedom to move, as a result of interacting with the traffic quantity and the capacity of the traffic system” -(DTU Transport 2012a, page 2).

Having defined congestion for this project, the remaining part of this chapter will analyze studies regarding the transport system in Denmark.

4.2. *Transport planning in Denmark - tools and planning hierarchy.*

The Danish transport planning process changed with the structural reform in 2007. Earlier municipalities, counties and the state had a shared responsibility for the road network. After the reform in 2007, in which the counties were merged into five regions primarily responsible for health infrastructure, the responsibility of maintaining and building roads was split between the state and the municipalities. The state is responsible for highways, national roads and several main roads, whereas the municipalities are responsible for their own local roads. The five regions have in this context no responsibility for the roads, but influence the transport development by developing regional plans and strategies. The goal of these plans are not to dictate the development, but to support it, and provide input to the municipalities (Danish Ministry of Interior 2005).

At the national level, the political aspect is also very important. Politicians represent different areas of the country, and they can potentially prioritize their own areas, even if they are not as congested as other areas, as a political goal, to maintain their popularity with voters, see chapter xx.

In regards of transport planning in Denmark, this project contributes to the field, by investigating how a municipality can work with a more efficient and sustainable use of resources through prioritized planning, using the four-step principle. As only two municipalities are using a similar approach, and they just started in 2017, knowledge on this topic is limited in a Danish context.

4.3. *Commuting and mode transport in Denmark*

Knowledge and data about commuting are collected in Denmark on a large scale. When investigating commuting and modes of transport, it is important to consider that transport consists of many different elements. Some elements are technical and some are social elements. Transport should therefore be understood as a socio-technical phenomenon, because it combines technical aspects such as transport technology, with individual choice and priority. This paragraph will introduce how the planning process currently is carried out.

4.3.1. *State actors*

One of the most significant contributions in terms of commuting and mode of transport is "*Transportvaneundersøgelsen*" (DTU Transport n.d) which is a yearly publication by DTU-transport. It investigates the distance commuters travel, their mode of transport, travel time, number of trips etc. (DTU Transport n.d). Furthermore, it helps to monitor trends and developments in Danish transport, as it is published yearly. As a tool to understand transport as a socio-technical phenomenon, the data is limited, because the investigation does not examine for example matters of attitude towards other transport modes. This project therefore contributes to the area of commuting and mode of transport in Denmark by having a focus on citizens and their attitudes towards alternative commuting.

Similar to "*Transportvaneundersøgelsen*", The Danish Road Directorate publishes a yearly report, which investigates transport on highways and national roads. Their report maps the level of congestion on the road network and uses prognoses to estimate growth on their roads (The Danish Road Directorate 2017c).

The Danish Road Directorate also published a rapport in 2017, "*Drivkræfter bag trafikvækst*" which explains why traffic is increasing in Denmark. In terms of cars, the report concluded that for drivers the reasons are increased prosperity, population growth and culture and norms etc. (The Danish Road Directorate 2017a).

The report introduces ideas of alternative modes of commuting which are relevant for this project. One of these is car-sharing. However, like "*Transportvaneundersøgelsen*", it does not investigate the attitude of citizens towards new means of transportation.

The most recent research from the Danish Ministry of Transport found that increasing capacity of the road network, increases the number of cars, and therefore congestion is not solved only through expansions, but rather just postponed. Their rapport concluded, that after some years, the congestion levels return to the earlier levels, simply because of the car growth (Ministry of Transport 2018). Likewise, The Danish Road Directorate made a similar remark, in their analysis of a new proposed highway. They stated that it would not solve the issue of congestion, but simply postpone it (The Danish Road Directorate 2016c). This indicates a need for alternative approaches to reduce congestion, to support the current planning practice.

4.3.2. *Non -government organizations*

Danish Industry, an NGO who publishes articles regarding transport, found in their latest investigation that on average, a Danish commuter travels further than ever before (Kraka 2018). This is an interesting point because it creates the foundation for investigating how to maintain the best possible flow on the road, to reduce time spent commuting, which is a part of the scope for this project.

4.3.3. *Contribution*

This project will contribute to the knowledge regarding mode of transport, by investigating if alternative solutions can be used to reduce congestion, with an emphasis on citizens and their behavior. The purpose of the analysis in the project is to identify possible solutions that have a lower resource use, and lower construction cost, than expanding infrastructure, by using the four-step principle as an approach.

4.3.4. *Behavior and mode of transport*

All of the above-mentioned rapports show that there exists significant knowledge about commuting in a Danish context. However, knowledge about citizens behavior in relation to transport is limited.

4.3.5. *State actors*

The Danish Ministry of Transport is investigating a new way of understanding transport. The concept is a system in which users can combine more modes of transport by using a "Mobility as a service" (MaaS) approach. In short, MaaS is a platform in which technology helps citizens combine public transport with bike- and car rental for a faster journey. The system is still in development, and the potential of MaaS in terms of reducing congestion is therefore yet to be seen (Ministry of Transport 2018).

In terms of behavior, recent studies in Denmark from higher learning facilities, which investigated behavior found that to change people's behavior and reduce congestion, road pricing is the most efficient mean. Road pricing is not very popular among citizens and politicians, based on a road pricing project which was suggested by the social democrats in the year 2011, but withdrawn again, as public opinion was against it (Ministry of Transport 2018, Trængselskommissionen 2013, Produktivitetskommissionen 2014).

4.3.6. *Contribution*

This project will contribute to the field regarding mode of transport and behavior, by investigating existing user behavior and attitude, and how these can be influenced and potentially changed. The purpose is to investigate the desirability of different transport systems and the behavior of users in the current transport system.

4.4. *Findings*

The findings from the state of the art are as follows:

- *Congestion is an expression of the harms drivers impose on each other in terms of reduced freedom to move, because of interacting with the traffic quantity and the capacity of the traffic system.*
- *Mode of transport, travel time, and distance travelled to work are well researched, and the state of the art review supports the findings from the introduction, that car ownership and congestion are increasing in Denmark.*
- *There is a limited knowledge about the user's attitude toward new transport initiatives and their behavior.*

Chapter 5. Theory

The purpose of this chapter is to present the used theories, describe how they are operationalized in this project, and how they relate to the problem formulation. Therefore, each theory will be concluded with a text box describing how the theory provides tools to investigate the problem formulation.

5.1. Plan analysis

To understand the planning context and gain insight into the planning agenda, an analysis of current plans and plans related to mobility, are investigated for the case area. This is done by analyzing the plans using three overall planning paradigms, which were identified by Theodor Geiger. The three paradigms for planning are as follows;

- *Corrective planning.*
- *Prognostic planning*
- *Programmatic planning (Lyager 1992, Gaardmand 1980).*

5.1.1. Corrective Planning

The first planning paradigm, corrective planning, is an approach that Geiger argues is not planning at all, but rather a conception of what used to be seen as planning. In corrective planning, the growth of cities is determined by free market forces. In terms of urban growth, these are demand for housing, jobs and transport. Geiger characterized it as "*unlimited traditional liberalism*". In this context "unlimited" is understood as if there is no obstruction for each individual, other than the market forces, although this can also be an obstruction in itself (Gaardmand 1980).

The reason for this is, that if the development of for example public transport does not follow the demand of the citizens, the growth of a city can be limited because a lack of mobility can result in lack of growth in other sectors.

In terms of the role the planner undertakes in corrective planning, their part is to not limit or direct the planning in any certain way. Planners will instead oversee the city grow and only make minor adjustments or corrections, as required. In transport, the passivity of the planner can though have a negative effect if actions are not taken until a significant need is present (Gaardmand 1980).

5.1.2. Prognostic Planning

The second planning paradigm is prognostic planning. Prognostic planning is an approach in which planners, based on statistics and prognoses, attempt to plan based on earlier and current development trends. These trends can be both population development or user trends in terms of transport.

For this paradigm, the role of the planner is to act accordingly to what the prognoses show. Geiger describes the planner as one whom "*clears the way*" for the natural development of the city, characterized as "*interventional new-liberalism*". Like in corrective planning, the planner is not actively steering the direction, but acting based on prognoses. There is no active decision-making by the planner (Gaardmand 1980).

The challenge with prognostic- and corrective planning is, that they are both descriptive types of planning. They describe the development of a city, based on what has already been developed, and what is going to be developed, and makes way for continuing that development, rather than actively steering the development.

5.1.3. *Programmatic Planning*

The last planning paradigm, programmatic planning is characterized, and varies from the previous two, because of the role of the planner. In programmatic planning, the planner is as an active decision-maker, who tries to steer the direction of the planning. Geiger characterized the planner as more of a politician, because of the active role. Compared to the previous two planning types, it is not descriptive, but normative instead.

While the prognostic planner made decisions based on prognoses, the programmatic planner analyzes the situation to determine if development trends are desired, and based on these results, attempts to steer the development (Gaardmand 1980).

Planning types can also be combined as it is not always possible to say that a certain plan is only one paradigm (Gaardmand 1980).

Operationalization

Using the paradigm descriptions, plans from the case area were analyzed to understand the planning paradigm and to understand how the actors in the case area conduct planning. Plans from different levels (regional and municipal) were investigated, and it is analyzed which paradigm the plan supports. The plan analysis can be found in chapter xx.

By combining the contextual knowledge from the plan analysis with the information from the interviews, it was possible to identify what characterizes municipal planning, and the influence of planning paradigms, which is the first sub-question related to the problem formulation.

5.2. *Users*

The user perspective is investigated, to identify how social practices can be influenced and how they emerge. The reason for including this perspective is to be able to argue for initiatives from the first step in the four-step principle, and how these initiatives can contribute to planning. This is also relevant in terms of sustainability because these initiatives have the potential to improve the road capacity by changing user practices instead of expanding the infrastructure.

Several approaches exist to investigate user behavior, such as theory of planned behavior, which investigates attitude, or citizen characterizing, which based on a data collection creates user types and defines behavior (Haustein, Jensen 2018, Møller, Haustein & Bohlbro 2018). Social practice differs from the above approaches because the theory has a larger focus on external factors, such as material configurations. It thereby recognizes the role of objects in individuals' everyday life and routine (Gram-Hanssen, Friis 2013). As the purpose of this project is to identify behavior, what defines it, and what influences it, practice theory was included.

5.2.1. *Social practice theory*

Social practice theory is a tool to investigate the variety of aspects that influence behavior and it explains change, stability and social order in society. The theory does so by investigating the elements related to how social practices emerge, evolve and disappear into an everyday routine. In terms of understanding what a practice is, it can be defined as a behavior that is carried out by an individual but shaped by a social order that is continuously challenged and changing. This continuous change is what influences and changes individuals' habits and routines (Gram-Hanssen, Friis 2013). Whether social practices are shaped primarily by social order and norms or through individual norms and personal choice is hard to decide. In this project, social practices are understood as an entity, in which several elements interact, and these interactions are the influencers of individual's social practice. These elements, see Figure 8, are explained further in the following paragraphs.

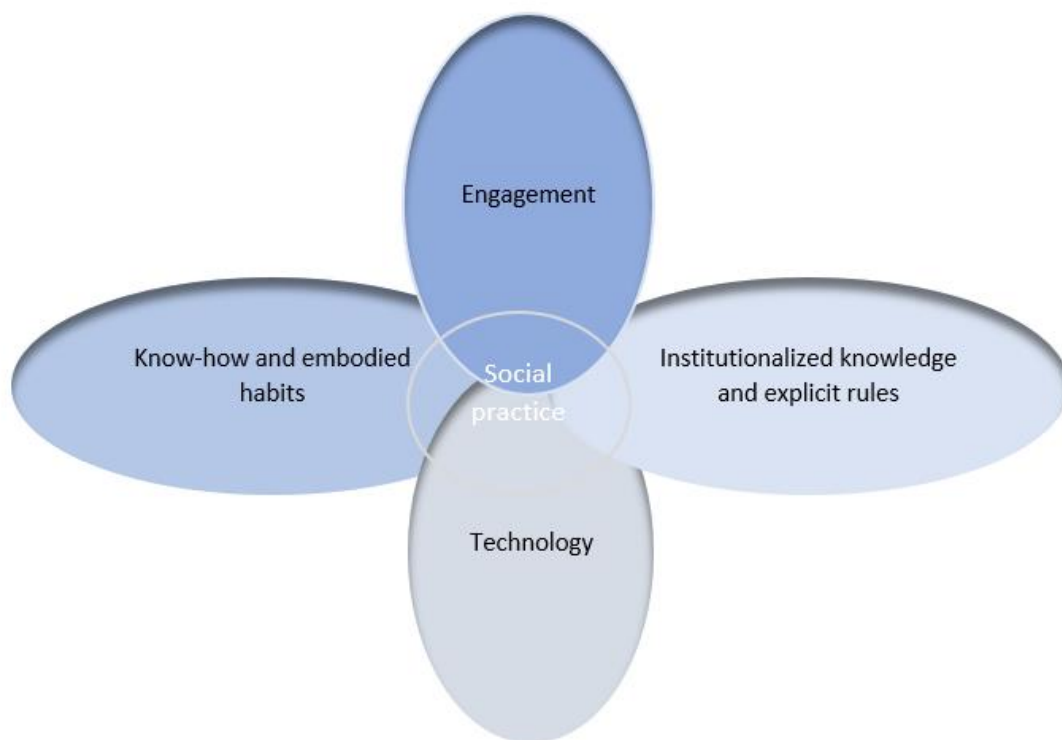


Figure 8. The four elements, which influences an individual is social practices. Source: (Gram-Hanssen, Friis 2013)

5.2.1.1. Know-how and embodied habits

The know-how and embodied habits consist of peoples' every-day-practices. These practices are the ones individuals carry out through their everyday life, and they are often carried out almost as a reflex without much reflection (Gram-Hanssen, Friis 2013).

5.2.1.2. Institutionalized knowledge and explicit rules

The institutionalized knowledge and explicit rules are different from the know-how and embodied habits, because it is something people actively choose, rather than it being a reflex. For example, choosing sustainable modes of transport to reduce one's carbon footprint.

This knowledge can be obtained from various sources such as campaigns or commercials and when applied, it is due to a reflection regarding the topic.

In the context of this project, it should be noted that there is no direct link between obtaining institutionalized knowledge and changing practice (Gram-Hanssen, Friis 2013).

5.2.1.3. Engagement

This element refers to there always being either an opinion or a goal when an individual is carrying out a social practice. When one actively changes his or her social practice, engagement is a part of the reason here for. This means that to influence social practice, it is necessary to influence an individual's opinion or goal (Gram-Hanssen, Friis 2013).

5.2.1.4. Technology

Technology typically influences people's social practices by providing new ways of carrying out their old practices. This relates to the engagement in terms of people's opinion towards the new technology (Gram-Hanssen, Friis 2013).

The understanding of technology as a part of users' social practices is one of the points that separate the social practice theory from other social theories.

5.2.2. *Changing practice*

As practices are held together by the above four elements, changing ones' practice is no easy task. Due to the interaction of elements, an introduction of a new technological element can influence other elements and thereby influence an individual's practice. If enough elements influence an individual, a social practice change can be accomplished. For the element of engagement, the point of it being driven by opinions or goals should be highlighted, as due to the entity of social practices. Good experiences are important because bad experiences can create a negative engagement towards a new element. If a negative engagement occurs for an individual, it can create a barrier for a change of social practice.

Lastly, it should be mentioned that the same element could have different understandings or effects, depending on the users' perception of it (Gram-Hanssen, Friis 2013).

Operationalization

Practice theory was used on the data collected from the focus group interviews with the purpose of identifying social practices and explore the opinion and behavior of the respondents in relation to the current transport system. It was also used to determine the desirability of the scenarios. Furthermore, practice theory was used as a tool to investigate the respondents' attitude to the four-step principle, which is the second sub-question related to the problem formulation.

5.3. *Scenario introduction*

For policymakers, it is challenging is to develop sustainable solutions and decide which steps to take, to realize these solutions, because the future effects of a given policy package involve a high level of uncertainty. A way to investigate this is a scenario

approach, which can explore the future development and effects of policy measures, by either forecasting or backcasting. The benefit of such a scenario approach is that it allows for an investigation between the desired scenario, an expected scenario, and a comparative analysis of the two (Shiftan, Kaplan & Hakkert 2003). To do so, several considerations are relevant to introduce, starting with a definition of a scenario.

5.3.1. *Scenario building*

In this project, a scenario is understood as a hypothetical sequence of logical and plausible events. To create the sequence, the scenario should be defined as a forecasting or backcasting scenario and based on either common opinion or knowledge of experts. Finally, it can be created as either a menu-driven or policy package approach (Shiftan, Kaplan & Hakkert 2003). Forecasting studies generally attempt to identify future societal development trends and how they will impact the societal context. Backcasting studies are focused on identifying how the desired goal can be reached.

In this project, a backcasting approach was chosen in order to investigate an overall goal that accommodated the challenge of the problem formulation and to explore how this goal could be reached. The backcasting approach is therefor further elaborated in the following.

5.3.2. *Backcasting approach*

Backcasting can be described as a tool to investigate which steps to take to transition towards a desired scenario. The researcher carrying out the backcasting does so, by investigating which societal steps are required to realize the desired scenario.

When working with a backcasting approach, there are several sub-approaches, which can be taken, and which have different focuses. Table 6 introduces these.

Approach	Focus
Participatory	The participatory approach focuses on key actors who can drive change and a strategic plan is created, in order to support these key actors. A good plan includes both actors and stakeholders and has a sub-purpose of increasing engagement and using their knowledge, to contribute to the scenario building. The primary purposes are social empowerment and increased social capital.
Path-oriented	The path-oriented approach has a higher level of focus upon the sub-goals, which must be realized before the desired scenario can be reached. The technique is to investigate the gap between present images and future images. The researcher must determine the path to reach the desired scenario, by creating the future images.
Target-orientated	A target-orientated approach is when an investigation examines what should be changed on a smaller scale than both the path-oriented and participatory approaches, in order to achieve the desired change. The emphasis is on the targets and their descriptions, and the targets are analyzed by looking into the feasibility, the path and the desirability of the scenario.

Table 6. *Backcasting approaches and the focus of each approach* (Wangel, Ilstedt 2014, Höjer, Gulberg & Petterson 2011).

In extension of the approach, there are also different types of scenarios to consider.

5.3.3. *Types of scenario building*

For scenario building, three types of scenarios were identified. The three types are; *predictive scenario building*, *explorative scenario building* and *normative scenario building*, see Table 7.

Scenario building types	Purpose
Predictive	Identifying “what will happen” if policy measures A and/or B are implemented based on previous experiences and expected development trends.
Explorative	Uncovers “what could happen”. The explorative scenario has a higher level of uncertainty and typically investigates a longer period of years.
Normative	Analyzes “how can a specific target be reached?” using either forecasting or backcasting.

Table 7. *Scenario building types and their purposes* (Höjer, Gulberg & Petterson 2011)

In relation to the previously introduced approaches, the scenario approaches and scenario building types can be paired as follows:

- *A forecasting approach is focused on predicting future changes in terms of what will happen, and can therefore, be paired with a predictive type of scenario building.*
- *Backcasting is a more systematic investigation of how the desired scenario can be reached, and it should be combined with the normative scenario building type.*
- *The explorative building type can be used both in terms of backcasting and forecasting, but its primary use is as a tool to create research questions, which can then be investigated using either predictive- or normative scenario building (Shiftan, Kaplan & Hakkert 2003, Höjer, Gulberg & Petterson 2011).*

5.3.4. *Scenario building in this project*

In this project a backcasting approach was undertaken by using the means of expert knowledge to construct policy package scenarios, using knowledge from the state of the art, the survey and the interviews. In combination with the backcasting, a normative type of scenario building was used to identify how the target could be reached. To do so, future images were created and compared to discuss policy measures and desirability. Furthermore, the target-oriented approach supplemented this purpose, by allowing for small-scale investigations, which provided case-specific knowledge that would not otherwise have been identified. Lastly, the target-oriented approach helped to identify future goals and conflicting interest because of the work with the future images.

In addition, as a foundation for the scenario building, the scenarios were developed in combination with the four-step principle, which means that four scenarios were developed. Each scenario therefore, represents a step in the four-step principle. This

resulted in Scenario I suggesting initiatives that can influence behavior. Scenario II focuses on better use of infrastructure, Scenario III on expansions of infrastructure and lastly Scenario IV on construction of new infrastructure. Furthermore, the scenarios were developed as a step-by-step process, so Scenario II contains the elements of Scenario I, Scenario III contains elements from Scenario I and Scenario II etc. The reason is, as argued in relation to the four-step principle, that most initiatives should be centered around step one and step two. They are therefore implemented in each scenario. This does not mean that Scenario III cannot be realized if Scenario I and Scenario II are not realized, as the paths for the scenarios are not dependent on the previous scenario paths.

It was not possible in this project to have an in-depth involvement of experts. Instead of using "The Delphi method", in which a controlled feedback approach is taken using questionnaires (Shiftan, Kaplan & Hakkert 2003), the scenarios were presented for experts through a short presentation and their feedback was then incorporated into the scenario, serving as a reality check.

Operationalization

The structure of the scenario building was based on the following steps for a target orientated approach:

A long-term target is identified based on the study. The target should be important and not easily reached. In addition, it should be unachievable without societal changes.

Feasibility is analyzed and if the analysis concludes that the long-term target cannot be reached within pre-existing development trends and structures, step three starts

At this point, multiple target-fulfilling images of the future are created

The developed scenarios are investigated in terms of desirability and in terms of the complexity of the path (Wangel, Ilstedt 2014). By carrying out these steps, it was investigated how mobility could be increased in a municipality, which is the third sub-question related to the problem formulation.

5.4. *Joint theoretical framework*

The theoretical framework consists of three aspects, with different purposes, and therefore this section will conclude the chapter by explaining how the various theories support each other in the investigation of users, planner and mobility.

The theoretical framework can be seen as a top-down investigation, in which the planning paradigm was investigated, to create the foundation for understanding how infrastructure is planned. By identifying the planning paradigm, the planning approach could be investigated in relation to the four-step principle, with the purpose of analyzing if the paradigm is suited to support a transition towards a new desired scenario.

Having investigated the planning level, the users being planned for were also relevant to include, to uncover how they act, and to identify their role in the system. The users were investigated in relation to social practices, and how to promote changes in these.

The purpose was to identify means to realize the potential in changed user behavior. This correlated with the planning level, because if user practice was the subject of change, alternative solutions should be taken into account in planning, which can compete with existing social practices, in order to obtain change. Furthermore, these alternative solutions should likewise support a transition towards the desired scenario.

Finally, by using a scenario approach, four different scenarios were investigated in terms of realization, potential and desirability. The purpose was to identify a path to transition towards the designed scenario for all four steps and create a foundation for a comparison of the four scenarios.

5.5. Findings

The key points from the theory chapter are:

- *Theodor Geiger's 3 planning paradigms; corrective, prognostic and programmatic will be used to analyze plans related to transport in Vejen Municipality to see if they support the desired transition. The analyzed plans were supplemented by interviews with planners from Vejen Municipality and Region Syddanmark. The primary contributions of the theory were that it allowed an analysis of how different planning paradigms influence municipal planning, and it helped to identify which barriers exist in planning and thereby under which circumstances planning is carried out.*
- *Social practice theory was used to investigate the practices of the focus group participants to identify ways of influencing their social practices. This was done using focus group interviews with commuters in Vejen Municipality and contributed to the understanding of their current social practices, and attitude towards the created scenarios.*
- *To investigate alternatives for mobility in Vejen Municipality four different scenarios were created. Each scenario represented a step in the four-step principle and was investigated in terms of their potential and desirability through interviews with planners and commuters from Vejen Municipality. The primary benefit was that the scenarios worked as a tool to develop solutions and investigate which steps to take, to realize their potential.*

Chapter 6. Case introduction: Vejle Municipality

The case study creates the basis for the analysis and scenario development. Vejle Municipality will be presented with a description of current infrastructure, public transport, and future plans for new transport infrastructure.

6.1. Vejle Municipality

Vejle Municipality is located in the middle of Southern Jutland and is part of Region Syddanmark. The municipality has approx. 50.000 inhabitants and none of the cities have more than 10.000 inhabitants. The average income per person is 231,000 kr., which is just below the regional average, and current prognosis shows that the population is becoming older. During the next 20 years the number of citizens between 25 and 64 is expected to decline by 7% while the number of citizens aged 64 or older is expected to grow by 34% (Region Syddanmark 2017).

The municipality has one of the largest car ownership rates in Denmark, with 75,9% of all families owning at least one car. (The Danish Road Directorate 2017b)

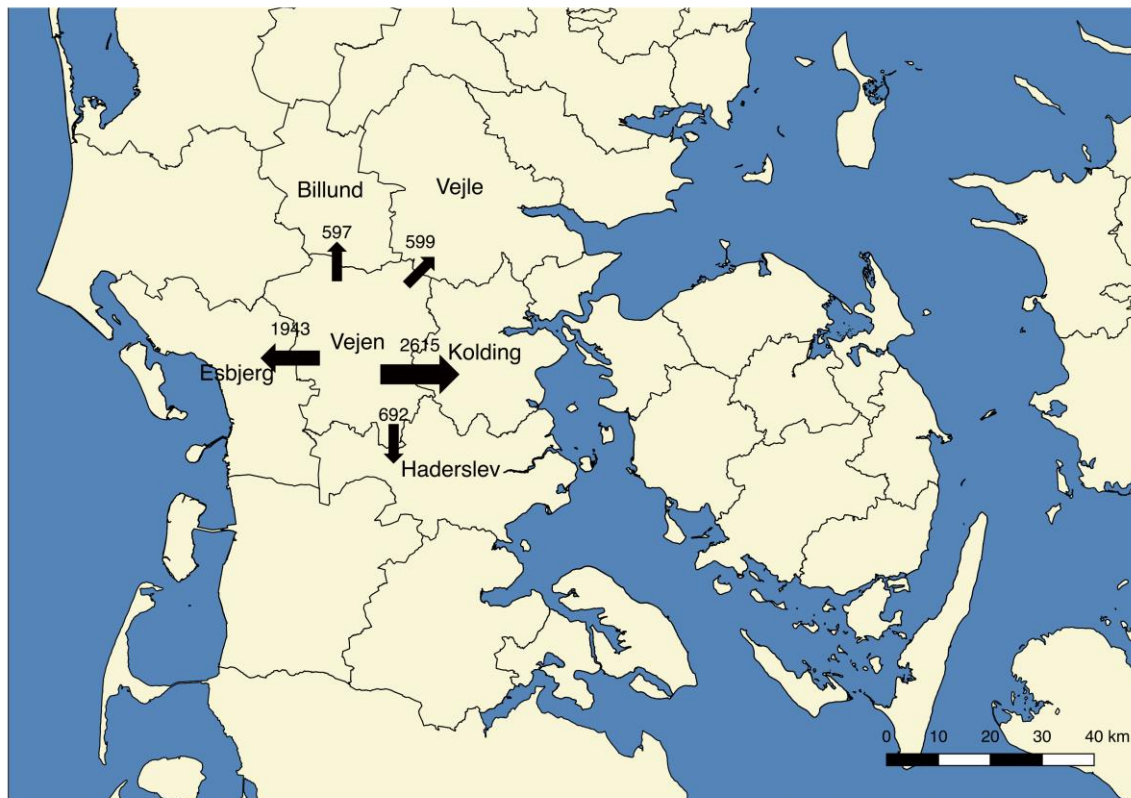


Figure 9. The number of daily commuters to neighboring municipalities, from Vejle (Region Syddanmark 2017). Own production. GIS data from: (Danish Geodata Agency 2018)

In terms of employment, a significant share of citizens is commuting to neighboring municipalities such as Esbjerg, Vejle and Billund, see Figure 9 and Figure 10.

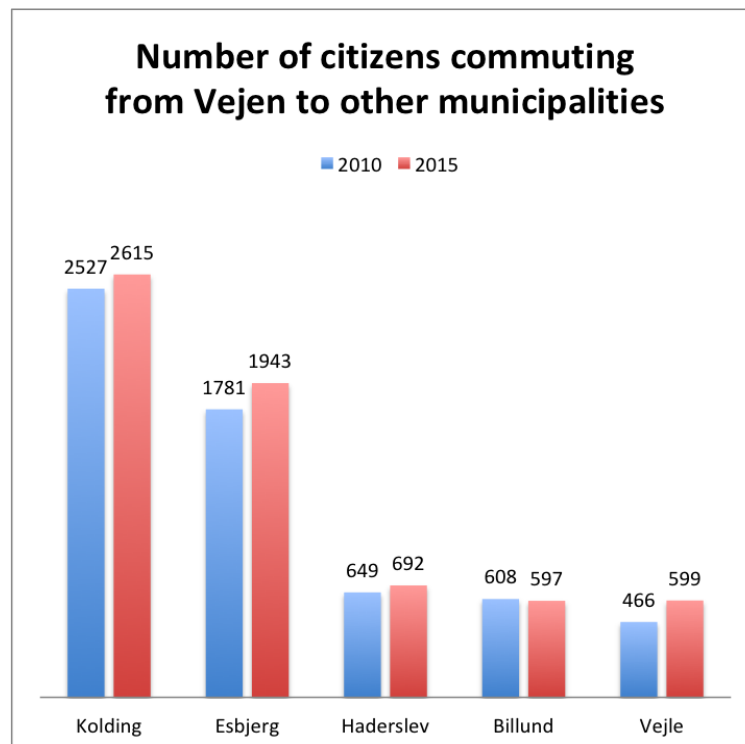


Figure 10. Number of inter-municipal commuters from Vejen (Region Syddanmark 2017).

6.2. Infrastructure

The two most used highways outside The Capital Region are found in Region Syddanmark and Region Midtjylland, which are *Østjyske motorvej*, with 82.000 annual daily users and *Sønderjyske Motorvej*, with 80.000 annual daily users in 2017 (The Danish Road Directorate 2017b). These two highways have been subject to an increase in traffic of more than 100% in the past 20 years, and this trend is assumed to continue, resulting in increasing congestion levels. Kolding and Vejle are specially identified as hot spots with high congestion and high risk of increased congestion if no actions are taken (The Danish Road Directorate 2016c).

For Vejen Municipality, the largest roads are *Esbjerg Motorvej*, which connects Esbjerg with Kolding through Vejen, and *Østjyske motorvej*, which creates a connection to Aarhus. The *Esbjerg Motorvej* has between 20.000 and 40.000 cars each day, which is approx. half of the other two mentioned highways.

Like *Østjyske Motorvej* and *Sønderjyske Motorvej*, *Esbjerg Motorvejen* also has experienced an increase in traffic of 25% over the last 10 years, despite the fact that the municipalities which it runs through; Esbjerg, Vejen and Kolding, have had limited inhabitant growth¹ during this period.

To accommodate these traffic trends, action must be taken.

¹ Population growth from 2012-2017, Esbjerg: 0,8%, Vejle: 0,3% and Kolding: 3,4%.

6.2.1. Political action

The solution suggested to reduce congestion in the area is a new highway, which can be seen in Figure 11. This highway was agreed upon by a political majority of V, LA, K, S, DF, RV² and the highway is planned to go from Give to Haderslev (The Danish Road Directorate 2017d) and is set to be investigated as a four-lane highway, with a speed limit of 130 km/h.

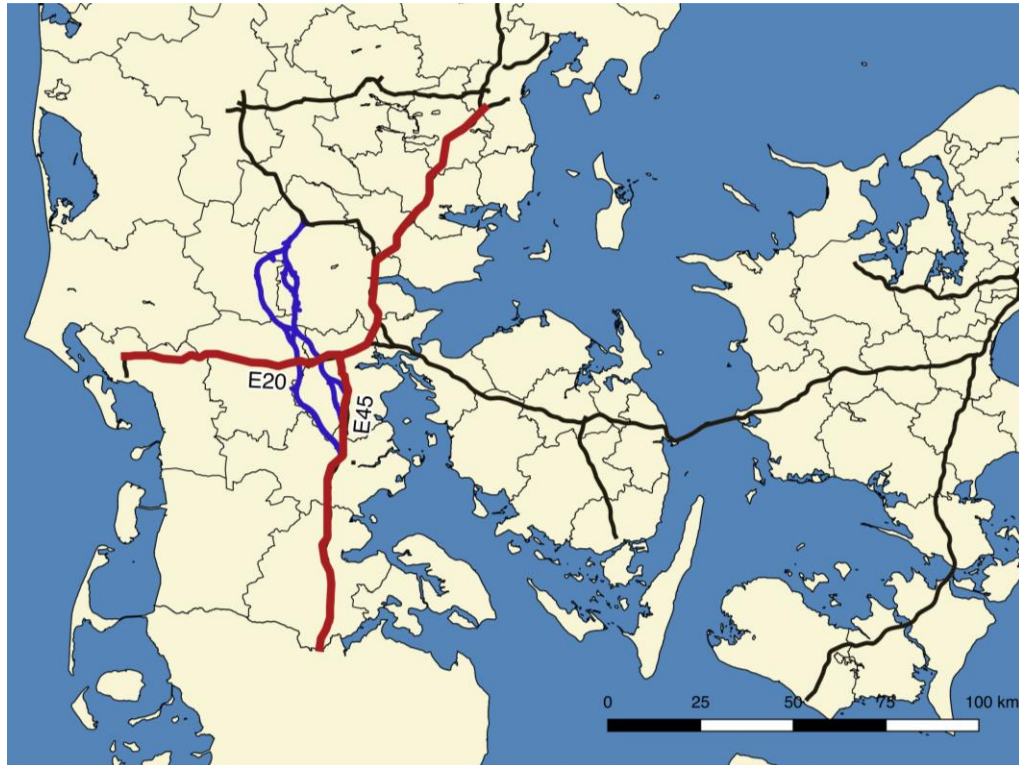


Figure 11. Østjyske Motorvej (E45), Sønderjyske Motorvej (E45) and Esbjerg Motorvej (E20), marked with red. The possible corridors for the new highway is marked with blue. Own production. GIS data from: (Danish Geodata Agency 2018).

The purpose of the new highway is to reduce congestion on *Østjyske motorvej*, create better connections between the cities in Jutland and reduce travel times (The Danish Road Directorate 2017d). Furthermore, a new highway can increase job catchment areas and calculations in both 2013 and 2016 have found the highway to be economically beneficial for both businesses and citizens due to the travel times reductions it will provide to its users (The Danish Road Directorate 2017d). It was found that the total amount of hours which could be saved by establishing a new highway would be between 19.000-29.000, depending on which alignment is chosen (The Danish Road Directorate 2016c).

A further investigation of the scenario was therefore initiated with a budget of 40 million DKK and will be carried out by The Danish Road Directorate (The Danish Road Directorate 2017d). The final placement of the traffic corridor is to be decided by the summer of 2019 (The Danish Road Directorate 2018).

² The political parties; *Venstre, Liberal Alliance, Konservative, Socialdemokratiet, Dansk Folkeparti, Radikale Venstre*

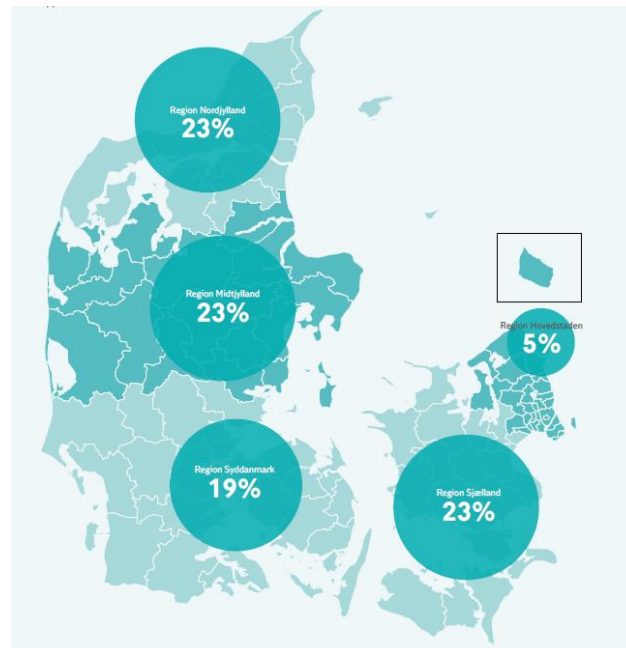


Figure 13. % of areas in each region, with no nearby bus or train stop (within 1x1km) (DI Business 2018).

This difference in accessibility means, that when comparing Region Syddanmark with Region Hovedstaden it is found that, in region Hovedstaden every 5th employee arrives to work by bus or train, while it is every 50th in region Syddanmark (DI Business 2018). In terms of the other regions, the accessibility is though somewhat similar.

6.3.1. *Public Transport in Region Syddanmark*

This chapter will provide an overview of the public transport systems for trains and busses servicing Region Syddanmark.

6.3.1.1. Trains

Public transport in Region Syddanmark is built around regional train lines, as it is most common in Denmark. The larger regional train stations in Region Syddanmark located close to the case area, are stations such as Fredericia, Vejle, Kolding. Further east is Middelfart station, and to the west, Bramming station, see Figure 14.

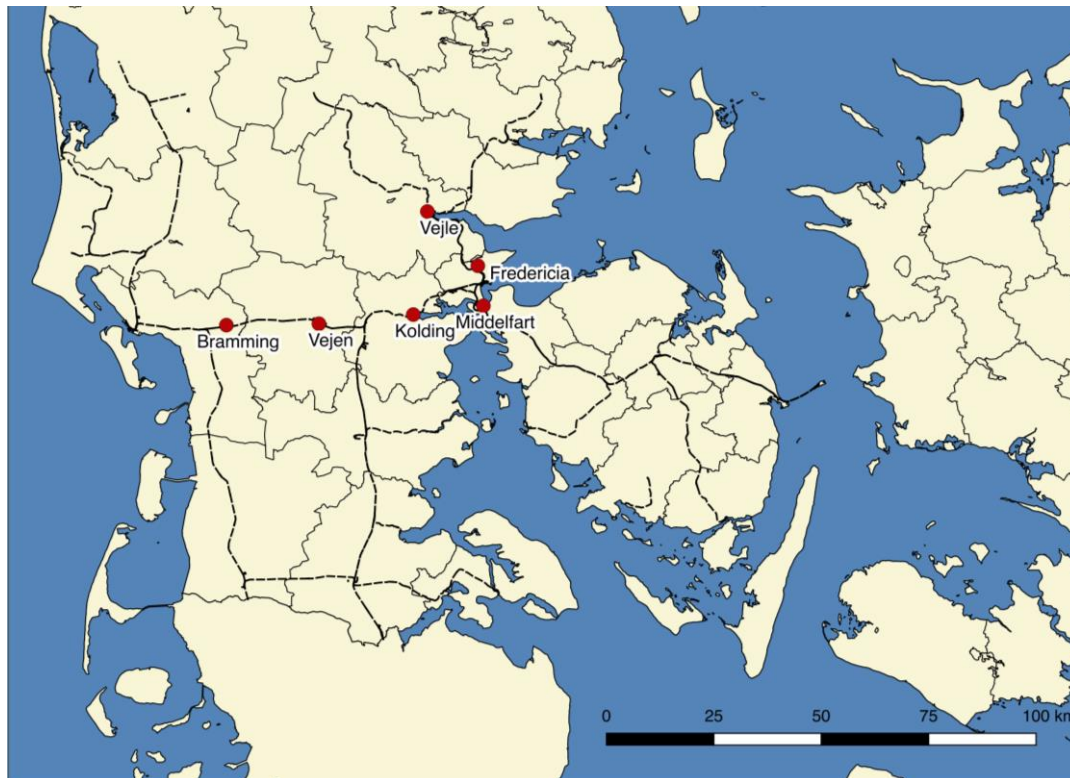


Figure 14. Trains stations near Vejen with interregional connections. Own production. GIS data from: (Danish Geodata Agency 2018)

These stations have in common that three or more train lines stop here. The stations are a part of the cross-regional train system and are traffic nodes. In terms of usage, train stations passenger numbers are presented in Table 8 for 2015 and 2032. The prognosis was created with a series of assumptions regarding which infrastructure projects that should have been realized in 2032 (Danish Ministry of Transport, Building and Housing 2018).

Station	Passengers 2015	Expected passengers in 2032	% Development
Fredericia	4900	5300	8
Veje	7900	8200	4
Kolding	5700	6000	5
Middelfart	2600	2900	12
Bramming	1800	2200	22
Vejen	1400	1500	7

Table 8. Daily passenger numbers for selected stations in Region Syddanmark, and their expected daily passenger numbers in 2032 (Danish Ministry of Transport, Building and Housing 2018).

To support these train lines, there are additional local train lines running from Esbjerg, through Tønder or from Kolding and through Padborg to Hamburg (Danish Ministry of Transport, Building and Housing 2018).

When looking at the development expectations in a 17-year prognosis, the growth is relatively low, and the train lines with the highest growth in traffic have at present a

low usage. This indicates that the train usage in Region Syddanmark is not expected to grow significantly.

6.3.1.2. Busses

The region is also serviced by busses, which primarily are operated at a low frequency (1-2 times per. hour). Numbers from Sydtrafik, the traffic company operating the busses, show that only 2% of all trips in the region are done by bus and only 1% are done by train. In relation to the travelled distance, cars account for 89% of all travelled kilometers, whereas busses account for just 2% and trains for 4%, see Figure 15 (Danish Transport and Constructions Agency 2015, Sydtrafik 2014)

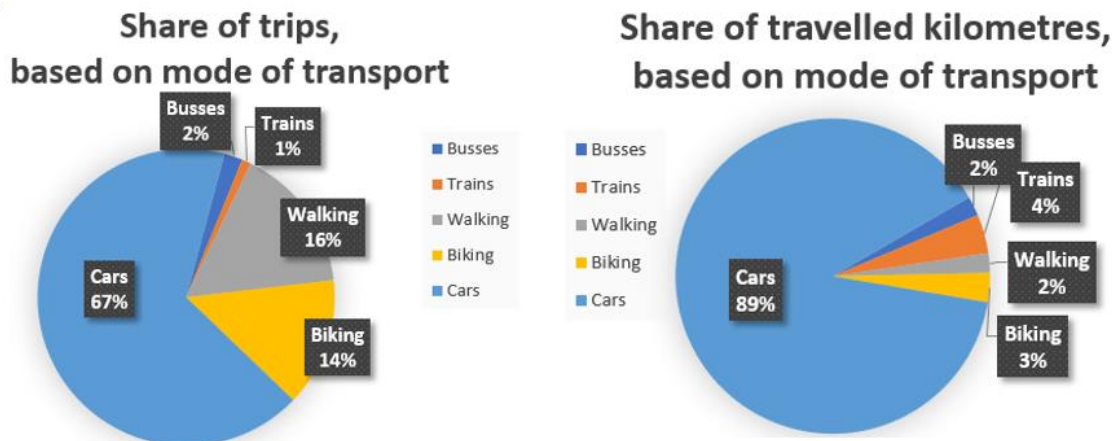
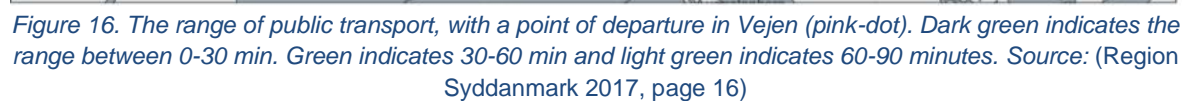


Figure 15. Distribution of trips and travelled kilometres, shared between five modes of transport (Sydtrafik 2014)

The latest reports released by the Danish Ministry of Transport, Building and Housing, also show that busses from Sydtrafik have relatively low numbers when looking at passengers. The total number of passengers in 2015 was 20.6 million passengers, and in comparison with other regions in Denmark, this is a low figure (Danish Transport and Constructions Agency 2018). The average number of passengers pr. inhabitant for the traffic companies in Denmark was 59,1 but for Sydtrafik the number was 29,3 which was the lowest of any traffic company in Denmark (Danish Transport and Constructions Agency 2018). This is partially due to the fact that large areas of region Syddanmark have a low population density, which results in that the potential number of passengers per square kilometer is lower than in other regions.

The busses driven by Sydtrafik also have the lowest number of bus operation hour's pr. citizen, so the frequency is also low (Danish Transport and Constructions Agency 2015). To conclude the chapter, Figure 16, presents the range of public transport based on three time intervals to illustrate current mobility.



The most important findings from the case area are the following:

- *It was found that the case area has a high car share compared to the regional and national averages and has a growing number of inter-municipal commuters.*
- *The range is significantly larger by car than by public transport, with a point of departure in the city of Vejle.*
- *Cars account for 67% of all trips made and 89% of all kilometers travelled.*
- *Hærvejsmotorvejen has in two model calculations been found to generate growth.*

Chapter 7. Plan analysis

To investigate the question "*Which planning paradigms characterize municipal transport planning and what influences it*" a plan analysis was carried out for transport planning related to Vejen Municipality. The analysis focused on plans from municipal and regional governmental levels. The reason for this is that they all influence municipal planning.

This chapter presents the chosen plans with regard to their goals, roles in planning and relation to Vejen Municipality. Each plan is analyzed in terms of traffic management perspectives, overall planning paradigm. The paradigms impact on Vejen Municipality will be identified and discussed.

The plans identified for analysis are:

- *The Municipal Plan of Vejen*
- *Trekantområdets fælles kommuneplan 2017-2029.*
- *The Regional Plan for Development*

The national planning report was not included because it was made by the previous government and does not reflect the ideologies of the government currently in office.

7.1. Introduction to plans

First, the municipal plans will be introduced and then the regional plans will be introduced.

7.1.1. Vejen Municipal plan

A municipal plan is a plan that sets the overall framework for the development of a municipality in Denmark. The municipal plan is applicable for 12 years but can be renewed sooner. In Vejen Municipality the last municipal plan was approved by the city council in October 2017 and published in January 2018 (Vejen Municipality 2018) and its primary focus is to attract new businesses and citizens to Vejen.

7.1.2. Joint municipal plan for The Triangle Region

The Triangle Area is a geographical area in the southeastern part of Jutland. The area is characterized by having a lot of businesses, jobs and a significant amount of traffic. The area consists of seven municipalities, which are; Billund, Fredericia, Haderslev, Kolding, Middelfart, Vejle and Vejen (Triangle Area Municipalities 2018).

The reasoning for the joint municipal plan is, according to the municipalities themselves, that they together can create more development than they would be able to on their own. Despite the collaboration, the municipalities still must create their own municipal plan. This means that the joint plan sets the main structure and guidelines, which the municipalities then interpret and plans after (Triangle Area Municipalities 2018).

"It's about using the strengths and qualities we have and agree to that. Together we are stronger, also when it comes to branding The Triangle Area in Denmark, and the world." -(Appendix 4, page 4)

7.1.3. *The Regional development plan for Region South Denmark*

The regional development plan was implemented with the structural reform in 2007, which merged 16 Danish counties into five larger regions. The plan must be made within the first half year of every election period, meaning that it is made approximately every fourth year. The plan is made in a cooperation between the region and municipalities in the region, with the purpose of finding strategic projects and common interest in the region. In addition, the municipalities must take into account the regional development plan when making their own municipal plan, as the municipal plans must be in compliance with the regional development plan. The regional plan focuses on different areas like nature, growth, and most relevant to this project, infrastructure. It identifies different areas that could be used for new infrastructure, or infrastructure projects that the region finds to be important for future development (Region Syddanmark 2016).

7.2. *Analysis of each plan*

7.2.1. *Vejen Municipal plan*

In relation to traffic, Vejen Municipality has some goals, which are shared with the other municipalities in The Triangle Area. These will be explained and analyzed in the next section.

Specifically for Vejen Municipality, transport and development of new business are closely linked together, because the highway in the center of the municipality attracts many businesses that rely on easy access to the highway system. As a result hereof, some of the goals in the municipal plan in terms of traffic management are:

- *Prepare for a new industry area near the eastern highway ramp in Vejen*
- *Establish westbound ramps to the highway.*
- *Work to promote the construction of Hærvejsmotorvejen*
- *Modifying municipal infrastructure to large modular trucks (Vejen Municipality 2018, page 1)*

The planning of infrastructure in Vejen is therefore in many ways used as a tool to support the development of new industry. The reason here for is, that when the current highway was developed it attracted new industry, and it is therefore assumed that a new highway would provide a similar increase in the municipality's attractiveness for new businesses. Hans Peter Due from Vejen Municipality supported this:

"We believe that we have some experiences from E20, the Kolding-Esbjerg highway, where a company like Danish Crown, northern Europe's largest cattle abattoir, located themselves here, by the highway" -(Appendix 4, page 2)

No prognosis is used to justify these goals in the municipal plan, only earlier experiences and expectations.

"If you look where growth has been taking place in the last 50 years, it is my guess, that there is a highway nearby. I do not think you need a grand exam to say that"
-(Appendix 4, page 12)

Which he also argued for earlier, in terms of industry growth in Vejen.

"We would never have been able to attract them (the businesses) if we did not have a highway system" -(Appendix 4, page 2)

But, in terms of using prognoses, Vejen Municipality uses Intelligent Transport Systems (ITS) as a mean to investigate the effects on new roads, and where to build them.

"We try to simulate different solutions. For example in Vejen, in the municipal plan there is an eastern road around the city, there we are using it (ITS), to monitor the development." -(Appendix 4, page 4)

For programmatic planning, the municipality uses ITS to support the development of a new highway and to develop new industrial areas. Especially choosing areas near the highway to locate new industry is a sign of programmatic planning.

This combination of planning paradigms allows the municipality to do two things. They can use statistics and prognoses to justify their actions or use them as a guideline for what they want to achieve. Programmatic planning could also be used to set out on new methods to reach these goals or plan a new direction for the municipality.

7.2.2. Joint municipal plan for The Triangle Region

The primary focus in this plan, related to transport, is to expand current highways across Fyn, and E45 in Eastern Jutland to reduce congestion. Like Vejen Municipality's own municipal plan, the joint municipal plan also proposes to work towards Hærvejsmotorvejen. Similarly, the highway system is seen as a catalyst for new business and as a way to increase the attractiveness of the region for new citizens. Therefore, one of the goals is to:

"Maintain good overall road connections within and to The Triangle Area" -(Triangle Area Municipalities 2018, page 132)

By supporting the current development trends and suggesting expansions of existing infrastructure to handle increased congestion, a prognostic planning approach is identified, because they use current prognoses as their justification for expansions.

In addition, the joint municipal plan has a goal that states:

"CO₂ emissions from road bound transport must be reduced in comparison to current prognoses, by making the transport more sustainable" -(Triangle Area Municipalities 2018, page 132).

To reach this goal a change in planning is needed. A shift away from current trends, meaning that it is indeed programmatic planning that is needed. It does though not say how transport should be made more sustainable, but in the review of their goals, it is described as follows:

"Nor expansion of public transport or condensation of cities will reduce the car traffic significantly, and because of this, it is not the answer to making transport in The Triangle Region more sustainable" -(Triangle Area Municipalities 2018, page 132).

This conclusion is interesting because there are now two objectives that to some extent are in opposition to each other. On one hand, there is a proposal to expand current roads, but on the other hand, there is a goal that states to limit CO₂ emissions from car traffic.

7.2.3. *The Regional development plan for Region South Denmark*

Like the joint municipal plan, the regional development plan argues for expanding infrastructure, reasoning that it supports a continuous business development and states that it can decrease congestion on E45 (Region Syddanmark 2016). It writes;

"Mobility should be increased through expansion of infrastructure, by influencing transport patterns and by more efficient use of existing infrastructure" -(Region Syddanmark 2016, page 51)

However, there are no defined goals or guidelines for how infrastructure should be used more efficiently or how transport patterns could be changed. From the interview with Erik Ørskov, his explanation of this was a lack of competences

"We have not worked with this (effective infrastructure use and changing behavior) earlier, and we do not have the skills in that area to do so." -(Appendix 3, page 7).

A mobility plan for the region has been discussed in a mobility council, but it was never initiated.

"From the beginning, one of the mobility council's tasks was to create a mobility plan, but it was never initiated." -(Appendix 3, page 7)

This points to a programmatic planning paradigm, but it has some uncertainties, primarily because there at the regional are very few tools to influence traffic. This is because the regions no longer have any legal authority over the roads.

In terms of traffic, Erik Ørskov made an in interesting point, which to some extent contradicts the regional development plan. He argued that the proposed Hærvejsmotorvej does not reduce congestion on E45.

"Not all, but many point to the fact that Hærvejsmotorvejen does not solve the problem you have (congestion on E45)" -(Appendix 3, page 14)

These quotes and the regional development plan points to two different types of planning:

Prognostic planning because it is taken into account how current infrastructure should be developed to accommodate increasing congestion and clear the way.

Programmatic planning because it attempts to steer the transport patterns and development. Due to their lack of skills, as Erik Ørskov states, this (changing transport patterns) it could be difficult for the region to achieve. The lack of legal authority puts another barrier to traffic planning from the point of the region.

7.3. *How are planning paradigms influencing planning in Vejen Municipality?*

Plan	Overall planning paradigms
Vejen Municipal plan	Prognostic and programmatic
Joint municipal plan for The Triangle Region	Prognostic and programmatic
The Regional development plan for Region South Denmark	Prognostic and programmatic

Table 9. Planning paradigms influencing Vejen Municipality. Own production

For Vejen Municipality the two paradigms mean that the municipality will act upon earlier experience and prognoses and use these to steer the development. Furthermore, many of their proposed goals are also a part of the joint municipal plan for The Triangle Region. It can be difficult to implement programmatic planning while relying on earlier experience and current prognosis, because programmatic planning and prognostic planning in some ways can be in opposition to each other. Relying on prognoses, while trying to set a new direction or reaching new goals, like for example decreasing emissions, can be difficult because it could lead to the use of best practice or earlier experience, as it was explained in the interview with Hans Peter Christensen, and the municipality's experience with highways. This does not change the direction though, but rather clears the way for a continued development of previous trends.

From Table 9, it is seen that the two most significant paradigms in the different plans are prognostic and programmatic. This is because a plan can have multiple goals and different means to reach these. The question is whether the department wants to take a new approach or act upon earlier experience? In terms of changing the planning approach and having a transition, it is clear that the division of planning responsibilities between municipalities, regions and state provides a barrier for some planning elements, and also complicates planning. It should also be emphasized that plans with multiple actors involved, in this case, the regional development plan and the joint municipal plan, there can be conflicting interests, which are not presented. Also within a municipality, there can be conflicting agendas, but these can be hard to identify as well.

7.4. Findings

From the plan analysis, the following points were identified:

- *Vejen Municipality uses a prognostic- and programmatic planning approach and their planning partners, the region and the municipalities in The Triangle Area. This current planning paradigm can make it difficult to work towards new initiatives because it relies on experiences and prognoses.*
- *Vejen Municipality is planning towards having hærvejsmotorvejen as close as possible because they believe it will generate growth. This argument is in line with the findings in chapter xx, case introduction.*
- *The Triangle Region, of which Vejen is a part of, wants to expand road infrastructure, but in contradiction to this also wants to reduce CO₂ emissions from transport.*
- *Region Syddanmark supports initiatives that can generate business development or reduce congestion but has no specific plan for mobility at present.*
- *The division of planning responsibilities between, municipalities, regions and state provides a barrier for some planning elements and complicates planning.*

Chapter 8. Users of the transport system

To investigate the users of the transport system a survey and a focus group interview with a selected group of the respondents was carried out. The purpose of this chapter is to introduce these users and to present the survey and focus group interviews.

8.1. Survey

The survey was used as a tool to investigate the case area and gain insight into the users in the area. It was also used as a way to approach the local users and invite them to a focus group interview. Therefore the survey is introduced first and then the focus group interview is introduced.

The survey can be found in Appendix 8, and the survey results can be found in Appendix 9.

8.2. Survey results

The general results of the survey are presented in Table 10. It shows the distribution of respondents in terms of gender and age. There is a clear majority of female respondents and of respondents between the ages of 25-59 years.

Sample size: 287		Male	Female	Total
Between 0-24 years	12	16	28	
Between 25-59 years	69	148	217	
60 years or older	16	26	42	
Total	97	190	287	

Table 10. General respondent characteristics. Own production

The primary mode of transport was cars, (as expected). The survey found that out of all the respondents having access to a car, 82% of them used the car as their primary mode of transport to work. The car usage was measured in terms of the distance travelled to work, and the survey was categorized into four categories; 0-5 kilometers, 6-15 kilometers, 16-25 kilometers and 25 + kilometers. In the analysis, 0-15 kilometers is characterized as short distance travellers, and respondents travelling 15+ kilometers are considered long distance travellers. By using this distinguishing, a larger group of respondents driving more than 15 kilometers per day could be identified, see figure xx.

The experiences of congestion, for the entire sample, showed a minor overweight of users rarely experiencing congestion, see Figure 17.

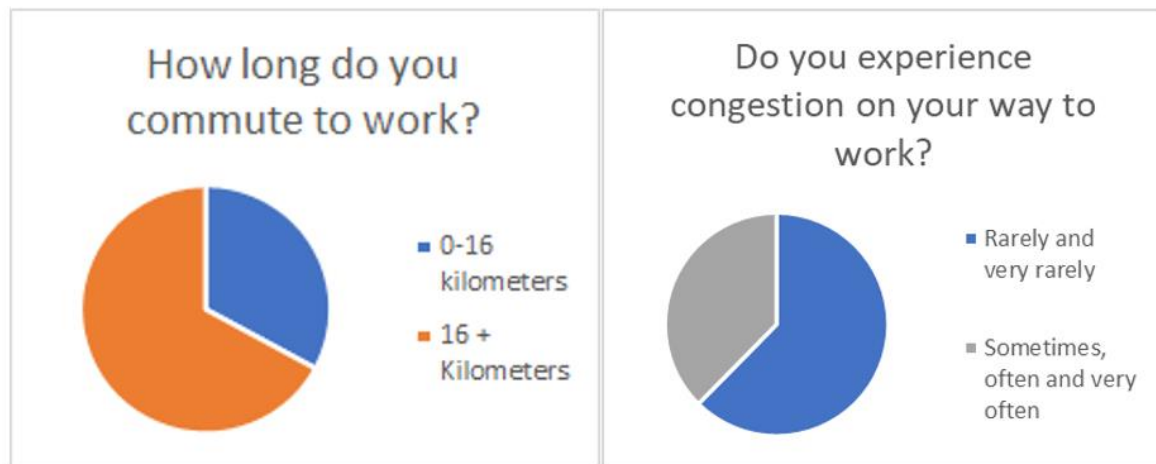


Figure 17. Travel distance and congestion experience for all respondents. Own production

In the methodology, Chapter 3, the importance of heterogeneous groups was established and then used as a tool to identify focus group respondents, the two groups were further investigated. The purpose was to investigate if they are homogeneous or heterogeneous groups.

8.2.1. Short distance travellers

This category contains respondents with access to a car which is their primary mode of transport to work and with a distance between 0-15 kilometers to work. The group is introduced in Table 11.

Sample size: 64	Male	Female	Total
Between 0-24 years	3	4	7
Between 25-59 years	20	29	49
60 years or older	4	4	8
Total	27	37	64

Table 11. Introduction to short distance travellers. Own production

Based on their daily commute, the respondents were asked if they experienced congestion on their way to work, see Figure 18. Fourteen of the respondents did, either to some extent or very often, which for this investigation were grouped as; experiencing congestion. On the contrary, it means that 50 respondents do not experience congestion on their trip to work.

Experienced congestion, short distance travellers

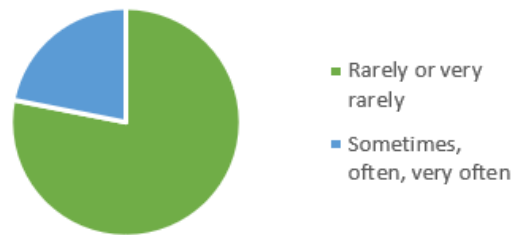


Figure 18. Experienced congestion, short distance travellers. Own production

8.2.2. Long distance travellers

This category contains respondents with access to a car which is their primary mode of transport to work and with a distance of more than 15 kilometers to work. The group is presented in Table 12.

Sample size: 158	Male	Female	Total
Between 0-24 years	1	5	6
Between 25-59 years	46	95	141
60 years or older	6	5	11
Total	53	105	158

Table 12. Introduction to long distance travellers. Own production

Using the same approach as for short distance travellers to investigate their experience of congestion, it was found that out of the 158 respondents, 70 often experience congestion when driving to work, and 87 rarely experiences congestion, see Figure 19. When comparing this to the experience of the short distance travellers, there is a clear difference, which indicates that the two groups have different views regarding congestion. Combining them would therefore, create heterogeneous groups for the focus group interview.

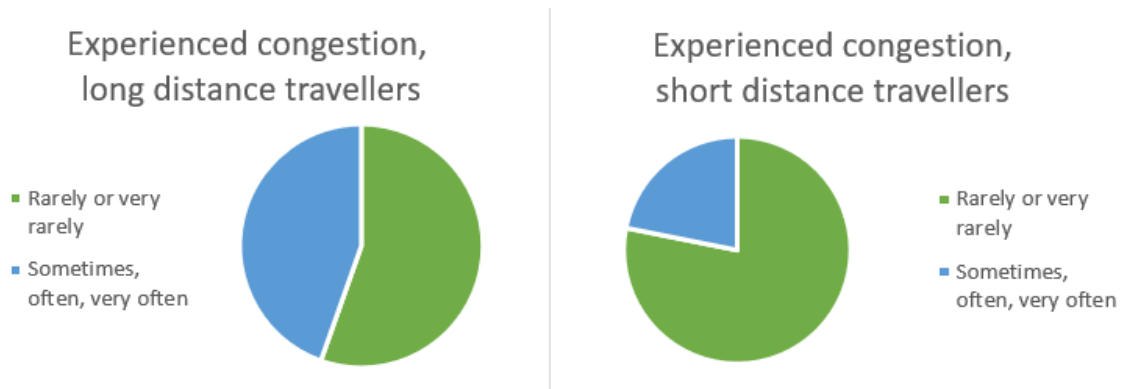


Figure 19. Comparison of experienced congestion. Long distance travellers and short distance travellers. Own production)

8.2.3. Respondents with no access to a car

Respondents with no access to a car are only briefly introduced, because they are not relevant for the congestion comparison, and they were not part of any of the focus group interviews. They are interesting because of their experiences with public transport, see Figure 20. The sample only consists of 16 respondents, of which eight were using public transport, three were biking, and five were unemployed.

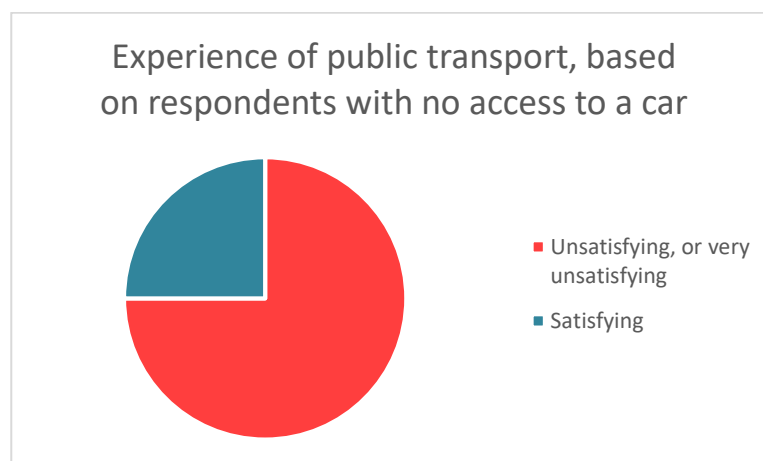


Figure 20. Experience of public transport for respondents with no access to a car. Own production

8.2.4. Cyclist with access to a car

The last type of respondents that are presented is the group choosing not to use their car despite having access to one. The sample consisted 18 respondents of which three were using public transport and 15 were biking. The bikers had primarily between 0-5 kilometers to work, whereas the public transport users all had more than 25 kilometers to work. The interesting point for this group was their choice of transport in their spare time, where 15 out of 18 chose the car, see Figure 21.

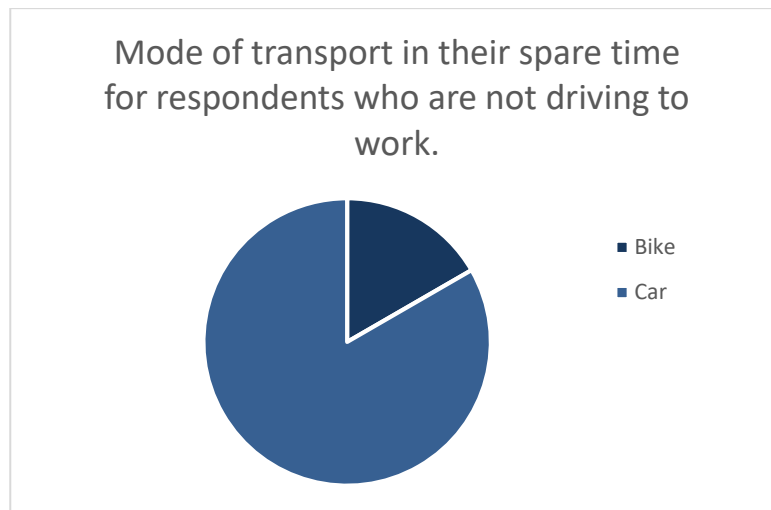


Figure 21. Mode of transport in their spare time for respondents who are not driving to work. Own production.

Out of the four groups of commuters, it was only possible to invite the short distance- and long distance traveller groups to focus group interviews. It was not an issue as the groups were heterogeneous and thereby able to challenge each other's practices.

The following chapter will introduce the focus group interviews and the participants.

8.3. Focus group interviews

In the state of the art review, it was found that there is a lack of knowledge regarding the opinions of citizens towards congestion and modes of transport. Therefore the focus group interviews were used as a tool to engage in a dialogue with local users to investigate their view on the transport system and their social practices. Furthermore, it provided an opportunity to discuss the trends from the survey and what challenges and possibilities the users see in the area.

The two focus group transcripts can be found in Appendix 1 and Appendix 2.

8.3.1. Focus group one

The first focus group interview was held with five respondents, who are introduced in Table 13. The group had a majority of female participants and were a mix of individuals having children living at home and people not having children living at home.

Gender	Age	Congestion experience	Type driver	of Children
Male	25-59	Rarely	Long distance	3
Female	25-59	To some extent	Long distance	2
Female	25-59	Very often	Long distance	1
Female	25-59	Very rarely	Long distance	None
Female	25-59	To some extent	Long distance	None

Table 13. Characteristics of the participants from the first focus group interview. Own production

In terms of the type of traveller, they were all long distance travellers, which during the interview meant that some social practices relatively quickly obtained a status of being commonly agreed upon, and therefore not challenged any further. This was, for example, the aspect of flexibility, which they saw as the primary benefit of their car, and which the participants quickly agreed upon. They were open towards car-sharing, but the system would have to accommodate sudden changes in schedule, for example in case of emergencies. The economic benefit from sharing a car was less important and seen only as a bonus. The child aspect was quite prevalent at the interview in relation to the role of public transport, which was judged to be ineffective and time consuming compared to driving.

The group was positive towards ITS solutions and did not find them to be inconvenient. A route change was found to be beneficial, even if it only saved one or two minutes. The group also agreed that ITS solutions could be a good solution to limiting delays from traffic accidents. A local point was also made for the case area, that every commuter had to go through the area where the accident occurred anyway because there are no alternative routes.

In terms of a new highway, the group was in disagreement. Some meant it was a necessity for society, while others felt that it destroyed nature, and had a more "Not in my backyard" approach.

8.3.2. *Focus group two*

The second focus group interview was held with six respondents and they are introduced in Table 14. The group had a slight majority of male participants and was a combination of people having children living at home and people not having children living at home.

Gender	Age	Congestion experience	Type of driver	Kids
Male	25-59	Very rarely	Short distance	None
Male	25-59	Very rarely	Long distance	1
Male	25-59	To some extent	Long distance	None
Male	25-59	Very often	Long distance	None
Female	60+	Very rarely	Short distance	None
Female	25-59	To some extent	Long distance	1

Table 14. Characteristics of the participants in the second focus group interview. Own production

Group two, like group one, agreed that their flexibility was very important, but they also saw benefits in car-sharing, that were not seen in the first interview. The point was made in group two, that not having to concentrate on driving every day could be a benefit. With regard to car-sharing, some members were concerned about who they would be sharing a vehicle with and would prefer operating the car themselves. In relation hereto it was argued that it would help if they knew the person, with whom they would share their car with.

Group two was also positive towards ITS solutions and pointed out examples on which they had benefited from flow speed regulation and real-time rerouting.

With regards to highways and new infrastructure, the positions were similar to group one. Some argued for its societal benefit, whereas others argued it would ruin nature. It was equally important for the group that no initiatives were forced upon them against their will.

8.4. Findings

From the user investigation, the following points were identified:

- *The findings from both the introduction and state of the art were confirmed based on the 287 respondents of the survey. The findings were long travel times, long commutes and a high share of cars.*
- *The findings from the case introduction in terms of low public transport usage were likewise confirmed with only 2,7% of the respondents using public transport.*
- *Two types of travellers were identified for the focus group interviews, a long-distance traveller and a short distance traveller. A characteristic difference between the two types was that the long-distance travellers experienced more congestion.*
- *Two focus group interviews were held with five participants in the first and seven in the second. Generally, their social practices were similar in terms of know-how and embodied habits, but their engagement varied.*
- *The focus group participants were generally positive towards most of the initiatives as long as they were not forced upon them. The criteria for changing behavior were primarily that their flexibility and travel time should not be significantly changed.*
- *In addition focus group one made the point that if public transport was more efficient, it would be more attractive for them to use instead of their car*
- *Focus group two identified safety as a criterion for changing behavior. Due to this business initiatives were suggested so that the driver and passenger would have some sort of relationship.*
- *Economic benefits were not identified to be the primary driver by the users*

Chapter 9. Scenarios

9.1. *Creating the scenarios*

Following the structure presented in Chapter 5 *Theory*, the scenarios and the reasoning for them will be elaborated in this chapter.

To begin the scenario building, the long-term target is introduced first, because the long-term target is the basis for the foundation for the backcasting. For the scenarios in this project, the long-term target is as follows:

Long-term target: To improve mobility in Vejen and the neighboring municipalities in the most sustainable way.

In terms of sustainability, the approach in the four-step principle is maintained and for the scenarios, it creates the foundation for the development of new and more sustainable initiatives. This was done by creating one scenario for each step of the four-step principle, thus resulting in four different scenarios.

The purpose was to investigate if an alternative planning approach could achieve similar results as the current planning approach, but using fewer resources.

Improved mobility in the scenarios understood as an increased capacity in the transport system, based on the previous definition of congestion, see Chapter 4.1 *Defining congestion*.

For Vejen Municipality, the benefit of increasing mobility is that the municipality becomes more attractive for new citizens as well as businesses.

Currently, Vejen is in a zero-growth situation, meaning that the inhabitant growth in the past 5 years was close to 0% (0,3%). Demographically, the average age in the municipality is expected to increase from 2017-2037 (Region Syddanmark 2017). Vejen is in this context interesting because it is located between declining municipalities to the west, and inclining municipalities to the east, in terms of population growth, while Vejen has almost a zero-growth situation. Examining prognoses for the future of Vejen, it is estimated that if nothing is done, there is a risk that Vejen will start to decline in population and experience an increasing share of elderly. A way to attract new citizens could be through improved mobility (Region Syddanmark 2017).

Moving on from the long-term target, the next step in creating the scenarios is an investigation of the feasibility. The purpose of the feasibility study is to conclude whether the long-term target can be reached within pre-existing forecasts and structures or not.

Feasibility

A feasibility study of a transport system does not follow the structure of a regular product feasibility study, because the context is significantly different, but it can be used to structure the analysis. For a product the feasibility analysis can be narrowed down to five main elements of consideration:

- *Who else is producing a similar product?*
- *What is the likely profit?*
- *What is the cost of producing the product?*
- *What is needed to make the product?*
- *Is there a demand for the product?*

The above investigations help to answer the question: *can the current structures and planned developments reach the long-term target?*

To investigate this, the analysis starts with a solution, which is being investigated by The Danish Road Directorate, *Hærvejsmotorvejen*.

Comparing Hærvejsmotorvejen to a product feasibility study some overall reflections regarding the context are:

- *There are no competing producers as the project is based on a political decision-making process.*
- *The element of profit and cost can to some extent be neglected, as the purpose of the product is not profit, but a societal interest.*

In relation to a sustainability perspective, the resources needed to build Hærvejsmotorvejen are quite significant, because it is a piece of infrastructure. Based on experiences from similar projects it was concluded in a life-cycle-assessment done by The Danish Road Directorate and EFLA, that 1 kilometer of highway roughly pollutes with 1030 tonnes of CO_2 (Pihl, Efla 2008). The assessment of the cost of the environmental impact is estimated to 40 million DKK for the first stretch of the highway and 25 million DKK for the second stretch. The construction has a total price of 15- 20 billion DKK, depending on which solution is chosen (Danish Ministry of Transport, Building and Housing 2013).

The remaining question is if there is a demand for a new highway?

Based on an analysis performed by several consultancies for The Danish Road Directorate investigating the potential of Hærvejsmotorvejen, it was concluded that primarily larger businesses would benefit. The effects are an increased job catchment area and increased customer range. Smaller companies can, on the contrary, be threatened by bigger companies, who are gaining advantages within their catchment areas, both in turns of customers and employees (Moe, Incentive 2018).

The municipalities near Hærvejsmotorvejen also benefit on varying levels, depending on their distance to the highway. This again depends on which alignment is chosen (Moe, Incentive 2018). In Table 15 the benefits are summed up as a % - increase in terms of access, for both alignments.

Travel times	Western alignment	Eastern alignment
30 minutes	2%	3%
45 minutes	3%	4%
60 minutes	4%	5%

Table 15. The % increases in businesses catchments areas regarding workforce, if Hærvejsmotorvejen is built. Source: (Moe, Incentive 2018)

Prior to the analysis above, model calculations made in both 2013 and 2016 found the highway to be economically beneficial for both businesses and citizens, due to the reduction in travel time it could provide for its users. It was found that between 19.000-29.000 hours pr. weekday could be saved, depending on the alignment (The Danish Road Directorate 2016c).

Whether this is considered a sufficient demand or not, is a matter of politics, because the decision-making lies at the national level.

To conclude and summarize the feasibility analysis, the question remains; does the construction of the highway help to accomplish the long-term target of improving mobility in a sustainable way?

Since the question being of a rather political matter, the report, which was written for The Danish Road Directorate, does not conclude on this matter. The Road Directorate did, however, answer this question when concluding their preliminary analysis of the project. Their conclusion was that the highway would indeed provide an increase in mobility, but after a span of years the new highway would potentially likewise be as congested as E45 (The Danish Road Directorate 2016c).

In the interview with the regional planner, his opinion was that it would not reduce congestion, because the bridge in Vejle is the real issue, and the traffic growth there is so significant, that the future problems of congestion will be at the bridge.

"[...] It is illusional to think, that it (Hærvejsmotorvejen) has a significant impact on the congestion on E45 (Østjyske Motorvej). You need a better connection across, south of Vejle. [...] if that is built, I believe it would help to reduce traffic on the bridge in Vejle" -(Appendix 3, page 3)

Taking into account that a highway promotes more car usage and has a significant carbon footprint in its construction phase, a new highway does not fulfill the aspect of sustainability and it is therefore, relevant to proceed to step three.

Step three means creating scenarios and future images to identify a path to reach the long-term target. The following section will first introduce a series of possible initiatives that can be implemented, and then the scenarios are presented.

9.2. *Initiatives*

The initiatives are presented based on which step they represent in the four-step principle. To recap, the steps in the four-step principle are as follows:

- *1st step - Influencing the need for transport and mode of transport*

The first step is to try to change citizens behavior, and thereby decreasing their need for transportation.

- *2nd step – Effective use of current infrastructure*

The second step is to introduce means that will make better use of the current infrastructure, e.g. traffic lights changing based on real-time data.

- *3rd step - Improving existing infrastructure*

The third step is to improve current infrastructure, for example by building wider roads

- *4th step - Building new infrastructure.*

The last step is to build new infrastructure to increase the capacity of the road net.

9.2.1. *Step 1 initiatives, influencing behavior*

9.2.1.1. Carpooling

Carpooling is the concept of several users sharing the same car instead of driving in separate vehicles, thus decreasing the total numbers of cars that use the road system and dividing the cost of transport between the users.

In some countries, for example, The United States, there are dedicated carpool lanes for cars with more than one passenger. These carpool lanes work as a fast track option for the drivers that use carpooling. The concept can also be applied to users meeting or being picked up at an agreed upon location, and from there sharing their trip to their desired destination. The concept of carpooling can be organized through clubs, online platforms, or through workplace initiatives. The workplace organization model is desirable because the users will have the same destination and point of departure after work (Correia, Viegas 2010, Vanoutrive 2011, Delhomme, Gheorghiu 2015).

The potential of carpooling lies in more people being able to benefit from a car, without owning one. The concrete potential of car-sharing in Denmark is currently unknown. (Ministry of Transport 2018)

Carpooling in Vejen faces several challenges. Carpooling is at the present time not very widespread in Denmark. An investigation of carpooling in Denmark found that approximately 10-15% of drivers are carpooling in Denmark. The investigation included parents dropping their children off at school as carpooling, so this number might be an overestimate (The Danish regions 2018). However, it is increasing with the acknowledgement of shared economy platforms, like Gomore.

In relation to social practices and carpooling, some barriers can be identified. The technological practice is challenged because there are a limited number of car-poolers,

both drivers and passengers, which leads to the inflexibility of the system, and thereby relatively unattractive compared to other alternatives. Since carpool lanes are not a part of the current road infrastructure, the attractiveness of lower travel times is absent. In terms of know-how and habits, studies show that sharing a car with a stranger is non-desirable and commuters are more willingly to carpool with a colleague because they have social identification through their common workplace. The most desirable carpool partners are friends or family (Correia, Viegas 2010). To accommodate this, and increase engagement to carpooling, carpooling could be promoted as a way to save money by sharing the transport cost with passengers and as a tool for the individuals to reduce their carbon footprint. Studies show that most commuters engage in carpooling because it reduces expenses (Correia, Viegas 2010, Vanoutrive 2011, Delhomme, Gheorghiu 2015). This was however not the case for the focus group participants, for whom economy was not a key driver in changing their behavior.

In terms of governing for carpooling, there are currently no plans in place that provide a financial incentive for users to carpool, neither in terms of subsidies or reduced taxes on for example fuel. At a local scale, planners could promote carpooling by implementing carpool zones and parking spots close to traffic nodes in the transport system.

To summarize, the following factors could be influenced to increase carpooling:

- *The user pool has to increase to increase the flexibility of the system.*
- *Good experiences and attractiveness should be points of interest for start-up initiatives.*
- *Availability of a joint carpooling platform to make it more user-friendly.*

9.2.1.2. Workplace Initiatives

Workplace initiatives are understood as initiatives between an employer and an employee. It could be an initiative in which the employee has a workstation at home, or flexible working hours rather than fixed working hours. The purpose is to reduce the numbers of cars during traffic peaks by giving drivers the opportunity to plan their trips accordingly to rush hour.

The potentials of the initiatives are hard to estimate because they depend on the combination of job type, employees, job catchment area, accessibility etc. Furthermore, it is between an employee and a business, which makes it difficult to promote from a planning point of view.

The social practices are to some extent already present as both technology and habits are already embedded in some peoples work environment.

9.2.1.3. Changing taxation on cars and car use.

In terms of car use, research shows that to limit congestion one of the most effective tools is through economic measures, but this is not used at present time in Denmark. The only road tolls in Denmark are the bridge to Sweden and the bridge from Zealand to Fyn. A toll to enter Copenhagen was proposed by the government in 2011, but it

was never implemented, as the parties in office could not obtain a majority for it despite being able to prove through studies that it would decrease congestion in Copenhagen (Hoffmann-Hansen 2012).

For car purchasing the taxation system in Denmark already has measures to promote more fuel-efficient cars. If a car has a fuel efficiency lower than 20 Km/L, the tax on the car is increased by 6000 DKK. per Km/L up to 20 Km/L. This means, that if a car drives 14 Km/L, there will be an additional tax of 36.000 DKK. On the contrary, cars with a higher efficiency than 20 km/L will have their tax reduced by 4000 DKK per Km/L, down to 20 Km/L.

Besides the fuel tax, cars have a basic tax of 85% on the first 185.100 DKK of the cars value and a 150% tax on the remaining value above this level (Danish Ministry of Taxation n.d.a, Danish Ministry of Taxation n.d.b, SKAT n.d).

Furthermore, there is the "Green owner tax" which is a yearly tax, which likewise depends on fuel consumption. The tax can vary from 330 DKK/year up to 11.430 DKK/year (FDM 2017).

Changing taxation would require new laws from the central government, and the current government is not likely to do so, based on their transport policies until now. Planners at the municipal- and regional level do not have either tools or the power to implement initiatives regarding tax changes and the initiative would therefore, have to come from national decision-makers.

In relation to social practices, regulating taxes would be an effective influencer of the institutionalized knowledge and explicit rules. From the social practice theory, it was argued that there is no direct link between obtaining this knowledge and changing practice, but studies of transport behavior in relation to road pricing indicates that it is indeed an effective tool (May 1992, Henderson 1974).

9.2.2. Step 2 initiatives, effective use

9.2.2.1. Mobility as a service (MaaS)

MaaS is the concept of shared platforms, which combines rental services with public transport as a normal part of an individual's transport patterns. In MaaS, high-frequency public transport is the backbone of the system, and services like car rental or bike rental work as supplementary links or alternatives. The concept is still under development, but early reports describe the system, in its most developed form, as being similar to mobile phone subscriptions, in which the user pays a monthly fee to have access to certain services, e.g. like a number of minutes or kilometers of transport. The system can be implemented on a smaller scale in combination with initiatives such as carpooling because they share the same basic approach of combining modes of transport (Ministry of Transport 2018). MaaS can be carried out in two different forms:

Pay as you go

The pay as you go form is not based on a fixed price, but rather the consumer purchasing specific transport services, depending on their need. This is the solution at present. With MaaS it should be merged into one platform rather than being divided into multiple platforms.

Multimodal travel planner

In terms of travel management, the latest idea is the use of a travel planner application. The travel planner application will identify possible journeys for example with or without car-sharing or bike rental and compare them with predefined preferences, most commonly price and time (Ministry of Transport 2018).

Common for all MaaS solutions are, that they rely on the users having a device with access to online platforms, which can use real-time data. Currently, the main challenge is the coordination between operators, who must agree to share data and create a joined platform that uses this shared data. The challenge is who should have the ownership of the platform because a platform like this would be a significant actor in a future MaaS system (Ministry of Transport 2018).

In Denmark, the technology is being developed and right now a multimodal travel planner is being tested in Region Nordjylland in cooperation with Nordjyllands Trafikselskab, but an evaluation is yet to be carried out (Ministry of Transport 2018, Hansen 2016).

From a realization point of view, the sharing of data and similar challenges are important to address because they must be overcome in order to develop a solution. In terms of governance, planners have a role in facilitating and stimulating collaborations in order to create the foundation for utilizing the potential of MaaS as a future transport solution. Furthermore, the solution focuses on combining different modes of transport using both private and public transport services, which will challenge the current norm of public vs private transport. For it to be successful, it would require a higher level of collaboration between the government and private companies to identify the best solutions.

The overall potential of MaaS is uncertain because technology is developing rapidly and solutions are unproven. Early estimates suggest that it could be somewhat comparable to current car-sharing services (Ministry of Transport 2018).

9.2.2.2. Alternative lane use

For effective use of infrastructure, The Danish Road Directorate has two relevant concepts, which they are investigating and testing. Both are types of alternative lane use and they will be introduced in this chapter.

Reversible lanes

Reversible lanes are the concept of changing the direction of a lane, based on the flow of traffic. For highways it can be used during morning peak hours, and then reversed in the evening peak hours, so that instead of having three lanes in each direction, there would be four lanes in one direction and two in the opposite direction, based on the flow of the traffic, see Figure 22 (The Danish Road Directorate 2017c).

	<u>Status quo</u>	<u>Morning peak hours Reversible lane</u>	<u>Evening peak hours Reversible lane</u>
<u>Lane 1</u>	Direction: → → → → → →	Direction: → → → → → → → →	Direction: → → → → → → → →
<u>Lane 2</u>	Direction: → → → → → →	Direction: → → → → → → → →	Direction: → → → → → → → →
<u>Lane 3</u>	Direction: → → → → → →	Direction: → → → → → → → →	Direction: ← ← ← ← ← ← ← ←
<u>Lane 4</u>	Direction: ← ← ← ← ← ←	Direction: → → → → → → → →	Direction: ← ← ← ← ← ← ← ←
<u>Lane 5</u>	Direction: ← ← ← ← ← ←	Direction: ← ← ← ← ← ← ← ←	Direction: ← ← ← ← ← ← ← ←
<u>Lane 6</u>	Direction: ← ← ← ← ← ←	Direction: ← ← ← ← ← ← ← ←	Direction: ← ← ← ← ← ← ← ←

Figure 22. Example of reversible lanes. Own production

Emergency lane

The second initiative is the possibility of using emergency lanes to increase the capacity of the road during peak hours and outside of peak hours status quo is maintained. This solution is only relevant for highways, which have emergency lanes. An investigation from 2016 found that 13% of the Danish road net was suited for a possible inclusion of the emergency lane (The Danish Road Directorate 2016b).

From testing, it was found that it provided an increase in car capacity from 3700-4400 cars pr. hour during morning peak hours, equal to roughly a 20% increase. This is a significant increase if the full potential is utilized (The Danish Road Directorate 2016b, The Danish Road Directorate 2016a).

In terms of realization and the two solutions' role in the current transport system, both possibilities are branches of ITS, and their foundation in the user's social practice depends on the engagement towards ITS and how well the system is incorporated into people's everyday practices. This is elaborated further in the following chapter also introducing ITS.

9.2.3. Step 3 initiatives, improved infrastructure

9.2.3.1. Intelligent transport systems (ITS)

ITS is a concept that widely refers to a transport system that interacts with users and the transport system through real-time data to find the fastest way. There are in terms of ITS several systems, but at an overall level, ITS can be put into five general branches.

Advanced transportation management systems (ATMS)

ATMS is a system, which has traffic control devices, emission monitoring, technological communication between systems (vehicle to vehicle and vehicle to infrastructure) and an emergency management system that can interact with vehicles and infrastructure.

ATMS is a holistic implementation of ITS, where there is a flow of data between users, infrastructure, and vehicles, to continuously optimizes travel times (Bazzan, Klügl 2013).

Advanced traveller information systems (ATIS)

ATIS is a system focused on providing information to the users. This is done via applications, signs or through GPS-routing. The system uses real-time data to update the user's routes, to avoid congestion and reroute the users if accidents occur and similar (Bazzan, Klügl 2013).

Advanced vehicle control and safety systems (AVCSS)

AVCSS consists primarily of technologies that improve safety and response time in case of emergencies. Within this category lies both anti-collision software and driver assistance control that uses sensors to stop the car, if a collision is probable to happen. In extension hereof lies a response system, which can alert rescue operators if accidents happen, giving the fastest possible notice to rescuers (Bazzan, Klügl 2013).

Advanced public transportation systems (APTS)

APTS is a combination of ATIS and ATMS. It includes e-ticketing and automatic vehicle monitoring solutions, so it is possible through real-time data to provide traveller information and optimize the mode of transport in the system.

In an APTS system the real-time data can be used to create a better flow for a prioritized mode of transport, for example, busses by extending green lights so the bus can drive its route faster (Bazzan, Klügl 2013).

Commercial vehicle operation (CVO)

CVO is the business aspect of ITS, in which the data of the system is used for fleet management and to provide accurate traveller information. Through road pricing systems are used to implement electronic payments based on the users' actual usage of a commercial vehicle (Bazzan, Klügl 2013).

In Vejen Municipality, ITS is not a part of any plans, see Chapter 7 *Plan analysis*, and a more advanced use of ITS is therefore assumed unlikely. At the national level, ITS was though investigated in 2011, and this resulted in six recommendations for implementation of ITS. The recommendations were centered on ATIS, APTS, and alternative lane use (The Danish Road Directorate 2011).

In terms of influencing social practices, the technology element of the social practices creates a foundation for its use, but only if the users can see an advantage of using it, or if there can be created an engagement towards it. This could either be through lower travel times or lower transport cost.

9.2.4. *Step 4 initiatives, building new infrastructure*

9.2.4.1. Expanding current roads / Building new roads

In terms of building new infrastructure, two solutions are relevant; expanding current roads and building new roads. Unlike the previous initiatives, these are very self-explanatory, and a further introduction will therefore not be given.

The potential of building new infrastructure is well researched, and the potential will primarily depend on the number of lanes and the length of the new infrastructure. For the realization and implementation, the construction of new infrastructure at a larger scale is a political matter as previously argued. New infrastructures influence on social practices is significant because building a new highway will most likely lead to an increase in traffic on that road until it reaches its capacity. In addition, as a transport practice, most users have an engagement towards new infrastructure, through their already embedded transport habits. It is therefore assumed that new infrastructure would be used if the option were realized. The sustainability perspective is challenged in continuing to expand and build new infrastructure because it generates more traffic.

Having presented all these initiatives, the developed scenarios will be presented.

9.3. *Scenarios*

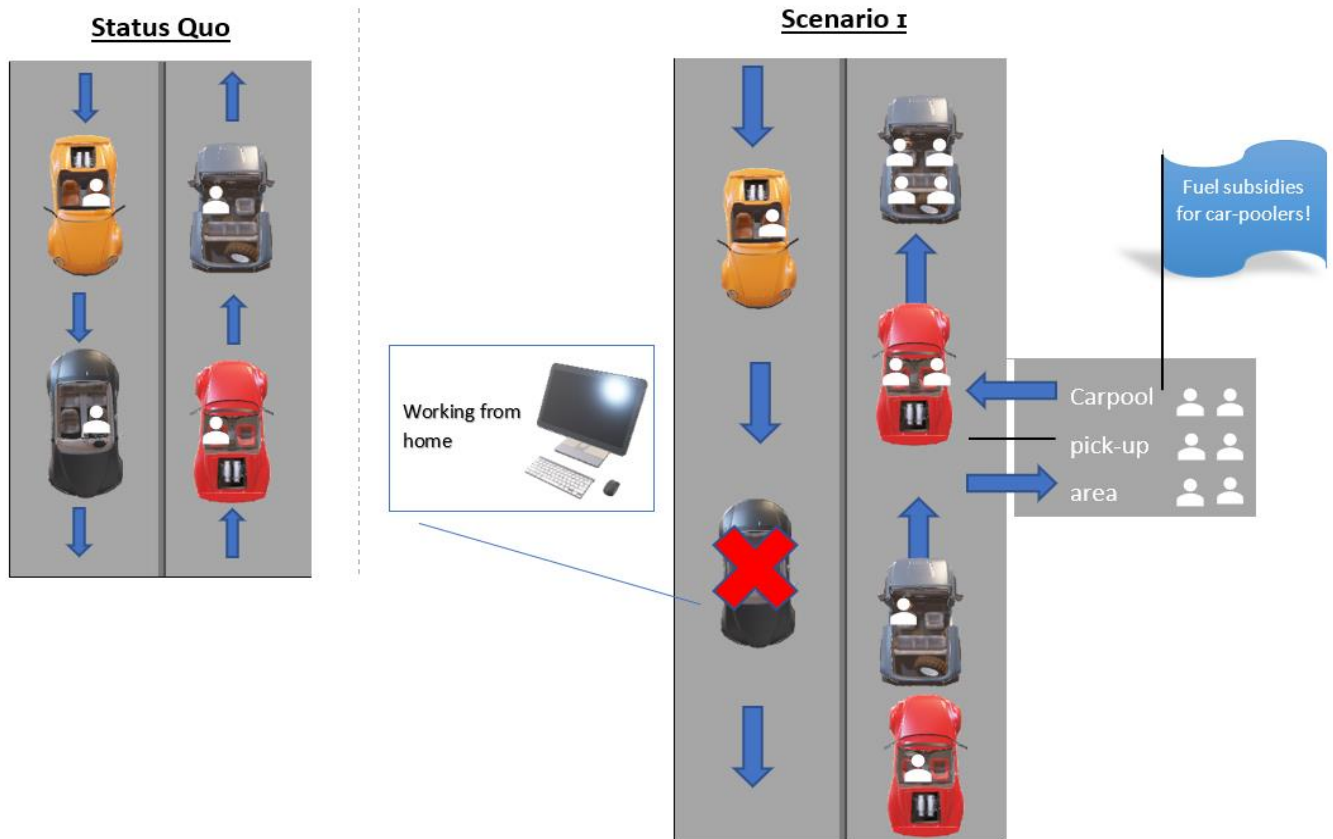
For the scenario building, each scenario will focus on a step from the four-step principle and present relevant initiatives. In addition, each scenario will add to the previous one increasing the complexity and price, but also the potential. This means that Scenario II will contain elements from Scenario I, Scenario III will contain elements from Scenario I and Scenario II etc. The scenarios can though be realized without the realization of previous scenarios, so Scenario III can be realized without realizing Scenario I and Scenario II. In addition, to discuss the scenarios, a series of future images are presented. These future images present the path from status quo to a scenario, which fulfills the long-term target.

To recap, the long-term target is as follows:

Long-term target: Improving mobility in Vejen and the neighboring municipalities, in the most sustainable way.

9.3.1. *Scenario I: Behavioral change.*

The first scenario is aimed on influencing behavior. The idea behind this scenario is to reduce congestion by reducing the amount cars and trips made by citizens. The scenario is presented in Figure 23.



For Scenario I the initiatives mentioned previously in the description regarding step one, are presumed implemented.

How to achieve the long-term target is illustrated in Figure 24, which identifies a path to reach the target in Scenario I. The path is based on programmatic planning where the planner has an active role in steering the development and engages in the process.

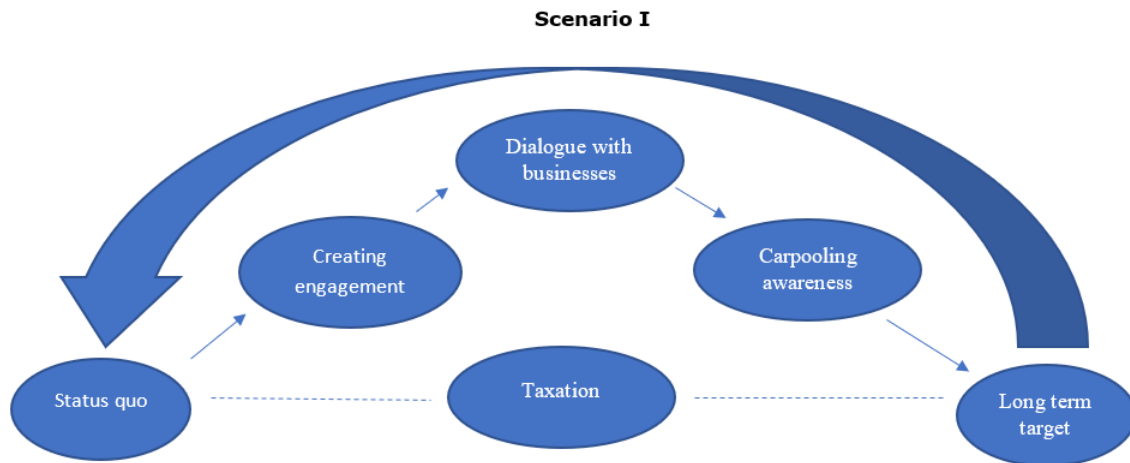


Figure 24. Visualization of the path from status quo to the long-term target, Scenario I. Own production

9.3.1.1. Future images (engagement-dialogue-awareness)

For the first future image, creating engagement is the challenge in order to change social practices. By creating a higher level of engagement towards alternative modes of transport for example, car-sharing or by stimulating a more flexible usage of the existing traffic capacity or through workplace initiatives engagement can be increased.

To do so, the planner can use tools that interact with the element of institutionalized knowledge and explicit rules, such as information to influence users' opinion.

This information strategy could be based on a point made by a participant in focus group two, who argued that the possibility to take turns driving was an advantage, and an argument from literature, that carpoolers can share transport expenses.

"Sometimes you are dependent on your car to purchase groceries on the way home etc. but, I could imagine an agreement with car-sharing three days per week. I think the biggest benefit would be not having to drive" -(Appendix 2, page 3)

However, for Scenario I there was also concerns, regarding safety.

"[...] what if you get paired with someone driving like crazy?" -(Appendix 2, page 5)

Which is an understandable argument, but another participant who did not have that concern challenged this opinion.

"I use GoMore (car-sharing service) regularly, both as driver and passenger, so I do not have an issue with that" -(Appendix 2, page 5)

The challenge of safety and trust can though be mitigated if the users have some sort of relation to each other, leading to a future image of business collaborations.

Business collaborations have a clear advantage in terms of carpooling because the users have a relation, a shared point of arrival and a shared point of departure. One participant had some experiences with this.

"I often have a co-worker with me who lives near Vejle, but that is exactly because we work the same place, start our shift at the same time, and are off at the same time" – (Appendix 1, page 4)

In relation hereto, prognostic planning could be useful to support the programmatic planning and use prognoses of growth to engage in collaborations with business areas expected to grow. The ideal area would have a relatively large number of employees, so there are a sufficient number of car-poolers in the system to reach a satisfying level of flexibility. To create further incentives to use carpooling, programmatic planning could support the transition by planning carpool parking spots etc.

For smaller local areas, a potential also lies in the communities. A user points to the fact that citizens often help each other in small towns. At least in his experience.

"I used to work in Vejen at one point, it is not that far, but someone always knew that you were planning to go, and they would call and ask if they could co-ride, and I used to do the same. In that manner, we help each other a lot." –(Appendix 1, page 5)

In terms of workplace initiatives, this approach differs. For the focus group participants, most of them had jobs requiring them to work at specific hours, so the topic was not thoroughly debated. A participant had some experiences, which illustrated how workplace initiatives and carpooling can work against each other.

"Yes, I have tried (carpooling) [...] but no one wants to ride with me, because I usually come into work at 8:30. [...] Nobody else wants to do that. They want to be there earlier" –(Appendix 1, page 4)

9.3.1.2. [Future image \(taxation\)](#)

For the future image of changing taxation, and the reason it is illustrated differently is because it is a matter of national politics, beyond the power of the actors in the case area. It can be promoted with a programmatic planning approach by the municipality, in which they can argue for its benefits for the government, but the actual changes must happen at the national level. Because it is such a difficult future image to realize, it is classified as a singular parallel process of advocacy.

From both focus group interviews, an interesting point was made that money was not the biggest driver of change. Time was the biggest driver of change:

"The motivating factor for me is not money. It is time. It sounds like we have plenty of money, we do not, but what motivates me is time." –(Appendix 1, page 10)

"The question is what the incentive should be, we do not need money, that is not what we are missing, we need time" –(Appendix 2, page 14)

These quotes identify a potential to change behavior if travel time can be reduced, for example through carpool lanes, which based on these findings would increase the carpooling rate.

9.3.1.3. Complexity

To realize Scenario I, the development of information to raise awareness regarding the potential of carpooling, the benefits of carpooling and how to carpool is relatively simple to do. In terms of changing taxation, it can without much further reflection be categorized as challenging.

The main question for Scenario I is though, if the influence of institutionalized knowledge and explicit rules is enough to change know-how, embodied habits and the commuters' social practices. The focus group interviews primarily identified time and flexibility as the significant drivers for change, which with the initiatives in Scenario I probably only can be improved for users using a slower mode of transport than the car.

9.3.2. Scenario II: ITS and Behavioral change.

The second scenario will build upon the first scenario and add ITS solutions to the scenario. It follows the second step of the four-step principle, which calls for a more efficient use of current infrastructure. The scenario is visualized in Figure 25.

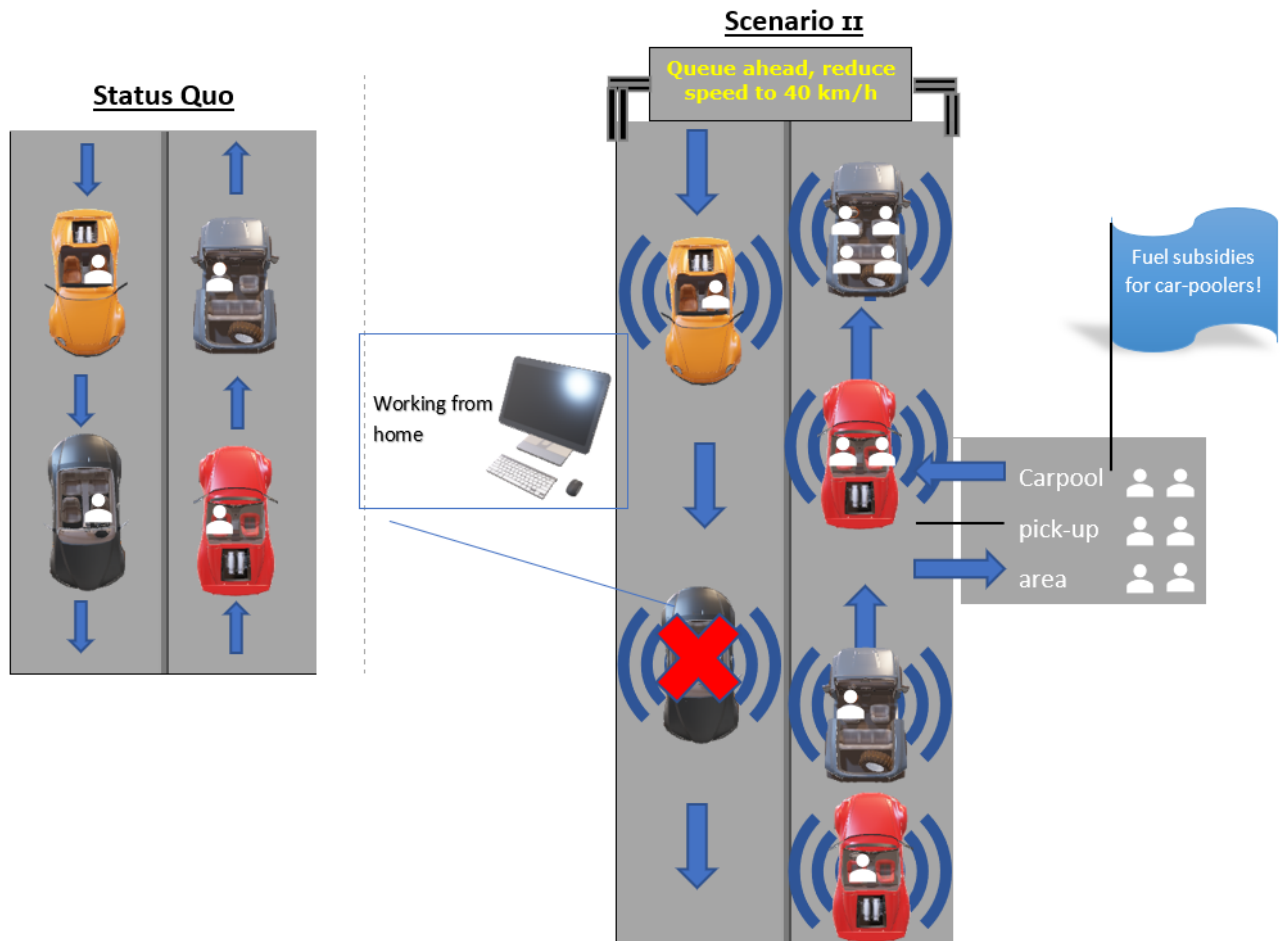


Figure 25. Visualization of Scenario II. Own production.

In Scenario II, to achieve the long-term target, the following pathing, see Figure 26, can be used to promote the initiatives and achieve an increased mobility in Vejen

Municipality. The elements from Scenario I can optionally be implemented and the path from Scenario I is therefore marked with grey in the figure, to illustrate it as an optional path. The path and complexity of Scenario I will not be investigated further in this paragraph.

In addition, because the initiatives from Scenario I and Scenario II, share a similar point of departure, Scenario II has the same planning approach.

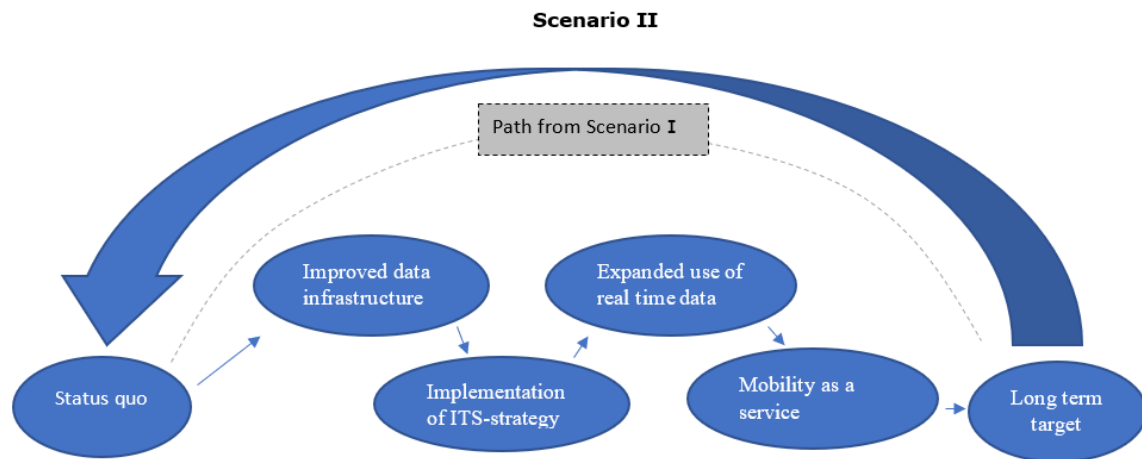


Figure 26. Visualization of the path from status quo to the long-term target, in Scenario II. Own production

9.3.2.1. Future image (ITS-solutions)

For the chain of future images, the path starts with infrastructure and planning and an improvement hereof, before an actual usage of the system can begin. The reason for this is that a system having insufficient services, such as a poor data infrastructure, can give users a bad first-time experience with the system. In social practices, a bad experience will, similar to a good experience, influence the user's engagement towards a new technology element, and therefore it is important that a transition to new technologies is as good as possible.

An interview participant made a remark summarizing why

"[...] currently the update (re-routing) is too slow. [...] if I am re-routed, and those behind me stay on the highway, and they arrive before me, that is when you get tired of this technology. That is when you decide to not use it the next time" -(Appendix 2, page 8)

The drivers' willingness to re-route was rather significant, as only one participant had bad experiences. The majority of the other respondents either had a GPS-system in their car or were using Google maps, listening to the traffic radio or similar sources of information in order to reroute. In the context of using ITS to have an alternative lane use, no participants expressed any concerns regarding the matter, although the remarks were similar to the ones in Scenario I, that it should not be at the expense of their travel time. The only remark regarding new technologies was if it was "overreacting".

"I do not think it is smart if it (the GPS-system) "overreacts", if there are too many pop-up suggestions of alternative routes. [...] then I think people would ignore it" - (Appendix 1, page 14)

At present, there are no plans in place to try to utilize some of the potentials from ITS-solutions, see Chapter 7 *Plan analysis*.

9.3.2.2. Complexity

To develop the data infrastructure in Vejen Municipality, the municipality cannot directly change the national strategies, but Denmark has a leading role in terms of attractive infrastructure for data, which creates an attractive location for private investors. Key elements are for example a reliable electricity supply, which Denmark has with a 99,99% supply rate in terms of electricity. Furthermore, Denmark has direct links to the USA in terms of fiber cables to provide high-speed data transmissions, and a significant production of sustainable energy to “fuel” the data centers (Behrendt 2017). As a result hereof, there has been an increased international attention towards Denmark, and three large data centers are being developed in Denmark at present time, which can be a step towards a general improvement of the national data infrastructure (Jensen 2017). So, in terms of improving data infrastructure as a foundation for ITS, the process is to some extent already on-going.

Vejen has in this context also an ideal location, because it is in an intersection for transport business, electricity and data:

"[...] There is the transport infrastructure, international fiber cables, large international electricity cables [...]. So, what is being branded, is that it (Vejen Municipality) is a strategic location with growth." -(Appendix 4, page 13)

To influence social practice, it is not enough to create the right conditions for ITS, an ITS-strategy is a prerequisite in reaching the long-term target. In this matter, the municipality is the key actor and could be a driver for inter-municipal planning using their network in The Triangle Area and in Region Syddanmark. To do so would require a change away from the prognostic planning approach and towards more programmatic planning. Hans Christensen said the following when talking about their use of ITS.

Interviewer: Do you use it (ITS) to collect data or in an alternative way?

"Well, we collect data, by measuring traffic on roads and bicycling lanes and then we hire some consultants to extrapolate the traffic development. Then based on these results, we simulate different solutions"

Interviewer: So the primary use is to determine where the traffic will go?

"Yes, and to qualify it with a prognosis" -(Appendix 4, page 4)

The implementation of an ITS system should be done in collaboration between the municipality and The Danish Road Directorate, who are responsible for highways and national roads.

In combination with the initiatives from Scenario I, it is relevant to plan for MaaS. MaaS also relies on an efficient data structure, real-time data, and a multimodal travel planner, to increase road capacity by having a more efficient use of, for example, cars by increasing the number of passengers in each car.

To create engagement and good experiences towards this solution, one participant noted that the municipality could take an active role as a facility provider.

"If the municipality provided cars to share in the local communities or near bigger shopping centers, which you could sign up to use. That would work. I think that, instead of having three cars in a household, maybe you would only have one or two, and then you could use the shared car some of the time." -(Appendix 1, page 15)

Hans Christensen had a different view on this matter.

"It (MaaS) is something we want to facilitate, but it is not a municipal task. [...] we would probably provide areas to park for car sharers, and similarly, for shared bikes [...] but in general it is decided by the market." -(Appendix 4, page 6)

But a collaboration between the municipality and the local communities could be a part of the solution, so the technology element is easily accessible and with easy access to designated parking areas. This could be one way of influencing social practices.

9.3.3. Scenario III: Scenario I and II combined with expanding infrastructure

Following the approach of the previous two scenarios, the third scenario will build upon the previous and add an expansion of infrastructure as a possible initiative. Scenario III is visualized in Figure 27.

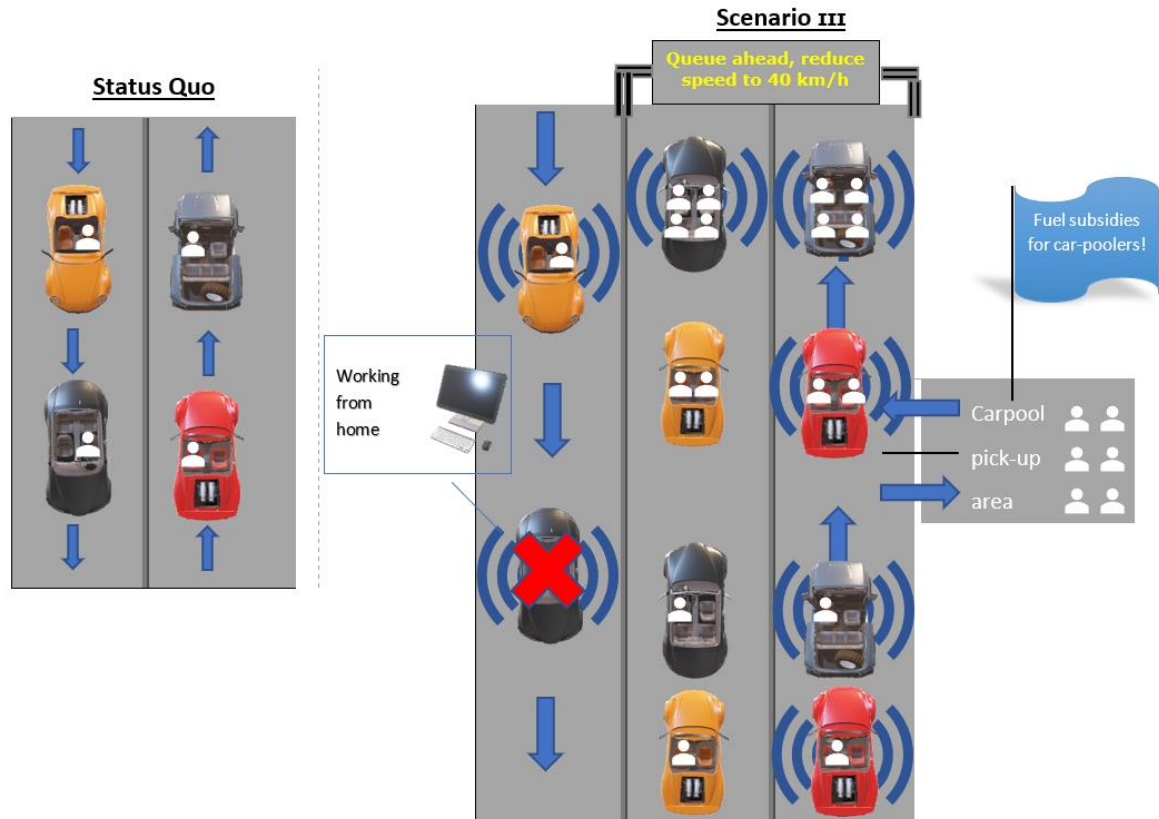


Figure 27. Visualization of Scenario III. Own production

As it was the case for Scenario II, Scenario III includes the paths from the previous scenarios as optional paths. The point of implementing the previous scenarios is, that implementation of ITS can have an influence on social practices, and could reduce the need for capacity increases. The path for Scenario III is visualized in Figure 28.

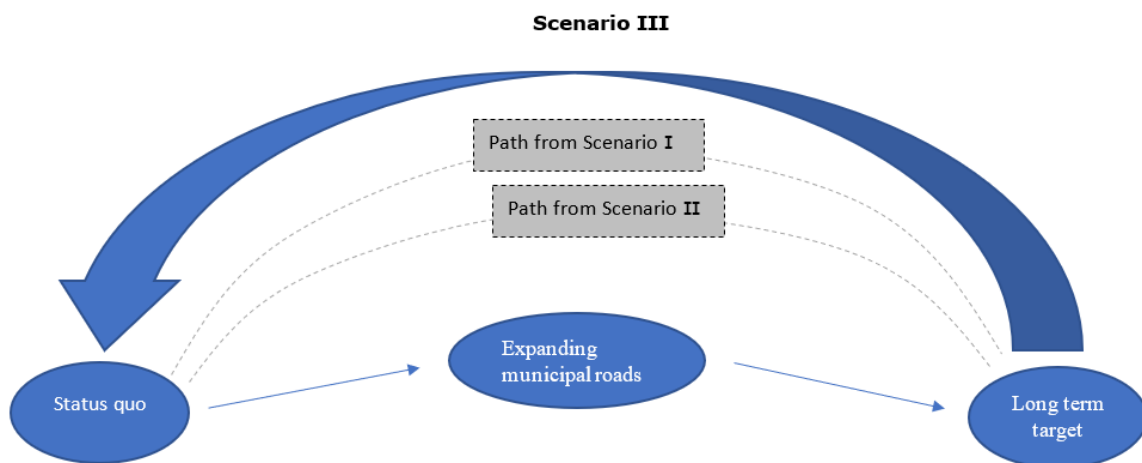


Figure 28. Visualization of the path from status quo to the long-term target, in Scenario III. Own production

9.3.3.1. [Future image \(expanding existing roads\)](#)

In terms of expanding existing roads, the municipality manages the local roads in the municipality and it is, therefore, a relatively simple process to expand them. The element of funding is a key issue, but unlike Scenario I and Scenario II the external factors are very limited, as the entire process can be handled by the municipality. In terms of deciding the location of the expansion, the municipality uses a prognostic approach as previously argued, see Chapter 7 *Plan analysis*.

From the social practice aspect, the new element is one the users are familiar with, and due to the potential travel time reduction, it can provide. For the users, there should be no barriers for it to become a part of their know-how and embodied habits. In a future perspective, the challenge of increased traffic over time on the expanded road will become an issue. This will always be the case with both road expansions and new roads.

9.3.3.2. [Complexity](#)

As argued as part of the path explanation the process of road expansion is relatively simple, and this paragraph will therefore not elaborate further on this matter, as the line of arguments follows the paragraph above.

9.3.4. Scenario IV: New infrastructure combined with Scenario I and Scenario II

The fourth and last scenario is the scenario which includes the construction of a new highway, that potentially could be combined with behavioral changes and ITS. The aim is that it is built as a state of the art highway to reduce congestion. This is understood as a highway where ITS is a part of the construction and future operation. Scenario IV is visualized in Figure 29.

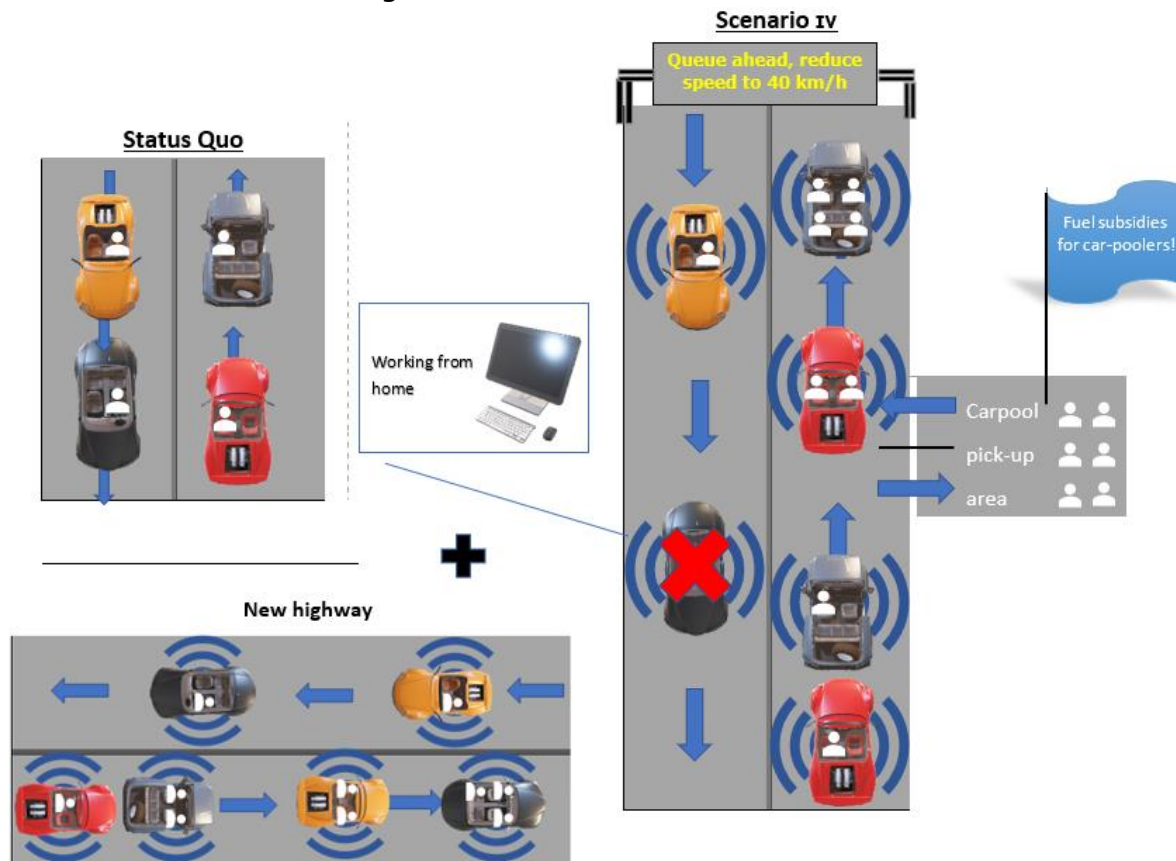


Figure 29. Visualization of Scenario IV. Own production.

Following the same structure as the previous scenarios, the path for Scenario IV contains the paths from previously presented scenarios, as they can be combined, but the paths from previous scenarios are again not mandatory for the realization of Scenario IV.

Since the main initiative for the scenario is the construction of a new highway, its path will focus on this process of constructing a new highway.

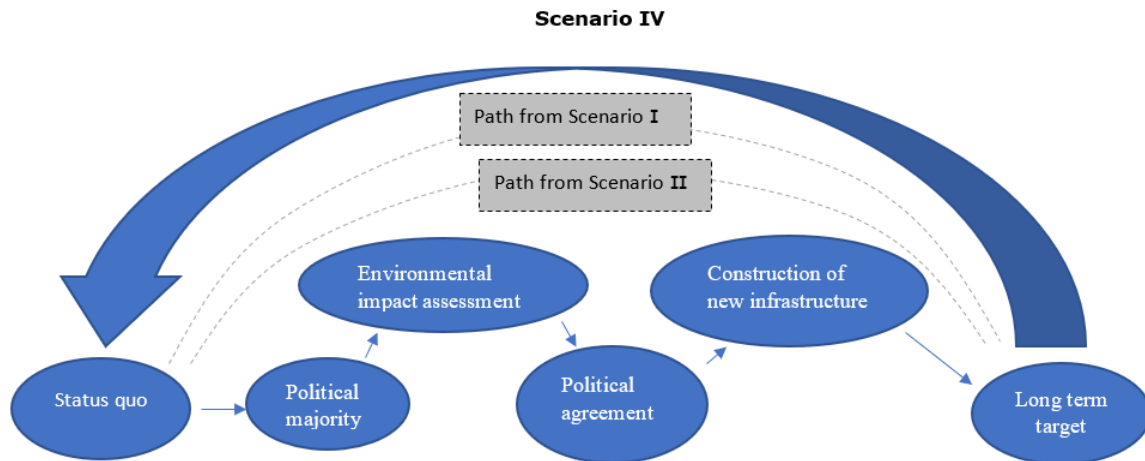


Figure 30. Visualization of the path from status quo to the long-term target, in Scenario IV. Own production

9.3.4.1. Future image (Building new infrastructure)

The last scenario, and the last principle in the four-step principle is to build new infrastructure. Due to the impact in terms of funding, resources and environment this path follows the rules for an environmental impact assessment before a decision can be made. After this construction can begin.

The citizen's possibility to influence the project is embedded in the legislation, but ultimately the final decision-making of the project is a political decision.

As the decision-making is at a political level, the focus group interviews discussed what the role of a highway should be, and there were different opinions on its role. Some found it to be beneficial for society as a tool to stimulate growth, some meant it was necessary to accommodate congestion, some had considerations regarding nature and one was both for and against because the participant lives in the possible corridor of the highway and was thereby directly influenced by the project.

"It is an interesting thought. Many businesses locate themselves near highways, so should you use the highway grid to determine where to develop? [...] if you build a highway it will not take long before you can see development" -(Appendix 2, page 13)

"I think if it (a highway) was there, there would certainly be businesses" -(Appendix 2, page 14)

"You just ruin more nature by doing it (building new infrastructure). I think it is better to expand infrastructure because we already destroyed nature there" -(Appendix 1, page 7)

"Well, I think the highway grid should be expanded, and I use it a lot, I drive to Zealand etc. But, I am influenced by being in the possible corridor for Hærvejsmotorvejen, where I am in the middle of it"

"So you could potentially be expropriated? Then I can understand you are against it"

"I am both for and against it" -(Appendix 2, page 12)

The planners also had two different views on the project, which reflects their position as municipal planner contra regional planner. The municipal planner was oriented towards the growth potential of a nearby highway;

"It (Hærvejsmotorvejen) will be a factor of growth [...] and of course we want part of it" -(Appendix 4, page 12)

The regional planner, on the other hand, was more oriented towards the current congestion challenges on E45, which he did not believe Hærvejsmotorvejen would reduce:

"It (Hærvejsmotorvejen) will reduce the number of cars on Vejle Fjord Broen by 6.000 cars. That is how much it is increasing on a yearly basis, so in relation to reducing congestion on E45, it is delusional to think that Hærvejsmotorvejen will have any significant effect" -(Appendix 3, page 3)

Among the actors involved in the planning of a highway, there is a wide variety of opinions, which have to be handled and considered.

9.3.4.2. Complexity

For the complexity of constructing a new highway, it can be seen from different points of view, with different conclusions.

From a decision-making point of view, it is relatively simple in the sense that the process follows the legislation, meaning that an EIA-investigation is carried out and afterwards the planners who carried out the EIA conclude which solution they would recommend.

For the planners carrying out the EIA process, the process is very complex and time consuming, as a wide variety of aspects must be thoroughly investigated, and stakeholders must be included in the planning process. All of this must be done within the predefined budget. The potential is well documented and there are not any challenges for utilizing the potential once the construction is finished.

9.4. Findings

Before the desirability of each scenario is further investigated the path and complexity aspects are restated in the following points:

- *Within pre-existing structures, it is not likely that Vejen Municipality will reach the long-term target of improving mobility in a sustainable way.*
- *Four scenarios were created based on a target-oriented backcasting approach to reach the long-term target, and the paths from status quo to the long-term target were identified.*
- *Scenario I was challenged by it potentially reducing flexibility for the driver, and the element of safety in terms of who the driver or passenger is was identified. Some participants also argued that it was a complication of their everyday routines, which were not worth the trouble.*
- *Scenario II was challenged by bad experiences with new technology for some participants, and the limited use of currently available technology. The social practice element of engagement is therefore challenged for this scenario.*
- *The primary challenge for Scenario III was funding. The focus group participants did not identify any challenges in terms of using expanded infrastructures.*
- *Scenario IV was in its approach unique, both in terms of its context and its impact. Contextually it is a political process and the decision-making is beyond the reach of the interviewed respondents. In terms of impact, there were no social practice barriers identified for its usage, although some concerns were related to its impact during construction.*

Chapter 10. Desirability

In this chapter, each scenario and the different initiatives from them will be analyzed, in terms of the challenges related to implementing them, by using the knowledge from the interviews with Vejen Municipality and Region Syddanmark to examine them.

The findings from the focus group interviews will be used to analyze how the users' social practices can be challenged by the initiatives.

By combining the view of the planner and the view of the user, it will be possible to make an overall assessment of the attractiveness of each initiative and determine desirability.

10.1. Scenario I

Initiatives	Pros	Challenges
Carpooling	Low implementation cost	Carpooling has a small user
Workplace	Reduces the number of	group in Denmark resulting in
initiatives	trips	poor flexibility
Taxation	Increases capacity	Tax regulations cannot be
		implemented locally

Table 16. Initiatives, pros and challenges for Scenario I. Own production.

The first scenario has initiatives, which attempt to change the users' behavior, increase the number of passengers per car, limit users need for transport, or attempts to provide a reduction in taxation for users that carpool. The advantages of these initiatives are, that the cost of implementation is relatively low. The challenge, on the other hand, is that it is targeted on social practices that can be difficult to change, and some initiatives would require political action, which is not likely.

10.1.1. Carpooling

Carpooling is not very common in Denmark and that is in itself challenging when implementing carpooling for daily commuting in Vejen Municipality. Only one participant from the focus group interviews had experience with carpooling for commuting, but it was not on a regular basis.

The number of passengers per car in Denmark has been declining from 1,84 passengers per car in 1981 to 1,31 in 2012 (DTU Transport 2015, Christiansen, Christensen 2003) but recently car-sharing services like Gomore, have been promoting car-sharing as an alternative to long distance trains and busses.

Another issue is the organization of carpooling itself, which actor should take action in order to implement carpooling? Vejen Municipality was hesitant when asked about being the organizer of carpool initiatives.

"We would probably provide areas to park for car sharers, and similarly for shared bikes [...] but in general it is decided by the market." –(Appendix 4, page 6)

Hans Christensen specifically suggested that they could support a social housing group and create a foundation for carpooling initiatives there.

"I strongly believe that the municipalities could provide areas for social housings areas (for parking for carpooling)" -(Appendix 4, page 10)

In doing so it would be easier for the users to carpool and create good user experiences, and thereby increase engagement.

The Region was also hesitant in being the primary developer of carpooling. Erik Ørskov was asked who had the responsibility for developing carpool initiatives and answered:

"I would say, that we (the region) do not have the responsibility" -(Appendix 4, page 6)

He does, however, say that the region could have a facilitator role, and provide economic support for the municipalities.

"I could see us taking a role as a facilitator; we just have not done it yet." -(Appendix 3, page 11)

So neither the municipality nor the region sees themselves taking an active position on carpooling, but they could see themselves as facilitators. Facilitating carpooling is an important role that is needed to work towards more carpooling, but an active and involved primary developer is needed. Alternatively, an arena for cooperation could be via the traffic company, where both municipality and region are represented because they take part in bus planning.

The users were generally positive towards carpooling, and some were already using it for longer trips. There were some concerns when it comes to traveling with people they did not have any relation to and most people would prefer a friend or a colleague. The concerned participants preferred to have control over the situation and chose who they would share their car with.

"I think I would be careful with who the driver was if I were to get into a car" - (Appendix 2, page 5)

The users had very different views on the potential economic advantage in sharing transport costs.

"The question is what the incentive should be, we do not need money, that is not what we are missing, we need time" -(Appendix 2, page 14)

"I think it depends on where you are in your life. Younger people might value the economic aspect higher than we do" -(Appendix 2, page 16)

There were also several participants that thought that the system was inflexible and would be hard to use if they, for example, had to return home earlier than planned.

"The day I have to go home because the children are ill, then what? Do I have to wait for someone to get home again? That does not work!" -(Appendix 1, page 4)

Their job situation also meant restrictions because it takes place at many different locations, and they, therefore, need a high flexibility.

"If I were a passenger in a car, I would not be able to visit the construction sites during the day"

Interviewer: So you would not be able to do your job?

"Yes, exactly" -(Appendix 2, page 4)

Several users pointed out that they sometimes drive with others from their local community in their spare time, or that students living in Aarhus but who grew up in Vejen, organize rides back to Vejen together, to save money. Based on this, having the same start or end destination would increase the chance of driving with someone they know, either neighbor or colleague, and limit the problem of driving with someone unknown.

"I know that many of the younger people studying in Aarhus use Facebook to organize rides back to Vejen" -(Appendix 1, page 6)

In summary, the conclusions on carpooling are:

Carpooling is not common in Denmark, and planners do not have much experience with it. Therefore planners are hesitant with using carpooling as part of their plans. The municipality and region both believe that the responsibility for increasing carpooling lies with others. Users find carpooling could be attractive for them, but are concerned about it being sufficiently flexible. In order for carpooling to be successful, it would require a large pool of participants, which again would make it more flexible. Also, the advantages of using it would have to be communicated to increase engagement towards it as mentioned earlier.

For the initiative to be successful, it would therefore, require cooperation between the region, the municipality, users and also companies and local associations, like sports clubs or homeowner associations, see also chapter xx. The benefit is that users have the same starting areas or destinations, which could be used as the foundation for carpooling.

10.1.2. *Workplace initiatives*

The planners had limited experiences with workplace initiatives such as flexible work schedules or moving shifts so they start outside of rush hour. Vejen Municipality explained that they had discussed a bus line going to an industrial area with the companies located there, and changed the bus line because of this. Hans Christensen could though not see it working any other way.

In relation to carpooling and as pointed out by both literature and by a focus group participant, flexible work hours and carpooling do not support each other (Correia, Viegas 2010, Delhomme, Gheorghiu 2015).

"You could say that an argument against evening out work hours, would be that carpooling becomes more difficult. [...] you cannot have it all" -(Appendix 2, page 17)

Another user thinks that the paradigm of working 9-17 is a societal problem because people expect that stores are open after work hours.

"But in general, we have a huge societal problem. When we get off from work at 5 pm, we want to be able to shop until 10 pm, but the lady in the store cannot have her child in childcare until 10 pm" -(Appendix 2, page 17)

Since not all have the possibility to plan their own work schedule, this could be a problem and recent numbers from Danish statistics show that around 1/3 of all employees have flexible work schedules. (Statistics Denmark n.da)

Danish society is quite "locked" in a paradigm of working from morning to late afternoon and changing it will be quite difficult. Some companies could change their schedule, but an overall change is not assumed likely if only to even out traffic.

10.1.3. Taxation

Planners cannot change taxation laws for carpoolers, because it is decided at a national level.

For the users, the monetary advantage was not as important as time or flexibility. One participant even pointed out, when asked if she would change habits if driving was taxed instead of the car itself, that;

"The price is still break even, but at some point, you would be forced to change your behavior (if road pricing was implemented), but for the most part you are paying for your convenience (driving alone in your own car)" -(Appendix 1, page 6)

10.1.4. Conclusion Scenario I

Providing an economic benefit for carpooling is not seen as useful, or something that is likely to occur. It would require an overall taxation change from the Danish government and this is not currently planned. Users also point out that their own flexibility and time is more important than money, and that these factors are something that they are willing to pay for.

In conclusion, the initiatives are desirable and the users could benefit from them if carpooling was planned in a flexible way. If carpooling should have an effect and be successful, it would require a primary developer of the initiatives, for example in a collaboration between the municipality, traffic operator and region, in which there should be identified flexible solutions.

10.2. Scenario II

Initiatives	Pros	Challenges
Scenario I	Scenario I pros	Scenario I challenges
initatives	ITS technology is already available	MaaS requires a joint travel platform
MaaS	Further increases capacity	To utilize the potential of ITS,
ITS	on the roads without	traffic needs to be significantly
Real-time data	expanding infrastructure	congested.

Table 17. Initiatives, pros and challenges for Scenario II. Own production.

The second scenario builds upon the first one and has an additional three initiatives, that works toward making the current infrastructure more efficient.

10.2.1. MaaS

Users have limited experience with Mobility as a Service because there is not yet a fully developed MaaS system in Denmark. Therefore, this paragraph will focus on the interviews and the rapport "Mobilitet for Fremtiden", which among other things examines MaaS (Ministry of Transport 2018)

In this context, Erik Ørskov mentioned that he knows of a cooperation between GoMore and Nordjyllands Trafikselskab.

"I have heard that they work with GoMore in Northern Jutland, the GoMore system does not work for short trips, but it is very good for longer trips." –(Appendix 3, page 10)

The collaboration is between the traffic provider in Northern Jutland and GoMore, which and it is a carpooling service implemented in the existing journey planner platform. The users can then choose carpooling as an alternative to busses or trains. Their goal is to be able to increase mobility for daily commuters. The challenging issue is the flexibility, which again is related to the user pool (Hyldal 2017, Christoffersen 2017).

In the rapport "Mobilitet for Fremtiden" experts estimated that for MaaS to be a success, good public infrastructure is required. This is not the case in Vejen Municipality, which does not have very much public transport, see Chapter 6 *Case introduction: Vejen Municipality*. The rapport also states that it could increase mobility for the youngest and elderly citizens because MaaS could use autonomous vehicles. The focus group interviews showed that especially mobility for children was desirable.

"Sometimes you have to pick up the children, and you cannot wait for the one car to get home (so you need a second). That is the situation out here in the countryside" –(Appendix 1, page 17)

"They (the children) take the bus to high school every day, but when they are going to other activities (sports etc), we need to drive them, because it (the busses) do not fit" –(Appendix 1, page 2)

"We live three people in my house. [...] but my daughter had to get a car to get work in Kolding, so we live three people in one house, with three cars. That is too much!"
-(Appendix 1, page 7)

MaaS is currently under development and there is a great uncertainty regarding the possible effects of implementing it as a transport solution. MaaS could solve some of the problems of mobility for children. Driving children to different activities was identified as an important part of their car practices.

10.2.2. ITS

Intelligent Transport Systems are well known to planners, and as explained in earlier chapters, planners think they are very useful. Vejen Municipality uses them to analyze future projects. The region cannot see how they could work with ITS because they do not own infrastructure.

"ITS does not help us, as we do not own infrastructure" -(Appendix 3, page 15)

The users were generally positive and mentioned that they had seen numerous examples of ITS, and the results of it.

"There is a road repair right now, from Horsens to Aarhus, almost all the way with a reduced speed of 80 km/h. We talked about how it does not take longer than before (to drive the distance), and how it actually is more relaxing" -(Appendix 2, page 7)

The users in focus group two discussed intelligent transport. They talked about how automatic cars could influence them. A majority of the participants believed that they in the future would feel safe in an autonomous car.

"I do not think I would feel safe today because the technology is not there yet, but in 20 years I think it will be okay" -(Appendix 2, page 10)

"Exactly, there are plenty of things that I could not even imagine 20 years ago, that I do today" -(Appendix 2, page 10)

Planners and users were both very content with the effects of ITS and the solutions already in place in some locations. These can quite easily be expanded to other locations. Users believed that they would feel safe using autonomous cars and likewise regarding an increased use of ITS on the roads.

The overall assessment is that ITS can be very useful, both for decreasing travel times and informing users of potential changes in the traffic system.

10.2.3. Real-time data

Users were positive towards an increased use of real-time data as a tool to optimize routes. Some users already received GPS information in their car and did not find it disturbing, and others used traffic radio, but all were generally satisfied.

"That would be perfect, the faster I can get to work and back again, the better"
-(Appendix 2, page 7)

"I have to hear the traffic radio on P4 because it (the traffic updates) determines if I am taking another route" -(Appendix 1, page 12)

It is however important for users that the information is precise and updated.

"[...] currently the update (re-routing) is too slow. [...] if I am re-routed, and those behind me stay on the highway, and they arrive before me, that is when you get tired of this technology. That is when you decide to not use it the next time" -(Appendix 2, page 8)

Another user appreciated the detour because she could explore the areas she drove through.

"I get to explore new parts of Midtjylland, see new landscapes and villages. But, it depends on when you have to arrive at your destination and things like that" - (Appendix 2, page 8)

Since real-time data is becoming more available as technology advances its potential is increased. It is a simple task to lead cars away from congestion, and spread cars over more roads, thus using the existing capacity more efficiently.

10.2.4. Conclusion Scenario II

The initiatives in Scenario II are desirable for both planners and users, who have positive experiences with the technology. Also, as technology develops and becomes more common, its usefulness is expected to increase for more users. The MaaS concept is currently under development, and if it develops as expected it can become an alternative to owning a car, as MaaS creates a new transport service, with greater possibility for pick ups, car-sharing, carpooling etc. combined with public transport. In terms of behavior, it is important that MaaS remains easy to use, like the current use of real-time data, so MaaS is accessible for all, and there can be developed a positive engagement to the new technologies.

10.3. Scenario III

Initiatives	Pros	Challenges
Scenario I	Scenario 1 pros	Scenario 1 challenges
initiativies	Scenario 2 pros	Scenario 2 challenges
Scenario II	Significant immediate	Determining which planning
initiativies	capacity increase from the	level should build and pay for
Expansion of	expansion	the road can prove difficult.
existing		Significant construction cost
infrastructure		

Table 18. Initiatives, pros and challenges for Scenario III. Own production.

The third scenario is based on the third step of the four-step principle, which is an expansion of current infrastructure. It also contains the initiatives from Scenario I and Scenario II, which were previously investigated.

10.3.1. *Expansion of current infrastructure.*

When the regional planner was asked about the need for expanding current infrastructure, he said that expansion should be in areas with the most congestion and that it should be prioritized over building a new highway.

"You have to expand here (in Vejle), it should be the highest priority. We hear that from all fronts. Let's get that expansion (on the bridge in Vejle). After that, we can look at Hærvejsmotorvejen" –(Appendix 3, page 14)

When asked if expansions of highways solve congestion, or if it is a temporary solution, he said:

"Yes, I think that sounds right (that expansions of highways are symptomatic treatment)" –(Appendix 3, page 14)

From Hans Christensen's point of view, there is no need for expanding the highway at present, but the problem is present in neighboring municipalities and it will develop. Therefore the municipality should, in his opinion, try to be proactive

"You could say, in what order should these projects (infrastructure projects) be carried out? Should you be proactive when it comes to infrastructure or should you be reactive? We try to be proactive" –(Appendix 4, page 11)

The point was made that they are being proactive by trying to have Hærvejsmotorvejen as close to the municipality as possible, based on their experiences with the highway from Esbjerg to Kolding (E20).

The users believed that expanding current infrastructure is necessary, in order to accommodate congestion.

"They expanded in Vejle, and that helped very much. Before the expansion, there would be a traffic jam every Friday" –(Appendix 1, page 9)

"We live in an area where everybody has to drive through, The Triangle Area, to get home. There is no other way. In Copenhagen there are other alternatives to get off the highway, we do not have that here" –(Appendix 1, page 9)

10.3.2. *Conclusion Scenario III*

Expansion of current infrastructure is an important and very useful tool, and users see the effects directly. However, it does not solve the underlying issue of car growth, and it only temporarily increases mobility because the number of cars is still growing. As the users also pointed out, expansion in some areas with congestion is necessary.

10.4. Scenario IV

Initiatives	Pros	Challenges
Scenario I initiatives	Scenario 1 pros	Scenario 1 challenges
Scenario II initiatives	Scenario 2 pros	Scenario 2 challenges
Building a new highway	The highest immediate capacity increase of all scenarios	Most expensive Scenario. Long planning process before it can be realized

Table 19. Initiatives, pros and challenges for Scenario IV. Own production.

The last scenario builds upon the three earlier scenarios and introduces the initiative of constructing a new highway.

From the planners' point of view, there were two different reasons for building the new highway. The first was that the E45 would be relieved of traffic, a point that Erik Ørskov questioned.

"From the beginning, the idea was that Hærvejsmotorvejen should be constructed to decrease traffic on E45. But that is not the case" –(Appendix 3, page 3)

The municipal planner Hans Christensen believed that a new highway would benefit Vejen Municipality because it can attract new business.

"Besides attracting new businesses and citizens, we also believe that it (Hærvejsmotorvejen) can secure growth for the existing companies" –(Appendix 4, page 2)

When the focus group participants were asked, their opinions varied. Some thought that Hærvejsmotorvejen was unnecessary, and wanted to protect environmental interests instead.

"I think it would be very sad if our society was covered in infrastructure facilities such as highways and electricity cables"

Interviewer: So we need to protect our limited nature?

"Yes, I believe so" (Appendix 2, page 11)

Others thought it was important to make sure that new highways support society and mentioned that it could be a catalyst for new growth, and compared the role of highways, with the role of railroads 100 years ago.

"If you compare it to 100 years ago, it was the same situation. The rail network lead to development of the cities, that all have a train station. If not for that, Vejen would not have been as big" –(Appendix 2, page 14)

"We have some big companies in Midtjylland, that are in need of transport, and right there, transport is the worst" –(Appendix 2, page 14)

10.4.1. Conclusion Scenario IV

Overall the attitude towards a new highway was divided. Some users saw benefits, while others thought that the negative consequences outweigh the positive.

The planners had different goals that they could achieve with the building of a new highway. On one hand, the focus was to generate new business development. On the other hand, the focus was to decrease congestion on an already existing highway. The initiative of building a new highway is a tool that is being used and assumed to continue to be so.

Concluding on the scenarios, the four-step principle as a whole will be analyzed, from both the planners and users' point of view, because it was the foundation for the scenario development.

10.5. The four-step principle

When asked about the four-step principle the planners and the users opinions differed. The municipal planner believed that the four-step principle would not work, because the municipality does not have the ability to work on all four levels. Furthermore, he pointed out that the principle would make the political system needless.

"[...] Where is the politics in this? This is very academic. [...] You would have to add an additional layer and say; we have an area for citizens, and one for business. Then you would try improving these two areas. [...] But I do not believe that this is how the world works." –(Appendix 4, page 5)

The concern is most likely due to the fact, that the system is very different from the way planning is carried out today. It requires a long time commitment and a higher level of collaboration than in the current planning process. At first glance, it can difficult to see it in operation.

The regional planner knew the principle and found that it was good, but also pointed out the fact, that the region would have limited use of it, because of their role in the Danish planning system. He conceded that the region could help by using the existing infrastructure more efficiently.

"The aspects in the first step, are very much tasks for the municipal level, and because we do not own infrastructure, it is hard for us to act there (in step 3 and 4). However, I think that we in the efficient use of current infrastructure use could do a lot when planning public transport" –(Appendix 3, page 6)

The citizens had one concern regarding the implementation of the four-step principle. When the municipality tries to change the behavior of their citizens, it should never be done by force. The participants believed it would work better, if they could receive some sort of benefit from using a new initiative, rather than being forced into solutions which they did not choose to participate in. For social practices, this again

relates to the engagement element, and the point of good experiences for new users, to influence social practice.

"If you are going on the highway anyway, you could stop by (a carpool pick-up spot) and see if anybody needs a ride. That was something the municipality could help with, but it cannot be by force, and it cannot be something you must do" –(Appendix 1, page 16)

In summary, the opinions regarding the four-step principle were divided. The most important concern from the planners was that there is no consensus on which step each actor should be responsible for. This is probably due to the fact that limited knowledge regarding the principle exists in Denmark.

The citizens were generally positive but mentioned that no initiatives should be forced upon them as a way of changing their behavior.

10.6. Findings

From the desirability chapter the following points are underlined:

- *The potential of each scenario is to some extent related to the cost of its implementation.*
- *For Scenario I the flexibility and time were central if the users were to change their behavior, more important than cost. At the overall level users found it desirable, but it was argued that its implementation preferably should be as a business initiative, so the users have a relation to each other.*
- *The Scenario II initiatives related to re-routing and real-time data were by the majority found desirable, but with present technology, some had bad experiences with slow re-routing. Both planners and users recognized the potential of MaaS.*
- *Scenario III was found to be an effective but temporary tool, as expanding infrastructure does not accommodate the underlying issue of car growth.*
- *In Scenario IV the respondents had differing opinions as some found it beneficial and a part of the development of the country's infrastructure to build new infrastructure, while other participants argued that the negative impact outweighed the positive effects.*
- *For the initiatives to be realized it would require that the municipality has a continuous effort to implement it, preferably in collaboration with businesses and transport providers.*

Chapter 11. Discussion

Based on the results of the project, the following three topics will be further discussed in this chapter:

- *The political aspect of transport planning*
- *The role of actors and planning institutions*
- *Social practice theory*

11.1. Political aspect

In transport planning, the largest investment in this millennium was the green transport agreement in 2009, which allocated 87 billion DKK for investment in the transport system. The political agreement included a series of principles and goals such as reducing CO₂ emissions, greener taxation on cars, and a greater protection of nature and citizens. Out of all the principles, the following is especially interesting for this project, as it is a political guideline for road planning (Danish Ministry of Transport, Building and Housing 2009).

"Road capacity should be expanded, where the need is greatest, but also where future business growth is assumed to need better road infrastructure" -(Danish Ministry of Transport, Building and Housing 2009, page 4).

When investigating the history of highway construction in Denmark, it is obvious that this principle is necessary, because this principle has not always been followed. From 1951, when the first highway was opened, to 2010, there has been constructed 1.416 kilometers of highway in Denmark with two periods (1971-1980 & 1991-2000) being the most significant, with approx. 350 kilometers of new highway being opened in each period (The Danish Road Directorate 2017c). The result was that Denmark was the country in Europe with the highest rate of highway per inhabitant in Europe in 2002 (Rothenberg 2002). In 2015 Denmark ranked 8th(Bjerring 2015).

Before 2000 the political aspect had an interesting role because there were examples of "political deals", where politicians provided a majority vote in one law and in return receiving majority in another law. This was seen in transport planning in Denmark with "Den jyske trafikmafia" (The traffic mafia of Jutland edt.). This group was in office in the 80'ies and 90'ies and were called this name for "demanding" highways in Jutland (Aalborg-Hirtshals and Aalborg-Frederikshavn), in exchange for the construction of Storebæltsbroen (Great Belt Bridge). After some arguments, the traffic mafia got it their way, and the highways were constructed, along with the bridge. The issue with these two highways in Jutland was, that the traffic in Jutland was not significant enough to justify these highways (Rothenberg 2006).

Looking at the effects of the agreement from 2009, the results are that since 2009 only 3,8% of the total travelled kilometers have been done by public transport, and the remaining 96,2% by car. The increase in travelled kilometers since 2009, has primarily been carried out by cars and not by public transport (McGhie 2018), despite

the fact that a key element in the agreement was that Denmark should have a transition towards more sustainable transport.

This was also the case before 2009 when cars on the national level travelled also significantly more kilometers than public transport (Statistics Denmark n.d.).

11.1.1. *Why new highways?*

In spite of the contradiction in cars carrying out 96% of the transport and political plans to promote public transport, the question of "*why new highways*", will be further evaluated.

An argument that is often used for building new highways is that they generate growth because they significantly increase mobility. This was argued for Hærvejsmotorvejen (The Danish Road Directorate 2016c, Moe, Incentive 2018) and was also an argument which was put forward in both the focus group interviews and used by the municipal planner from Vejen.

"We would never be able to attract them (companies) if we did not have a highway system" -(Appendix 4, page 2)

"It (Hærvejsmotorvejen) will be a factor of growth [...] and of course we want part of it" -(Appendix 4, page 12)

"I think if it (a highway) was there, there would definitely be businesses" -(Appendix 2, page 14)

What is not discussed is growth where and growth for whom? Does a highway provide municipal growth in Vejen, or does it provide an improved connection to bigger cities, which in turn then get an increased catchment area and thereby benefit more from the highway than Vejen? This depends on the point of view:

If a business relocates to Vejen because the new highway provides just what they need, then it provides a growth increase in term of an increased tax base for the municipality. On the other hand, it can also have a "straw-effect" where the increased mobility provides an opportunity to leave the municipality or move ones' business out of the municipality. Businesses outside the municipality create increased competition to local business due to increased catchment areas outside the municipality.

Relevant to the growth argument of highways, a study investigating the influence of highways on rural municipalities in Denmark from 1950-2000, found that a municipality being located near a highway does not necessarily experience growth in terms of population. The challenging question is what drives growth? It is clear that areas, which have highways and are located near larger cities experience growth, but areas with good highway access such as Lolland-Falster, Korsør and Nyborg have not experienced the same rate of development. In order to investigate this, a study focused on areas outside the larger cities was made to see if it could be argued that a highway was the cause of the growth of the population or not. The conclusion was, that the highway was not the cause of population growth nor decline. For the areas, which did experience growth, it was found to be a combination of the near proximity

of larger city areas and increased mobility from the highway (Kaarsen, Weissert 2016).

The study concluded with the interesting recommendation that the increased potential for employment in local areas should not be included in the cost-benefit analysis of infrastructure projects, (Kaarsen, Weissert 2016).

This leads to a discussion regarding decision-making, and the tools available to decision-makers, primarily in the cost-benefit analysis.

11.1.2. Tools for decision-making

The purpose of a cost-benefit analysis is to provide a systematic assessment of the advantages and disadvantages of carrying out initiatives and a suggested solution (Danish Ministry of Transport, Building and Housing 2015, page 9). In the cost-benefit analysis, the internal rate of return (IRR) determines the rate of return for an investment and thereby is an indicator to determine whether a project is beneficial or not. In a Danish planning context, the IRR should be 4% or larger in order for a project to be economically attractive, based on the required rate of return defined by the Danish Ministry of Finance. If this is the case, society will benefit from the investment (Incentive 2018).

Public transport can have a relatively bad IRR, compared to road projects, for example, the IRR for Hærvejsmotorvejen is 9% (best solution) (Danish Ministry of Transport, Building and Housing 2016) versus 3% for the current metro expansion (Cityringen) in Copenhagen (Metroselskabet, By og Havn 2011). The Fehmarn Belt project has an IRR of 7% (Metroselskabet, By og Havn 2011) and the metro to Copenhagen airport had an IRR below 4% (Svane n.d.). The question is if anyone today would describe the Metro as a bad investment, despite it was found to be so at the time of construction.

After 10 years of service, the metro has had more than 63 million trips, and every fourth airport user takes the metro, and the metro is now an integral part of the city's development plans (CPHAirport 2017).

In this context, another point is that public transport increases access and mobility for the greater good, and is an important part of a sustainable transition. Cars on the contrary, have a significantly larger environmental impact and are from a sustainability perspective not desirable.

Combining the decision-making tools with the political aspect it was noted in a recent ex-post investigation of five transport projects that were carried out for the Danish Ministry of Transport- Building and Housing, that four out of five of them were highway projects, and thus car projects. The fifth was Storebæltsbroen, which services both cars and trains. The analysis shows a larger emphasis on road projects than on public transport, despite the ambitious goals from the agreement from 2009. Furthermore, the investigation evaluated the projects based on their IRRs' (Incentive 2018).

The absence of similar ex-post analysis of for example the Copenhagen metro or larger rail projects is also notable. The ministry has an overview of all rail projects and

road projects, presenting their IRR and budgets (Danish Ministry of Transport, Building and Housing 2017) but no in-depth analyzes were found.

Lastly in terms of decision-making and transport planning, it has been argued that a complete removal of congestion should not be a goal, because the cost of having a transport system with no congestion would outweigh the benefits. Congestion should only be reduced if travel times can be reduced to a level, which justifies the costs. Therefore congestion can be "allowed" in areas where it is of least harm to the overall traffic (DTU Transport 2012a).

11.2. *Actors and institutions*

As previously identified the different levels of government in Denmark disagree on who is responsible for what, in regards to the four-step principle. This disagreement is evaluated in this paragraph.

At present, the Danish planning system is set up in a way, where the municipalities are responsible for local roads and The Danish Road Directorate is responsible for highways and national roads. The only traffic related responsibility the regions have is the operation of inter-municipal bus lines. But, before the structural reform in the year 2007, the counties were responsible for infrastructure in Denmark and had the responsibility of maintaining roads, and the possibility to expand them if need be. Earlier all three levels of government were able to plan roads, and there were local, inter-municipal, and national road planning institutions. The result from the current organisation is, that the regions role is limited to being either a facilitator or partner. Furthermore, municipalities and regions disagree when it comes to the tasks they should undertake. When Erik Ørskov from Region Syddanmark was asked, if the region could help to facilitate carpooling at hospitals, which are owned by the regions, he said the initiative had to come from the hospital.

"There is a pretty steep division in the region, so it is not us that can start the dialog, the hospital would have to do that themselves" –(Appendix 3, page 11)

This is an example of how the regions are not willing, or able, to be the primary developer of new initiatives. This is a barrier since workplaces like hospitals would probably not have the resources or knowledge to start initiatives themselves. The hospitals have many employees that could benefit from carpooling and meet some of the mentioned criteria for carpooling.

As the planning system is changing and cooperates more and more with the civil society, e.g. citizens and companies, it is equally important to discuss how other actors can influence the planning process. Earlier we discussed how politicians influence planning, but companies also influence planning. For example, did LEGO, the biggest company in Billund, recommend a western alignment of Hærvejsmotorvejen (Bruun Jarl 2017).

Another example is a proposed bridge between Fyn and Als. In this case, a private group is investigating the effects of connecting the two islands. The chairman of the group is the owner of Danfoss, Jørgen Mads Clausen.

As chairman of the group, he uses his network to promote the project. Furthermore, the group has three additional board members, of which two of them are mayors. Their approach is to use a well-known person that represents local interests in order to promote better infrastructure in the local area. This also creates a basis on which the municipalities can legitimize their investigations of the possible bridge and their arguments for promoting it.

Danfoss' interest in the project is that it can provide better opportunities for expanding their business and attract new employees. In infrastructure projects, it is therefore important to be aware of private stakeholders who can attempt to influence projects.

11.3. *Social practice theory*

In working with social practice theory the primary source of data were the answers from the participants in the focus groups interviews and to some extent the survey. The data collected can be challenged. From literature and behavioral investigations, it was found that respondents tend to answer in accordance with who they want to be and how they see themselves, rather than who they actually are. The effect from interviewer-pleasing, where the respondents try to answer the questions in a manner they think is pleasing for the interviewer, rather than answering the "truth" (Kvale, Brinkmann 2015, Gram-Hanssen, Friis 2013). An example hereof occurred early in the second focus group interview, when a participant wanted to know how to answer.

"Can I just ask, our answers, should they be what we think, or what would be good if we did?"

[..] *"So it should be what I do?"*

Interviewer: Exactly [...] -(Appendix 2, page 3)

For the participants interviewed, a method to investigate this perspective was by comparing their survey results with the interview transcripts. A simple way of doing it was to compare their answers from the survey with their answers to the introduction questions at the focus group interviews, to see if they were similar. In terms of distance and time estimates, two out of the thirteen respondents overestimated with less than 10%, and there was therefore not found any significant differences. The transcripts were also investigated to see if participants contradicted themselves, which can be an indicator of them trying to answer what they think is right, rather than their actual behavior. By doing so, one participant had a bit of a contradiction.

"Well, I think the highway grid should be expanded, and I use it a lot, I drive to Zealand etc." -(Appendix 2, page 12)

But on the contrary, the participant also says

"If there are long queues I sometimes decide, if I have the opportunity, to take a detour and explore [...] I experience new landscapes and cities"

Interviewer: So you actually spend more time?

"yes, I get an experience" -(Appendix 2, page 8)

Which is rather contradicting as the first quote was in the context of saving time by expanding the highway grid, and the second identifies that she was willing to spend more time.

In terms of her practice of experiencing nature and cities, it was not something the other respondents recognized, and it is assumed to be a relatively unique practice for that one participant.

Chapter 12. Conclusion

This chapter will conclude on the problem formulation shown below:

Under which circumstances can the four-step principle be used, as a tool to prioritize planning, and utilize the potential of the four steps, in terms of transport?

And the sub-questions:

- *Which planning paradigms characterize municipal transport planning and what influences it?*
- *What are the attitude from planners and citizens with regards to the four-step principle?*
- *How can a long-term target of increased mobility be planned for in a municipality?*

12.1. Planning Paradigms

The dominant planning paradigm in Vejen Municipality for transport planning is a combination of prognostic and programmatic planning. This was reflected in their use of ITS, to prognostically identify development and plan to accommodate the expected development. The programmatic planning was used in the steering of the development by engaging in inter-municipal initiatives. It was positive to find that collaboration exists between neighboring municipalities with a joint planning strategy. It strengthens the area, that the municipalities are working towards the same goals. In terms of utilizing the potential of the first two steps of the four-step principle, a joint effort is ideal for generating a higher degree of influence and a wider range of the initiatives. Lastly it was found that Vejen Municipality relies on earlier experiences when justifying their choices regarding transport planning.

12.2. Attitude towards the four-step principle

The users were generally positive towards the four-step principle, but the issues of time and flexibility, in particular, were repeated in both focus group interviews, as core issues in changing their behavior. Users did not find monetary benefits as attractive as benefits from flexibility and time saved.

The users also stressed that the initiatives should be carried out on a volunteer basis, rather than being forced upon them in order to change their habits. To increase the users engagement some key circumstances should be considered; the new practice should not reduce their flexibility nor increase travel time and it should be easy to use. It was also found that changing behavior in terms of mode of transport should be based upon business initiatives or local initiatives, so the users have a relation to each other.

For the planners, their attitude regarding the principle varied:

The municipal planner could not see the system working in a political context, because the principle would not allow for political maneuverability. The regional planner, on the contrary, was positive towards the principle, as he saw a big potential in influencing user behavior.

In terms of realizing elements from the scenarios and utilizing the potential of the different steps from the four-step principle, both planners argued that they did not have the proper tools nor empowerment to implement all of them. This barrier must be overcome to use the principle, through either a higher level of empowerment, joint efforts between actors, or a national implementation of the principle as a planning principle.

12.3. Long-term planning

The four-step principle could be implemented in the Danish planning system if some criteria are met. The municipalities, regions and state must agree on who is responsible for each level of the principle and agree on committing to the principle. In order to realize the created scenarios and have a more sustainable transition, all three levels of government must cooperate and ideally be primary developers with new technology and initiatives. When working with these initiatives the circumstances from the users should furthermore be considered and accommodated, to have the most effect of the changing-behavior initiatives. In terms of implementation, the relatively long timeline of implementing initiatives from Scenario I and Scenario II means, that the initiatives should be initialized as fast as possible. From a sustainability point of view, these initiatives should furthermore be considered expanded as much as possible, rather than expanding or building new infrastructure.

Regarding the regions, they have very limited tools to influence transport and are at present responsible for inter-municipal bus planning and the regional development plan. To increase the use of the regions as an inter-municipal institution that can facilitate and combine municipal ideas and investigate alternatives, the role of the regions should be increased and they should be empowered.

12.4. In conclusion

A full implementation of the four-step principle requires a long-term commitment from politicians and planners, and a continuous effort to change the transport system in Denmark. There is no quick or easy fix for the problems related to congestion and mobility, and therefore a long-term approach is needed, in which both the users and the planners are included.

Chapter 13. Recommendations and future research

To complete this project, this chapter will present a series of recommendations for future planning based on the findings. Hereafter elements that could be investigated in future studies within this field are introduced.

13.1. *Recommendations*

13.1.1. *Rethinking bus planning*

The municipalities are already collaborating in terms of public transport, however the planning could focus more on increasing access to areas where the jobs are located. Vejen Municipality had one attempt with this approach, which were found unsatisfying and it was therefore reversed back to usual practice. To rethink bus planning it is therefore recommended to use prognostic planning to identify present and future commuter flows and then plan based on these flows. Furthermore, a corporation with larger businesses could be beneficial, to see if it could change existing practices.

13.1.2. *Using ITS*

In terms of influencing the technology element of individual's social practices, it is recommended to implement more advanced ITS to use existing infrastructure more effectively, and thereby limit the need for new infrastructure and obtain better flow speeds. As the potential of ITS is somewhat related to its level of implementation, a collaboration with the neighboring municipalities is likewise recommended to increase the range of the ITS solutions and thereby also its social practice impact. In this context, the region could be a facilitator where municipalities could meet and discuss usage of ITS, experiences, and coordinate inter-municipal strategies.

13.1.3. *Creating an arena for change*

As actor-driven initiatives are desirable for, for example carpooling, municipalities are advised to investigate how they can create a framework, which can encourage new companies or citizens to work with initiatives like carpooling, MaaS etc. Recent testing in Northern Jutland is for this matter a relevant case to learn from (Hyldal 2017).

For the facilitator, a way to create engagement towards new initiatives could be by creating reserved parking spots for carpoolers, raising awareness, or by providing other sorts of facilities, that the initiatives can have their foundation in. Thereby the municipality would provide technology, some funding, and their expertise on the area to the collaboration and on the contrary, local organizations or businesses would be in charge of daily operations and the remaining funding.

13.1.4. *Co-creation*

When involving citizens and businesses it is important that they can influence the final product. Ultimately it is their habits that are the subject of change. In terms of co-creation it is recommended that the process has a high level of citizen participation, so the local needs and challenges are identified in a collaboration with the citizens and their ideas are taken into account. Furthermore, the process should from the start be well defined in terms of what can be influenced and what cannot, to avoid misunderstandings.

In terms of social practices, it is important that the process works as a tool to create engagement through good experiences and to make it locally embedded through the co-creation process. For the context of changing behavior, it is also recommended to embed the initiatives in bigger companies at the early stages of implementation, because a relationship between the participants is a key element.

Informing new citizens

To influence the institutionalized knowledge and explicit rules it is recommended that the municipality distributes a pamphlet to new and old citizens, which presents the municipal offers in terms of transport alternatives, and the benefits of the alternatives. Furthermore, it should contain a chapter on how transport is organized in the municipality, and what future initiatives citizens can take part in, to raise engagement towards new technologies.

13.2. *Future research*

Lastly, based on the findings, discussion and conclusion some elements which could be investigated in future studies, were identified.

13.2.1. *Assessment of infrastructure projects*

A common way to investigate infrastructure projects is through a cost-benefit analysis, which is summed up in its internal rate of return. This is to some extent positive as all projects can be compared on the same parameter, but it could be investigated if other tools could do the same thing more accurately, or if the cost-benefit should be modified, as argued in the discussion. For this context, the weight of sustainability in current practices could be investigated. Alternatively, the study could investigate the pricing used in a cost-benefit analysis and be a discussion of these price estimates. This is important in terms of transport planning as the value of lost labour time from congestion is relatively high, and the potential for reducing travel times is therefore significant.

Furthermore, it could be investigated if the goals of new infrastructure should be dependent on the purpose of the infrastructure, rather than its economic impact on society.

13.2.2. *Highways as public-private partnerships*

An alternative way to get more projects started, which could help to develop new technologies, is through public-private partnerships. Projects could be realized in a collaboration between an investment company, which helps to finance and development, for example, MaaS, and a state actor. In repayment, the company will have a lead market role in a future expansion of MaaS to other areas. For this context, there have already been discussions between the Danish Secretary of Transport and some Danish pension companies, who have shown interest in investing in Danish infrastructure, for example an eastern ring-road around Copenhagen (Vikkelsø 2016, Poulsen Løgstrup 2016).

There is a need to investigate these types of partnerships in a Danish context, for example in terms of what can be done within current legislation.

13.2.3. *New tools for regional planning*

After the reform, the regions do not have any empowering tools to carry out programmatic planning and steer the planning of new infrastructure in their respective regions. An argument therefore is, that highways are a nationally strategically important piece of infrastructure, and therefore should be planned taking national considerations. It, therefore, makes sense that highways are under the planning consensus of the national government. On the contrary, are there many local interests at play when planning large infrastructure, which is primarily governed by the municipality. But, due to the municipalities relatively small size, having them plan infrastructure would not make sense. However, a middle ground could be the regions. An aspect for future research could, therefore, be the role of the regions in terms of inter-municipal planning.

Chapter 14. Bibliography

- Aarhus Municipality 2012, *Trafik i Aarhus 2030*, Aarhus Municipality.
- Banedanmark 2018, *Ny Bane til Billund, VVM-høringsudgave*, Banedanmark.
- Barth, M. & Boriboonsomsin, K. 2010, "Real-world Carbon Dioxide Impacts on Traffic Congestion", *Transportation Research Record*, vol. 2058, pp. 163.
- Bazzan, A.L.C. & Klügl, F. 2013, "Intelligent Transportation Systems" in *Introduction to Intelligent Systems in traffic and Transportation*, eds. R.J. Brachman, W.W. Cohen & P. Stone, Morgan & Claypool publishers, , pp. 5.
- Behrendt, M.L. 2017, 06/10-2017-last update, *4 grunde til, at Apple bygger endnu et datacenter i Danmark* [Homepage of DR], [Online]. Available: <https://www.dr.dk/nyheder/viden/naturvidenskab/4-grunde-til-apple-bygger-endaenue-et-datacenter-i-danmark> [2018, 05/19].
- Birk Olesen, O. 2018, 04/05-2018-last update, *Ole Birk: Sådan gør vi noget ved trængslen*. Available: <https://www.altinget.dk/transport/artikel/ole-birk-saadan-goer-vi-noget-ved-traengslen> [2018, 04/15].
- Bjerring, D. 2015, 04/17-2015-last update, *1500 kilometer danske motor- og motortrafikveje* [Homepage of Dagens Byggeri], [Online]. Available: <http://www.maskinteknik.dk/artikel/84355-1500-kilometer-danske-motor-og-motortrafikveje> [2018, 05/23].
- Bruun Jarl, A. 2017, 09/13-2017-last update, *LEGO anbefaler motorvej vest om Billund*. Available: <https://www.jv.dk/billund/Lego-anbefaler-motorvej-vest-om-Billund/artikel/2539247> [2018, 05/23].
- Christiansen, H. & Christensen, A. 2003, *Personer pr. bil*.
- Christoffersen, C.T. 2017, 17/03-2017-last update, *NT og Gomore går sammen om at transportere nordjyderne* [Homepage of TV2 Nord], [Online]. Available: <https://www.tv2nord.dk/artikel/nt-og-gomore-gaar-sammen-om-transportere-nordjyderne> [2018, 06/05].
- City of Odense 2017, *Handlingsplan for mobilitet og byrum*, City of Odense.
- Commission of Infrastructure 2008, *The Danish Transport Infrastructure 2030*, Commission of Infrastructure.
- Copenhagen Municipality, Capital Development council, Copenhagen University, The Danish Road Directorate, Denmark's Technical University & COWI 2004, *Projekt trængsel*, Kailow Graphic A/S.
- Correia, G. & Viegas, J.M. 2010, *Carpooling and carpool clubs: claryfying concepts and assessing value enhancement possibilities through a stated preference web survey in Lisbon, Portugal*.

- CPHAirport 2017, 09/28-2017-last update, *Efter 10 år: Metroen har flyttet lufthavnen tættere på byen* [Homepage of Københavns lufthavn], [Online]. Available: <https://www.cph.dk/om-cph/presse/nyheder/2017/9/efter-10-ar-metro-har-flyttet-lufthavnen-tattere-pa-byen/> [2018, 05/23].
- Danish Geodata Agency 2018, *Data download*.
- Danish Ministry of Interior 2005, *Kommunalreformen - Kort fortalt*, Danish Ministry of Interior.
- Danish Ministry of Taxation n.d.a, n.d.-last update, *Registreringsafgift for nye køretøjer, 2008-2017* [Homepage of Danish Ministry of Taxation], [Online]. Available: http://skat.dk/SKAT.aspx?oId=8686&ik_navn=link [2018, 02/19].
- Danish Ministry of Taxation n.d.b, n.d.-last update, *Skat* [Homepage of Danish Ministry of Taxation], [Online]. Available: <http://skat.dk/skat.aspx?oid=2234529> [2018, 02/19].
- Danish Ministry of Transport, Building and Housing 2018, *Trafikplan for den statslige jernbane*, Danish Ministry of Transport, Building and Housing.
- Danish Ministry of Transport, Building and Housing 2017, *Undersøgte baneprojekter*, Danish Ministry of Transport, Building and Housing.
- Danish Ministry of Transport, Building and Housing 2016, 07/01-2016-last update, *Midtjysk Motorvej vil reducere rejsetiden markant* [Homepage of Danish Ministry of Transport, Building and Housing], [Online]. Available: <https://www.trm.dk/da/nyheder/2016/midtjysk-motorvej-vil-reducere-rejsetiden-markant> [2018, 06/06].
- Danish Ministry of Transport, Building and Housing 2015, *Manual for samfundsøkonomisk analyse på transportområdet*, Danish Ministry of Transport, Building and Housing.
- Danish Ministry of Transport, Building and Housing 2013, *Faktaark*, Danish Ministry of Transport, Building and Housing.
- Danish Ministry of Transport, Building and Housing 2012, *Bedre og Billigere offentlig transport*, Danish Ministry of Transport, Building and Housing.
- Danish Ministry of Transport, Building and Housing 2009, *Det grønne transportforlig*, Danish Ministry of Transport, Building and Housing.
- Danish Transport and Constructions Agency 2018, *Nøgletal for offentlig busdrift, ekskl. handicapkørsel. - Regnskab 2016*, Danish Transport and Constructions Agency.
- Danish Transport and Constructions Agency 2015, *Nøgletal for offentlig busdrift ekskl. handicapkørsel 2015*, Danish transport and constructions Agency.
- Dansk Erhverv, FDM & DTL 2012, *Notat om beregning af trængselsniveauet i Hovedstadsområdet*, Dansk Erhverv; FDM; DTL.

- De Vaus, D.A. 2001, "The context of design" in *Research Design in Social Research* SAGE publications, London, pp. 1-17.
- Delhomme, P. & Gheorghiu, A. 2015, "Comparing french carpoolers and non-carpoolers: Which factors contribute the most to carpooling", .
- DI Analyze n.d, *Redegørelse for transport og mobilitet i Danmark frem til 2050*, DI Analyze.
- DI Business 2018, "Offentlig transport", *DI Business*, vol. 1, pp. 43.
- DTU Transport n.d, n.d-last update, *Transportvaneundersøgelsen*. Available: <http://www.modelcenter.transport.dtu.dk/Transportvaneundersogelsen> [2018, 03/21].
- DTU Transport 2015, *faktaark om antal personer pr køretøj*, DTU Transport.
- DTU Transport 2012a, *Definition af trængsel + anbefalet definition*, DTU Transport.
- DTU Transport 2012b, *Definition of congestion*, DTU Transport.
- FDM 2017, 11/28-2017-last update, *Ejerafgift 2018* [Homepage of FDM], [Online]. Available: <https://fdm.dk/alt-om-biler/dine-rettigheder/boder-afgifter/ejerafgift-2018> [2018, 04/14].
- Federation of Danish Motorists 2013, 10/23-2013-last update, *Trængsel koster dig dyrt* [Homepage of Federation of Danish Motorists], [Online]. Available: <https://fdm.dk/nyheder/2017-10-traengsel-koster-dig-dyrt> [2018, 02/19].
- Flyvbjerg, B. 2010, "Fem misforståelser om casestudiet" in , 1st edn, Hans Reitzels forlag, Denmark, pp. 463.
- Gaardmand, A. (ed) 1980, *Plan og politik - Om fysisk planlægning og dens muligheder for at være med til afklaringen af nye samfundsmål*.
- Gram-Hanssen, K. & Friis, F. 2013, "Integration of smart grid technologies in households – how electric vehicles and dynamic pricing change social practices in everyday life", *Transport and Mobility: How to deliver energy efficiency*, .
- Halkier, B. 2008, *Fokusgrupper*, 2nd edn, Samfundslitteratur.
- Hansen, M. 2016, 10/31-2016-last update, *MaaS er mobilitetens svar på Netflix*. Available: <http://www.ktc.dk/artikel/maas-er-mobilitetens-svar-paa-netflix> [2018, 04/14].
- Haustein, S. & Jensen, A.F.:. 2018, "Factors of electric vehicle adoption: A comparison of conventional and electric car users based on an extended theory of planned behavior", *International Journal of Sustainable Transportation*, vol. 0, no. 0, pp. 1.
- Henderson, J.V. 1974, "Road congestion: A reconsideration of pricing theory", *Journal of Urban Economics*, vol. 1, no. 3, pp. 346.

- Hoffmann-Hansen, H. 2012, 02/22-2012-last update, *Analyze: derfor døde trængselsringen*. Available: <https://www.kristeligt-dagblad.dk/danmark/analyze-derfor-døde-trængselsringen> [2018, 04/29].
- Höjer, M., Gulberg, A. & Petterson, R. 2011, "Backcasting images of the future city- Time and space for sustainable development in Stockholm", *Technological Forecasting and Social Change*, vol. 78, pp. 819.
- Hyldal, C. 2017, 03/17-2017-last update, *Trafikforsker: GoMores bussamarbejde bliver banebrydende* [Homepage of DR], [Online]. Available: <https://www.dr.dk/nyheder/regionale/nordjylland/trafikforsker-gomores-bussamarbejde-bliver-banebrydende> [2018, 06/05].
- Incentive 2018, *Ex post samfundsøkonomisk analyse af fem transportprojekter*, Danish Ministry of Transport, Building and Housing.
- Jensen, D. 2017, 01/19-2017-last update, *Overblik: Internet-giganterne buldrer ind i Danmark med datacentre* [Homepage of Computerworld], [Online]. Available: <https://www.computerworld.dk/art/239043/overblik-internet-giganterne-buldrer-ind-i-danmark-med-datacentre> [2017, 05/19].
- Kaarsen, N. & Weissert, C.J. 2016, *Ingen effekt af motorveje på lokalbefolkningsvækst i landområderne*, Kraka Analyze.
- Kraka 2018, *Danskerne pendlere længere*.
- Kvale, S. & Brinkmann, S. 2015, *Interview - Det kvalitative forskningsinterview som håndværk*, 3rd edn, Hans Reitzels Forlag, Denmark.
- Lyager, P. 1992, *Københavnske generalplantilløb 1932-1958*.
- May, A.D. 1992, "Road pricing: An international perspective", *Transportation*, vol. 19, no. 4, pp. 313.
- McGhie, S. 2018, 02/02-2018-last update, *Eksplodivt voksende biltrafik efterlader togene i støvet* [Homepage of Ingeniøren], [Online]. Available: <https://ing.dk/artikel/eksplosivt-voksende-biltrafik-efterlader-togene-stovet-210297> [2018, 05/23].
- Metroselskabet & By og Havn 2011, *Cityringen, udredning om en afgrening til Nordhavnen*, Metroselskabet.
- Ministry of Transport 2018, *Mobilitet for fremtiden*, Ministry of Transport.
- Moe & Incentive 2018, *Erhvevsanalyse af midtjysk motorvej*, The Danish Road Directorate.
- Møller, M., Haustein, S. & Bohlbro, M.S. 2018, "Adolescents' associations between travel behavior and environmental impact: A qualitative study based on the Norm-Activation Model", *Travel Behavior and Society*, vol. 11, pp. 69.

- Narwal, A. 2016, "Study of impacts on traffic congestion", *International Journal of Enhanced Research in Science, Technology and Engineering*, vol. 5, no. 6, pp. 104.
- Nielsen, O.A. & Fosgerau, M. 2014, 01/20-2014-last update, *Bane til Billund - økonomisk galimatias* [Homepage of Berlingske], [Online]. Available: <https://www.b.dk/kommentarer/bane-til-billund-oekonomisk-galimatias> [2018, 05/11].
- Pihl, K.A. & Efla, H.B. 2008, "Livscyklusvurdering", *Dansk Vejtidskrift*, , pp. 8.
- Poulsen Løgstrup, H. 2016, 08/12-last update, *pensionsdirektører: vi har 30 mia. kr til en ny tunnel*. Available: <https://ejendomswatch.dk/Ejendomsnyt/article9210805.ece> [2018, 06/06].
- Produktivitetskommissionen 2014, *Infrastruktur*, Produktivitetskommissionen.
- Region Syddanmark 2017, *Kontur - kommunale nøgletal for udviklingen i Region Syddanmark - Vejen Kommune*, Region Syddanmark.
- Region Syddanmark 2016, *Regionale udviklingsplan*, Region Syddanmark.
- Rosenstand, K. & Olsen, L. 2014, "Ny metode til opgørelser af forsinkelser og trængsel", *Annual Transport Conference at Aalborg University (Trafikdage)*Trafikdage, , 08/25 - 08/26, pp. 1.
- Rothenberg, M. 2006, 10/30 -2006-last update, *Mafia med hang til broer, motorveje og gibbernakkere* [Homepage of Politiken], [Online]. Available: <https://politiken.dk/indland/art5010933/c> [2018, 03/27].
- Rothenberg, M. 2002, 03/17-2002-last update, *Danmark har flest motorveje* [Homepage of Politiken], [Online]. Available: <https://politiken.dk/indland/art4938076/Danmark-har-flest-motorveje> [2018, 05/23].
- Sellebjerg, C. & Strøjer Lyster, R. 2006, *Udbygning af Ringvejen i Silkeborg – med anvendelse af kubemodellen som planlægningsværktøj*.
- Shiftan, Y., Kaplan, S. & Hakkert, S. 2003, "Scenario building as a tool for planning a sustainable transportation system", *Transportation Research Part, vol. 8, no. Part D*, pp. 323.
- Siggaard, P.F. & Skovgaard, M.J. 2018, 01/11-2018-last update, *Tulle-banen er kommet på skinner* [Homepage of DR], [Online]. Available: <https://www.dr.dk/nyheder/regionale/trekanten/tulle-banen-er-kommet-paa-skiner> [2018, 05/11].
- SIKA 2005, *Fyrstegsprincippet – Infrastrukturplaneringens nye Potemkinkuliss?*.
- SKAT n.d, n.d-last update, *Betaling af og satser for registreringsafgift*. Available: <http://skat.dk/SKAT.aspx?oid=2234529> [2018, 04/14].

- Statistics Denmark n.d., n.d.-last update, *Persontransport efter tid og middel*
[Homepage of Statistics Denmark], [Online]. Available:
<http://www.statistikbanken.dk/10221> [2018, 06/06-2018].
- Statistics Denmark n.d., n.d.-last update, *Lønmodtagere efter arbejdstidsordning, køn og tid* [Homepage of Statistics Denmark], [Online]. Available:
<https://www.statistikbanken.dk/AKU604> [2017, 05/19].
- Statistics Denmark n.d., n.d.-last update, *Statistikbanken*. Available:
<https://www.statistikbanken.dk/10516> [2018, 04/15].
- Statistics Denmark 2018, n.d.-last update, *Nyregistrerede motorkøretøjer efter køretøjstype* [Homepage of Statistics Denmark], [Online]. Available:
<https://www.statistikbanken.dk/statbank5a/selectvarval/define.asp?PLanguage=0&subword=tabel&MainTable=BIL5&PXSID=90153&tablestyle=&ST=SD&buttons=0> [2018, 02/19].
- Statistics Denmark 2017, *Danmark i tal 2017*, Statistics Denmark.
- Svane, M. n.d., n.d.-last update, *Investeringer i infrastruktur gør Danmark rigere*
[Homepage of Dansk Industri], [Online]. Available:
<https://www.danskindustri.dk/di-business/arkiv/blogs/2018/5/blog-investeringer-i-infrastruktur-gor-danmark-rigere/> [2018, 05/23].
- Sydtrafik 2014, *Trafikplan 2014-2018*, Sydtrafik.
- The Danish regions 2018, *Faldende samkørsel*, The Danish regions.
- The Danish Road Directorate 2018, 02/06-2018-last update, *Ny midtjysk motorvej*
[Homepage of The Danish Road Directorate], [Online]. Available:
http://vejdirektoratet.dk/DA/vejprojekter/Ny_midtjysk_motorvej/Sider/default.aspx [2018, 02/17].
- The Danish Road Directorate 2017a, *Drivkræfter bag trafikvækst*, The Danish Road Directorate.
- The Danish Road Directorate 2017b, *Nøgletal for vejtransport*, The Danish Road Directorate.
- The Danish Road Directorate 2017c, *Statsvejnettet 2017*.
- The Danish Road Directorate 2017d, *VVM-undersøgelse, Give-Billund-E20-Haderslev*, The Danish Road Directorate.
- The Danish Road Directorate 2016a, *Forsøg med kørsel i nødspor på Hillerødmotorvejen*, The Danish Road Directorate.
- The Danish Road Directorate 2016b, *Kørsel i nødspor*, The Danish Road Directorate.
- The Danish Road Directorate 2016c, *Midtjysk motorvej - strategisk analyse - genberegninger med Landstrafikmodellen*, The Danish Road Directorate.

The Danish Road Directorate 2011, *Danmarks strategi for ITS*, The Danish Road Directorate, Denmark.

TomTom 2017, 02/21-2017-last update, *TomTom Traffic index 2017* [Homepage of TomTom], [Online]. Available:

<http://corporate.tomtom.com/releasedetail.cfm?releaseid=1012517> [2018, 02/19].

Trængselskommisionen 2013, *Mobilitet og Fremkommelighed i hovedstaden*, Trængselskommisionen.

Triangle Area Municipalities 2018, *Trekantsområdet kommuneplan*, Trekantområdet.

Vanoutrive, T. 2011, "What determines carpooling to workplaces in Belgium: location, organisation, or promotion?", .

Vejen Municipality 2018, *Kommuneplan*, Vejen Municipality.

Vikkelsø, S. 2016, 11/02-last update, *COWI: OPP bør handle om effektiv udnyttelse af samfundets ressourcer*. Available: <https://www.altinget.dk/transport/artikel/cowi-opp-boer-handle-om-effektiv-udnyttelse-af-samfundets-ressourcer> [2018, 06/06].

Wangel, J. & Ilstedt, S. 2014, *Designing Sustainable Futures*, ResearchGate.