University of Stavanger

Faculty of Science and Technology

Master's thesis

Study program/ Specialization: Urban Design and City Development	Spring semester, 2013 Open access
Writer: GAMAAL MUHAMMED AHMED EL-ATTAR	..... (Writer's signature)
Faculty supervisor: Anders Langeland	
External supervisors: Eddie Westad & Helge Ytreland	
Title of thesis: **The Feasiblility of Transition Plans towards more Bus Mobility at Northern-Jæren**	
Credits (ECTS): 30	
Key words: Transport, Nord Jæren, buss, bussfelt, regional plan, bærekraftig, urban utvikling, regional utvikling, bærekraftig ferdsel, transition towards sustainble mobility, bus priority scheme, bus lane, urban development, regional development, land use transport policy	Pages: 119 + Annexes: 35 Stavanger, 17th June, 2013.

This research is sponsored by Norwegian Road Authority

Statens vegvesen

“We have on this land –Palestine- what makes life worth living”

Darwish, Mahmoud

"وعلى هذه الأرض ما يستحق الحياة"

محمود درويش

For my lovely Parents,

For my brother Hamza

For my Aunt Laila Hamed

For Fadi, Amir, Wahid, and Yahya

For Gerd Synnøve Østerhus, Rita, Heidi and Olav Eritsland

For Eduardo Missoni

For Nidal Arif and Ghattas Sayej

For Al-Ouds Scout Group-Northern Gaza, Palestine

For 7th Kristiansand Sea Scout, Norway

For Houens Odde International Scout Center, Denmark

For Muslim Student Organization-Stavanger MSOS

For Vittorio Arrigoni and Free Gaza Movement

For the *Fenikso* of this era: Gaza, Palestine

For where I looking forward one day to return: Yebna, Palestine

For all who have faith in and supported me

I dedicate this research

اهداء

إلى والداي الحانيين
إلى أخي حمزة
إلى خالتي ليلى حامد بشير
إلى فادي العطار وأمير المنسي ووحيد الهمص ويحيى جبر
إلى أولاف وغريد سونيڤا وريتا وهايدي ايريستاد
إلى ادواردو ميسوني
إلى نضال أبو عريف وغطاس صايغ
إلى مجموعة القدس الكشفية-شمال غزة
إلى مجموعة كرستيان ساند السابعة للكشافة البحرية- النرويج
إلى مركز هونس اوده الكشفي العالمي
إلى فيتوريو أريغوني وكل بحارة الحرية
إلى عنقاء العصر: غزة
إلى حيث سأعود يوماً: يبنا
إلى كل من وثق بي ودعمني خلال حياتي

أهدي هذا البحث

I. Abstract

Northern-Jæren region is rapidly growing in the population, business and mobility. The current mobility pattern is highly based on car mobility. The car mobility accuses long queues beside its effects on the greenhouse gas emissions. This stated the need to improve bus and non-motorized mobility in a transition towards sustainable mobility for the region. The current situation and plans of the local administrations among the four cities of Northern-Jæren challenge the long-term regional plans for Jæren and the transition towards sustainable mobility. The research aims to assess and evaluate the plans, implementations, actions and management of transition towards sustainable mobility in different levels. The research question is: How feasible is the transition plans towards more bus mobility at Northern-Jæren? My personal motivation to answer this question came out from my commitment towards sustainability.

The research method starts by building a foundation of understanding for the current and future situation of the three main dynamic elements of the region (population, working places and mobility) and the related issues to these elements (pattern of mobility, land use, parking policy, traffic volume, trips per day, planning management and greenhouse gas emissions). Studying those two categories paved the way towards stating the conflicts and challenges. Surveying samples of students (the largest user of the bus service at Northern-Jæren) to understand their current/future behaviors in mobility and their evaluation (from the user of the service point of view). The research is supported by a case study of bus priority scheme implementation along Fv.44. The studies went from the planning to alternative choices to implementing phase to functioning in the reality.

The results of the evaluation was a surprise, the bus travel speed along Fv.44 was improved for the first two years (2010-2011) before the travel speed sink again to lower than the speed before implementing the bus priority scheme. The bus service acted against the logic of implementing a bus priority scheme would lead a better travel time. The results also marked the lack of integrated land use transport policy, the absence of feasible management of the transition process towards sustainable mobility.

The research concluded that the transition towards sustainable mobility process is going in the wrong way because of the double face plans, conflicts of interests, absence of transition management; however the bus priority scheme is an important step and there is a need to stretch it along all the transport corridors but it needs support from land use policies in order to achieve better competitiveness.

II. Sammendrag

Nord – Jæren vokser raskt med hensyn på befolkning, bedrifter og ferdsel. Det nåværende ferdselsmønsteret er hovedsakelig basert på bilferdsel. Bilferdsel forårsaker lange køer og perioder med mye trafikk og påvirker utslipp med tanke på drivhuseffekten. Dette viser at man må forbedre buss og ikke-motorisert ferdsel mot en overgang til en mer bærekraftig ferdsel i regionen. Den nåværende situasjonen og handlingen fra den lokale administrasjonen blant de fire byene på Nord – Jæren utfordrer de langsiktige planene for Jæren og overgangen til en mer bærekraftig ferdsel. Forskningen har som formål å vurdere og evaluere planene, implementeringen, handlingene og evnen til å endre seg i retning av mer bærekraftig ferdsel på forskjellige nivåer. Problemstillingen er som følger: Hvor gjennomførbart er overgangsplanene i forhold til mer bussferdsel på Nord – Jæren? Min personlige motivasjon for å besvare denne problemstillingen er basert på min interesse for bærekraft.

Forskningsmetoden begynner med å bygge opp en grunnleggende forståelse av den nåværende og den fremtidige situasjonen av tre dynamiske elementer i regionen (befolkning, bedrifter og ferdsel) og tilhørende problemstillinger relatert til disse elementene (ferdselsmønster, bruk av landområder, parkeringsregulativer, trafikkmengde, turer per dag, planledelse og utslipp av drivhusgass). Dersom man ser nærmere på disse to kategoriene, vil man se at disse har dannet grunnlaget for konfliktene og utfordringene. Man kan undersøke en andel studenter (den største forbrukeren av busstilbudet på Nord – Jæren) for å forstå deres nåværende/fremtidige oppførsel innen ferdsel og deres evaluering (basert på forbrukerens innstilling). Forskningen er støttet av en case – studie angående implementering av busstrasér langs Fv. 44. Studiet gikk fra planlegging til alternative valg til implementeringsfasen til funksjonalitet i virkeligheten.

Resultatet av evalueringen ble en overraskelse. Hastigheten på bussreisen langs Fv. 44 ble forbedret de første to årene (2010-2011) før hastigheten sank til et lavere nivå enn før man implementerte busstraséne. Buss-selskapet/busstilbudet handlet mot den logiske implementeringen av bussfelt som skulle forbedre reisetiden. Resultatet viste også mangel på integrert bruk av landbruk i forhold til retningslinjer for transport, fravær av praktisk gjennomførbart lederskap i overgangsprosessen til en mer bærekraftig ferdsel.

Forskningen konkluderte med at overgangen mot en bærekraftig ferdselsprosess går feil vei på grunn av dobbeltsidige planer, interessekonflikter, mangel på overgangsledelse; uansett er busstraséne et viktig steg og det er et behov for å bygge det ut i alle transportkorridorene, men det er behov for støtte basert på retningslinjer for bruk av landområder for å oppnå bedre konkurranseevne.

III. Master Thesis Structure

IV. List of Tables

V. List of Figures

VI. Acknowledgments

I would like to express my gratitude to my supervisor Langeland, Anders for his engagements through the learning process of my master and this thesis. Furthermore I would like to thank Westad, Eddie and Ytreland, Helge for their supervising from Norwegian Road Authority, Stavanger Office. Special thanks to Juhler, Vogt Martin, Al-Khodari, Walid and Aslam, Atif for their precious help along the revision phase.

Also, I like to thank the participants in my survey, who have willingly shared their valuable time during the process of the questionnaire. I would like to thank also to the sponsor of this thesis: Norwegian Road Authority, Stavanger Office for their contribution.

VII. Foreword

Four years ago, I arrived to Oslo from Gaza, Palestine. I came to Norway with one goal: MSc. in Urban Design. There were many other side goals most of them were modified but the master studies were always untouched. By time, I started to get integrated in the Norwegian society mainly by the Scouts and I started to make friends and there always had one question: What do you want to do in Norway? I said: Master in urban design.

During the time to achieve my goal I worked as a 3Ds designer in Tweek® design office and Trainee at Plan and Environment section, West-Agder County. The two positions helped me to understand the architecture and urban aspects of Norway and made me surer about my goal; however things in Norway take time. It took me almost two years before I was qualified enough to attend the Norwegian language master program of Urban Design and City Development, University of Stavanger.

Two years ago, just after I got accepted, I set in a car driving south to city of Kristiansand in company of Langeland, Anders my teacher at that time, and my master thesis supervisor. We had a nice time during the travel while speaking about almost everything from urban design, street planning, life experiences, Norway, Palestine, Middle East crisis, religion last but not least: What is the theme of my master thesis and further studies? I had one, clear and sharp answer: "Transport! I think this will be the future, how to transit mobility pattern towards sustainable mobility."

Northern-Jæren as a region is potential for future place development. The development happened in the area since the 1970s changed the region's profile from agriculture, canning, fishing and trading calm small region to a pioneer technology platform for Oil industry. I found out that studying the pattern of mobility transition of the region would be a key-role in the future of the region as far as the plan goes towards sustainable mobility.

January 2013, during the carrier day of University of Stavanger for Engineer Faculty (TEKNA) I met Westad, Eddie a decent gentleman representing The Norwegian Road Authority, Stavanger office. We had a small conversation by the stand of Norwegian Road Authority about my master thesis and we made an appointment later in his office. Later in the meeting I was introduced to Ytreland, Helge another decent young gentleman and we discussed my thesis and by the end of the week I was honored by the offer by Norwegian Road Authority, Stavanger office to sponsor my master thesis. Both Eddie and Helge are my supervisors in the Road Authority.

This thesis is a result of long four years where I did not meet my family and I could not travel back home. Four years are full of many good time and hard time. Four years full of tears of success and tears of falling. Four years full of trying and keep trying. Four years full of understand a brand new culture for me; however through this time I learned a lot, I gained a lot, I gave a lot and I expected nothing back.

I hope that the reader of this thesis would find that the four years of hard working to reach this moment were feasible and the outcomes are good; even though the thesis was written only in four and half months.

Sincerely,

GAMAAL MUHAMMED AHMED EL-ATTAR

Stavanger, Norway 9th June, 2013

The Feasibility of Transition Plans towards more Bus Mobility at Northern-Jæren

1.0 Introduction

Northern Jæren urban area is home for over 201 000 inhabitants and the population growth increases by 2%(SSB 2013) each year which is higher than the Norwegian average (1.3%)(SSB 2013). The population in 2040 is expected to reach around 330 000 (SSB 2013). The working places in the region are 135 000 (Statistics 2013) and it is expected to reach 155 000 to 190 000 working places by 2040 according to FDP 2000. The region has high usage of cars in the pattern of daily mobility (71%)(Thesen 2006) and low use of public transport (8%)(Berg 2006). This pattern of mobility is expected to continue with the growth of population, working places and also the increase of incomes and material welfare at the region towards 2040.

This high car mobility counteracts the region plans and goals regarding environment, transport and land use. The regional goal is more sustainable mobility by increasing public transport passengers from 8% at 2005 to at least 15% by 2040(Regionalplanseksjonen 2012) and even higher in the central areas. This goal addresses the need of transition process that aims to reduce cars and increase the public transport passengers.

The County of Rogaland stated action plans to transit pattern of mobility towards sustainable mobility by implementing bus priority scheme and bicycle lanes. The research will evaluate the plans for the bus priority scheme (bus lanes and junction priority) to figure out if the plans, investments and results are feasible.

The research model is the county road Fv.44. The road is a regional main transport corridor between the two main cities of the region (Stavanger and Sandnes), and it has been supported by a bus priority scheme at 2009. The bus lanes were implemented in two phases and there are other phases in progress.

1.1 Research Questions

In light of the foregoing introduction the research main question is:

How feasible is the transition plans towards more bus mobility at Northern-Jæren?

Following factors will help to explore and assess the main research question:

- What is mobility transition?
- How to transition pattern of mobility towards sustainable mobility?
- What is bus prioritizing?
    - Why bus prioritizing?
    - How could buses get prioritized?
- What improvements happened in travel time since the implementation of bus lanes along Fv.44?
- What are the impacts (cost-benefits) of the bus lanes along the implemented section?
- What improvements in travel time might happen if bus lanes stretched all the way between Stavanger and Sandnes?
- What else policies should be implemented to support bus priority scheme?

1.2 Goal and limitations

This research aims to assess the contribution of bus priority scheme to achieve the regional plans of increasing bus mobility. The output of this process is an evaluation of the plans feasibility to transit mobility pattern towards sustainability. The evaluation will be in different stages: the plans, the actions, and the results. Measurements and criteria for evaluating bus priority scheme are the practical lessons from other North European cities.

The research is limited in detail researching into the implemented bus lanes in the section between Stavanger centrum and Mariero Landscape Bridge. This is the only section built and running (until the day of writing this thesis) of the lane according to the plans of The Norwegian Road Authority, Stavanger office.

1.3 The Area under Study

The area under research is Northern-Jæren region which could be called Stavanger region as well in some Norwegian references. The region consists of the uniting of: Stavanger, Randaberg, Sola and Sandnes urban areas. The research area covers different municipalities but not influenced by the administrational borders. Northern-Jæren is a strip peninsula in the south west coast of Norway.

Norway (the figure to the left shows the map of Norway and Northern-Jæren area highlighted in red) is a Scandinavian unitary constitutional monarchy whose territory comprises the western portion of the Scandinavian Peninsula. Norway has a total area of 385,252 square km and a population of about 5 million.(SSB 2013)

The country shares a long border with Sweden (1,619 km long) that it is the longest uninterrupted border within both Europe and Schengen Area; it is also bordered by Finland and Russia to the north-east; in its south Norway borders the Skagerrak Strait across from Denmark. It shares maritime borders with Russia by the Barents sea, Greenland, Faroe Islands and Iceland by the Norwegian Sea, Sweden, Denmark and United Kingdom by the North Sea. The capital city of Norway is Oslo. Norway's extensive coastline, facing the North Atlantic Ocean and the Barents Sea, is home to its famous fjords.

To the top: Figure 1.6.1 shows a map of Norway and the location of Northern-Jæren highlighted in red by the south west coastline

Rogaland (the figure to the left) is a county in South-Western Norway, bordering Hordaland, Telemark, Aust-Agder and Vest-Agder. Rogaland is mainly a coastal region with fjords, beaches, and islands, the principal island being Karmøy. Boknafjorden is the largest bay, with many fjords branching off from it.

The third-largest urban area of Norway(SSB 2013) is located in Rogaland. Stavanger, along with Sandnes, Randaberg and Sola, are ranked above Trondheim. Cities of Rogaland are: Stavanger, Sandnes, Haugesund, Egersund, Sauda, Bryne, Kopervik, Åkrehamn and Skudeneshavn.

To the top: Figure 1.6.2 shows a map of Rogaland county and the location of Northern-Jæren (administrational borders) highlighted in red by the south west coastline

Northern-Jæren region is the continuous urban structure of Stavanger, Sandnes, Sola and Randaberg. The region has a population growth rate with 2.0%(SSB 2013) which is an exceptional rapid population growth in Norway. The Norwegian average population growth is 1.3%(SSB 2013) In 2012, the population is approximately 201 000 inhabitants.

The research Case study will be Fv.44[1]. The road is owned by county of Rogaland and it is the main transport corridor of the region (Authority 2012)connecting city of Stavanger and city of Sandnes.

To the left: Figure 1.6.3 shows a map of Northern-Jæren and the urban structure of the region. Cities of Randaberg, Sola, Sandnes and Stavanger are presented with the main roads and the railway

[1] The shortcut Fv. means a county road

2.0 Research Theory

This chapter provides the research theory foundation of the thesis. Theory about public transport and city development are included: the need of the public transportation, who uses public transport, and relating those reasons to Northern-Jæren region. It is including also city development and transport theories and the use of public transport as a tool for urban developments and the importance of integrating land use, transport policies and plans for transition towards sustainable mobility. City development theories will be also related to Northern-Jæren current/future situation.

2.1 public transport

Public transport is a shared passenger transit system that run through fixed routes for charged fares and accessible for public. Public transport could offer special arrangements to travel out of the routes and for other rate of fares for groups in agreements with the service provider. Public transport may be provided by one or more private transport operators or by a transit authority. Public transport services are usually funded by government subsidies and fares charged to each passenger. Urban public transport modes include buses, trolleybuses, trams and trains, rapid transit (metro/subways/undergrounds, etc.) and ferries. Other modes of public transport appear to join cities such as airlines, coaches, and intercity rail.

The public transport has been to many development phases since the start of the concept by water ferries thousands of years ago; however the last two centuries had projecting developments since the start of industrial revolution. Before the industrial revolution, the mobility was in a small range where house, work and enjoyment is in the distance of walking or riding a horse. The town planning all over the world was based on walking distance and human scale cities. The mobility of goods was basically by walking or horses, in individual or convoys aspects. Importing and exporting were in limits and the food usually was not able to travel to the other side of the world like today.

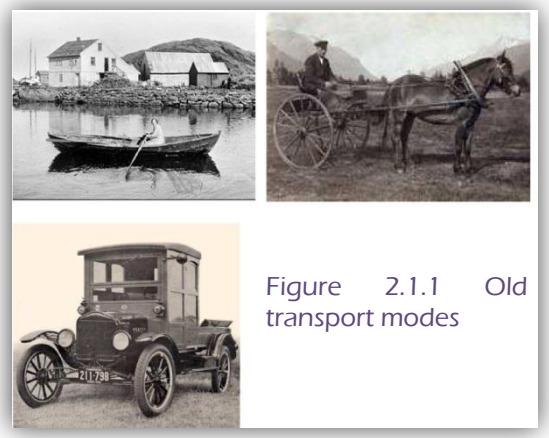


Figure 2.1.1 Old transport modes

The transport modes have been in development over time in order to cope with the people needs and desires. The sea transport started from small boats, to steam power boats and now there are cargo ships and ferries. The land public transport started with animals and the exploring the wheels developed the number of transported passengers. However the greatest development happened by the industrial revolution when it offered the train and the cars. Buses, LRT and railway are the most used land public transport mode currently.

The future development of public transport will be a need to cope with the people needs and desires. The public transport is a service provided for the public; hence it has to meet their needs.

2.1.1 Public Transportation at Northern-Jæren

The public transport in Northern-Jæren has been a need since long time. The geography of Rogaland shaped the need for sea transport between Stavanger as an urban core with all the islands around. The main activity in Stavanger started as a bishop school and a market(Fuglestvedt 2009) while Sola, Randaberg and Sandnes were rural areas. Stavanger had a bishop school where people gathered themselves every Sunday. By time Stavanger changed to be the main commercial center for those out on the islands and Jæren area. Therefor the north peninsula "Holmen" of the city became an active port. The transportation from sea has been developed because of the need for it. At the time the canning(Municipality 2012) industry started at the Norwegian industrial revolution the city was dense and small as it shows in figure 2.1.2. The sea transport developments were the main city planner. People wanted to live close to the main port where all main activities happen.

Figure 2.1.2 Stavanger city urban plan. Source: Omland, 2011

The railway transportation at Northern-Jæren was developed in three phases with 6 decades between each two phases. The train station at Stavanger opened in1878(NSB 2013) to join city of Stavanger and city of Egersund. That was the main land transportation in Stavanger while the focus was more into the sea transport regarding to the commercial activities. During the Nazi occupation of Norway *Sørlandsbane* was opened at 1944.(NSB 2013) Lately in 2009 the two track railway between Stavanger and Sandnes was opened and there are four departures every hour between the two cities.(NSB 2013)

The land transport, apart from the train, started in Norway with the horses with and without carts; however at the end of 19th century the car arrived to Norway. And the public transport transited from the horse to the automobile.(Skudal/Ottesen. 1966) The development in this field was low until the end of the World War II most likely because of the size of the cities in the region. However the need of the buses rose up after the World War II and the oil exploration. Nowadays the region has a service operator *Rogaland Kollektivtrafikk, Kolumbus.* There has been much development since 2001 in the routes, frequency or the number of buses and their capacity. Figure 2.1.2 shows the hybrid bus runs the service in Stavanger. The latest development was the bus lanes in Fv.509 and

Figure 2.1.3 Kolumbus hybrid bus. Credits: Darek Berger

Fv.44. there will be more study for Fv.44 later in the research.

2.1.2 Who use public transport service at Northern-Jæren

The public transport service at Northern-Jæren (bus/train/boat) model split (Table 2.1.1, 2.1.2 & 2.1.3) shows that pupil/students have the highest usage of public transport among categories of employments in RvU, 2005. Military/civilian service, unemployed and social insured follow them. RvU, 2005 stated that:

> *Transport is used especially by young people and there were increases among their use of public transport from 1998 to 2005. As mentioned previously public transport users has a low-income profile, and this distinction grows as low-income groups consume more public transport and those with higher incomes use it less(Berg 2006)*

Table 2.1.1 Model split the usage percentage of mobility modes by sex(Berg 2006)

Sex	Pedestrian %	Bicycle %	Motorcycle %	Car driving %	Car passengers %	Public transport %
Women	14.6	5.9	0.8	57.0	12.1	9.0
Men	8.7	7.8	1.6	69.2	4.4	6.9

Table 2.1.1 shows that there are more women take the bus than men. Women have lower access to cars as drivers but they have higher usage of cars as passengers.

Table 2.1.2 Model split of usage percentage of mobility modes by age(Berg 2006)

Age	Pedestrian %	Bicycle %	Motorcycle %	Car driving %	Car passengers %	Public transport %
13-17	31.1	22.7	4.7	2.1	15.5	22.8
18-29	10.8	4.6	1.5	57.8	10.4	14.3
30-44	6.8	5.2	0.8	78.0	5.1	3.4
45-59	8.7	6.2	0.8	72.5	6.0	4.6
60 and over	14.7	4.5	0.2	64.6	10.1	4.5

Table 2.1.3 Model split the usage percentage of mobility mode by employment(Berg 2006)

employment	Pedestrian %	Bicycle %	Motorcycle %	Car driver %	Car passenger %	Public transport Bus/train/boat %
Employed	7.4	5.5	0.9	75.3	6.0	4.0
Home-based Workers	17.4	3.7	0.2	67.3	7.2	3.6
Pupil / Student	22.7	14.3	3.4	19.3	14.3	25.2
Military or Civilian service	0.0	2.8	0.0	65.2	21.3	10.7
Pensioners	18.4	4.2	0.1	58.1	12.7	5.0
Social Insured	13.7	1.9	0.5	60.9	13.6	8.4
Unemployed	20.0	3.3	1.1	51.5	14.4	9.8
Others	16.9	3.3	0.0	62.7	5.3	3.9

The table 2.1.4 shows that the more income people get a year the less they take the bus. And the lower income people get a year the less they travel by car as driver or passengers.

Table 2.1.4 Model split the usage percentage of mobility modes by income(Berg 2006)

Income[2]	Pedestrian %	Bicycle %	Motorcycle %	Car driver %	Car passenger %	Public transport Bus/train/boat %
Below 200	22.9	5.5	1.0	48.8	9.0	10.8
200-399	13.5	5.6	0.7	65.0	7.7	6.6
400-599	8.4	5.2	1.2	72.8	7.4	4.5
600-799	6.8	5.6	0.8	74.5	6.9	4.3
800 and over	7.0	5.2	0.7	76.0	6.0	3.9

As far as the public transport in the region attracts the low-income inhabitants in Northern-Jæren, therefor any improvements in the service have to take into consideration two main factors: prices and needs (destinations, frequency, travel time, etc.) of low-income inhabitants.

[2] The income in thousands NOK per year

2.1.3 Why do We Need Public Transport?

There are many reasons to be told why we need public transport. Reasons, perspectives and the point of views are different from a place to another according to what are the environment, infrastructure, culture, urban and economical aspects. In other words there are different reasons for each country, region, or city to implement a public transport. The public transport is usually a response for community's needs and requirements, an urban develop measure or both; however the service have to provide and adopt the inhabitants needs of mobility.

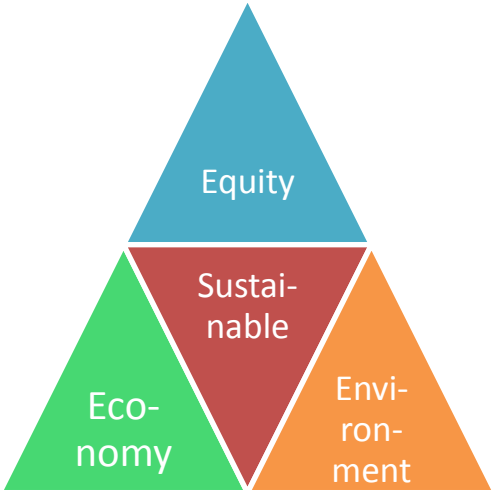
The implementation of public transport is an important issue but what is more important is the efficiency of service. If the public transport does not function according to inhabitants' needs and requirements, then it has a negative impact on the pattern of mobility. The efficiency of public transport is about providing the public mobility alternatives that attract more passengers to take a bus instead of driving cars. The competitiveness with cars could be done through different factors: fares, travel time, accessibility to attractive destinations (i.e. centrums), frequency and routes. According to Hi-Trans 2 stated that there are three ways to achieve the competitiveness: improving the bus service, confining the car traffic, or both.

The needs for public transport are: Sustainable needs (Environmental, Economical and Equity), Queues and street space, reduce relaying on oil and cheaper travel.

2.1.3.1 Sustainable Needs

The definition of Sustainable development will come later to be discussed in a further phase under 3.3 Terms and Definitions; however according *Our Common Future*, also known as the Brundtland Report(Press 1987):

> *"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:*
>
> - *The concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given;*
> - *The idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs."*



The sustainability consists of three pillars Environment, equity and economy. The sustainability is to balance between the three elements during the process. I.e. sustainable mobility means mobility keep the balance in all the aspects between environment, equity and economy. A sustainable land using means land use policies keep the balance between environment, economy and equity; and so on.

The sustainable needs for public transport from the three pillars for examples are:

- Reducing greenhouse gas emissions (one of the main reasons behind *Global Warming* and *Climate Change*)
- Offering access to mobility in a reasonable prices for all the inhabitants

During the last 3 decades there were discussions about *Global Warming* and *Climate Change*. Global warming is the rise in the average temperature of Earth's atmosphere and oceans since the late 19th century and its projected continuation. Since the early 20th century, Earth's surface temperature has increased by about 0.8 °C, with about two-thirds of the increase occurring since 1980.(Press 2011)

2.1.3.2 Queues and Street Space

The population growth in urban areas and the accessibility to cars shaped a new mobility pattern where there are rush hours of traffic. The rush hour happens twice a day because of the mobility towards working places from homes and the opposite. The rush hour is not about the transport mode but it is about the number of travelers in the same time which means public transport has a rush hour as cars and other traveling modes. The public transport rush hour in not because of many buses stuck in the queues but it is because of the number travelers; however the figure 2.1.3 shows the space required to mobile 40 travelers by cars, bus and bikes. The figure shows how could public transport mobile 40 persons going to the same destinations, or sharing the same route, in a small place while the cars take many double size of the street. The figure also shows in the aspect of street capacity and space how could public transport contributed to city planned according to human scale without wide streets which could act like a barrier between the sides.

Figure 2.1.4 shows the space required to mobile 40 travelers by cars, bus and bikes.

2.1.3.3 Reduce the Relaying on Oil

In 1973-1974, the world had the first oil crisis at the time of the war in Middle East. The impact of that crisis were not only instant of long queues around the world waiting to get fuel at oil stations, but it encourages the Scientifics to start a long term researches on how could we get out of relaying on oil as a mobile fuel. This aspect is related to the environment case but it is originally about being independent from the oil sources, which could not be secured, and the oil prices projecting in that crisis. Public transport provided train and trolley bus runs on electricity that was one step to get out of the oil control. These days the public transport provides some hybrid buses service and the work around the world is on progress to have hybrid/hydro bus system to service in the routes with low/zero gas emissions with lowest need of fuel. There are some researches about using the renewable energy as well.

Figure 2.1.5 shows the oil crisis in the states by 1973. Credits: Piximus.net

2.1.3.4 Cheaper Travel Fares

The public transport is a shared travel mode. This means the passengers shares the vehicle and the expenses of travels as well. Thus public transport offers a cheaper travel expenses than cars and it is one of the benefits of traveling in a public transport mode.

2.1.4 Why do we need public transport at Northern-Jæren?

There are any many needs for the public transport at the region. Northern-Jæren is growing rapidly in population and business sector which mean more people to mobile around. The current/expected mobility patters are in conflict with the regional goals and plans as it will be explained further with details at 4.4 conflicts. Northern-Jæren region plans and goals are to transit the mobility patterns towards more sustainable mobility; which means less cars traffic and more pedestrian, bicycling and public transport.

2.1.4.1 Sustainable Needs at Northern-Jæren

Northern-Jæren region current mobility pattern is based on cars (71%)(Berg 2006) with low use of public transport (8%).(Berg 2006) The region has rapid rate of growths in population and business state the fact of need for more mobility in the future. The current mobility pattern accuses over 50% of the greenhouse gas emissions of the region. The world average of greenhouse gas emissions by transport is 18%(Herzog 2009). Cities of Stavanger and Sandnes are participating in the national project "the cities of the future" among the largest 14 cities of Norway. The cities also signed the agreement to decrease the amount of greenhouse gas emissions 20%(Municipality 2010) of 1991 emissions; however the region had experienced only increasing in the emissions in the last years to find out that the cities had to cut 30%(Municipality 2010) of nowadays emissions. The previous facts

Therefore the regional plan is to increase public transport passengers and decrease car mobility. This plan is in a conflict with the current mobility situation and the scenario expecting more trips per day and more reliable on car as a pattern of mobility in the region. The challenge in the region is how to manage increasing the bus passengers or what it could be called: the transition towards more sustainable mobility. Sustainable mobility is:

> *"Mobility that meets the needs of society to move freely, gain access, communicate, trade and establish relationships without sacrificing other essential human or ecological requirements today or in the future." Mobility 2030: Meeting the challenges to sustainability*[3]

The Environment is the first issue out of three sustainable mobility pillars. Securing equal chances for the society at Northern-Jæren to travel in the region is the second issue. Sustainable mobility would gain access and provide reasonable travel fares in order to allow the low-income inhabitants to communicate and mobile themselves freely in the region.

The public transport will provide a development in the region with a reasonable price than the price might be paid for the same development based on car mobility. The cost-benefits study of building an efficient bus service and bus priority scheme over the main corridors would be less than extending and increasing street capacity to face 4 hours of traffic jam in the region.

---

[3] *Mobility 2030* is the final report of the WBCSD's Sustainable Mobility project. Twelve international companies – eight automobile, two oil and two large suppliers – are behind the initiative.

2.1.4.2 Queues and Street Space

The queues of traffic at 2008 illustrated by Norwegian Road Authority, Stavanger office in figure 2.1.5 shows that motorway E-39 and Fv.44 are in significant flow problem during both rush hours. If we take into consideration the current mobility pattern so we could understand the reason. The high use of cars in mobility fills the streets with cars and queues. Public transport service with own bus lanes in the region will secure that buses skipping the queues and travel faster. In case of the successes of transition of pattern mobility, there will be no need to stretch the street network in the soon future.

Figure 2.1.6 shows the oil crisis in the states by 1973. Credits: Piximus.net

2.1.4.3 Cheaper in Travel

The public transport at Northern-Jæren region offers a cheaper mobility than the prices for car mobility. Even though the prices are not competitive if we compare that car travel from A to B with no stop or waiting time while the bus service can't offer that for public. Table 2.1.5 shows the prices of person mobility survey has been done during the last four decades and it shows that the bus was always cheaper. The prices in the table are for a travel for two zones in the region. The prices are in NOK.

Table 2.1.5 Prices for person mobility[4](Statistics 2013)

Year	Consumer Price Index	Buying a car*	Fuel	Total car's cost	SOT/Kolumbus
1986	183,1	176	172	531	260,0
1990	231,2	230,4	232,2	693	390,0
1995	260,0	277,7	310,7	847	455,0
2000	291,4	275,5	415,2	981	650,0
2007	327,6	300,7	480,9	1107	715,0
2008	339,9	304,7	521,3	1164	747,5
2009	347,3	310,6	496,4	1153	780,0
2010	355,6	312,3	537,4	1207	812,5
2011	360,2	315,9	588,8	1263	845,0
2012	362,9	316,1	616,5	1294	877,5
jan.13	364,9	317,5	604,6	1285	975,0
feb.13	367,3	317,5	613,8	1297	975,0
mar.13	368,5	317,5	612,7	1297	975,0
apr. 13	370,7	316,9	604,6	1290	975,0

*The price of the car is divided by trips.

[4] SOT / Kolumbus: Single ticket bus 2 zones. 1986 = 260
As of August 1999: Fuels and lubricants.
As of August 1999: Passenger transport on the way.
Source: Statistics Norway and Rogaland County / SOT / Kolumbus

2.2 City Development and Mobility

The modern city development around the world after the industrial revolution started because of the need for mobility. The new mobility modes were a tool for urban design and city development. In the start the cities had rapid growths in population and working places. After the world war II European cities were demolished partly or totally. These demolished urban areas were a new chance for urban planning new downtowns and urban areas. The mobility played a role around European cities in the new planning phase. Today we could see that the new transport modes are used in France, Germany, UK and Denmark as a city development tool where high dense corridors served by hybrid transit (train, LRT, bus, etc.). Suburbs and sprawls are connected with direct fast access to the main cities.

2.2.1 Land use Transport History

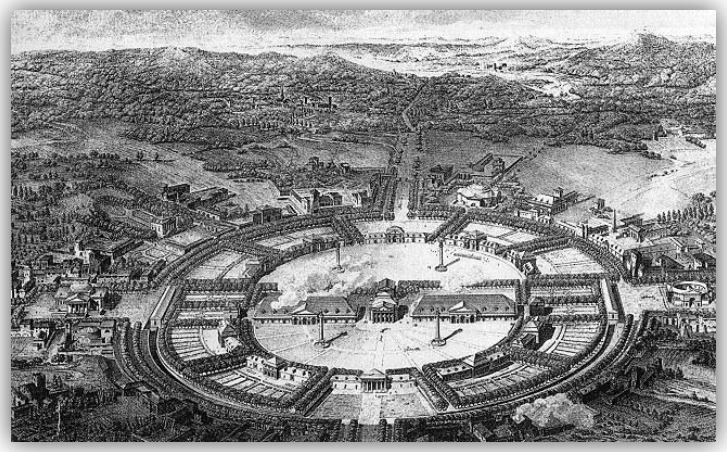


Figure 2.2.1 Idealist city of Chaux illustrated by Claude Nicolas Ledoux. Source: European Architecture and town planning in the 20th century, 1996

The industrial revolution had impacts on people life style. Villagers left the rural areas towards urban areas, this transition started by the middle of 18th century and until today it is in progress in what is called Urbanization. The Urbanization process created new aspects both in city developing and mobility. The crowded small houses full of families sharing one room in the start of the industrial revolution in cooperation of the need to transit bigger amount of workers to one destination at a time addressed the need for new cities. New cities had to handle new comers and their mobility. Cadbury chocolate factory in England planned one of the first cities that would be called an Industrial city. The industrial city is a city (or a town according to the British origin of it) based on a factory facility(s) in the core and residential area to house the workers around it. Idealist city of Chaux, France was the first French edition of industrial cities at 1804. The city of Chaux is not a reflection of town planning only but it is a reflection of movement inside the French society after the first French revolution. The liberal movement in the social and urban aspects in France played a role in this town planning; however this city has never moved to reality from plans.

The development of this city took many phases and residential area became urban areas where workers are not only supposed to work and sleep but also to enjoy their life. The new industrial cities faced the challenge of interior mobility by reducing the door to door trip for the workers but it increased the distant to other town. Connection to other cities were important both for goods and workers mobility. This aspect and the environment/health aspect of those cities created the base of many theories about new cities/towns with higher standard of mobility, health, urban and environment. The planning of the new cities took many faces like functionalist and environment, artificial, etc.

One of the most known theories in the new town planning came out in the book *To-Morrow: A Peaceful Path to Real Reform* by Sir. Ebenezer Howard, 1898 before the reprinting of the book with a new name: *Garden Cities of To-Morrow*, 1902 almost a century after city of Chaux, France. The book held out the first firm theory of an urban area based on factory still it has a green structure and direct mobility relation interior and exterior. The book started a worldwide movement for *Garden Cities*; however Howards himself experienced hard time to convince firms of his idea until the first garden city "Letchworth" came out to reality at 1907. One of the lessons to learn from this city is: the rail train station was opened before the city. The public transport service and the infrastructure were ready as well.

The theory was used in Garden cities is locating sub-cities (sprawls) around a big central city. The mobility between this sprawls and the main city happens through roads and railways (the major public transport at that time). The cities are in a good connection and in between them it is located a big green area. The city will lie over 6000 acres (buildings will be only 1000 acres) in circular form with radius of 1240 yards. With 6 sprawls each one is 120 feet diameter to seize inside water and gardens.

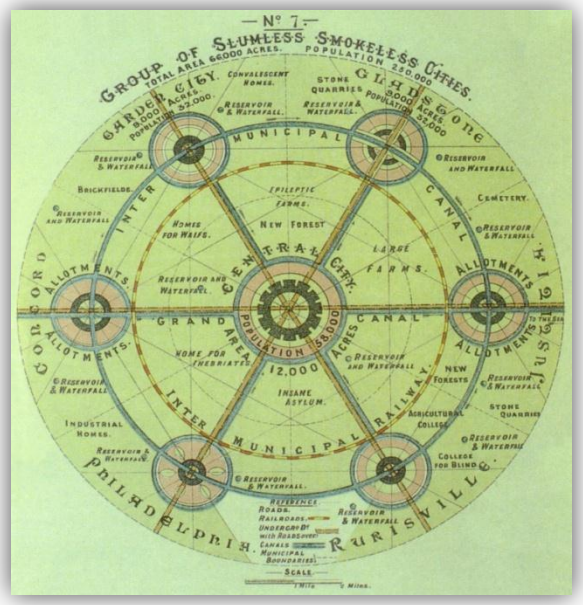


Figure 2.2.2 The Garden city theoretical illustration by Howard. Source: *Garden Cities of To-morrow,* 1902

Sir. Howard started early to see the dark back side of the growth of big cities. At the time when everyone was thinking of the muscle of the machines he set down and thought about healthy place with large contain of green areas (5/6 of the city).

The foregoing historical review addressed the necessity of public transport over time. During the two last centuries, urbanization addressed the need to improve the transportation service inside the cities and to cities. A new method of mobility appears in

addition to interior mobility and between the cities. The method of commuting started to take a place in the middle of 19th centuries in the United States of America in cities such as New York, Philadelphia, Boston and Chicago. The start was discount charges or "commuted" fares for the mentioned cities to its suburbs. By time, the technology developed and the automobile vehicles were accessible by the public in the suburbs and the commuting method faced a challenge but the method adopted a new sub-method by applying drive and park scheme. The need for this scheme was that cities were crowded by the cars and queues impacted heavily the street capacities.

2.2.2 Land Use Transport Policy

> "*There is a growing awareness that the integration of land use and transport (LUT) planning is a crucial prerequisite for the transition towards more sustainable transport patterns and urban development that foster interaction between people, support a sustainable business climate and reduces negative effects on the environment and climate*"(Bertolini 2009)

This awareness by planner and public rose up through the past decades but still the relation between Land use and transport is not totally defined. Is it coordination or integration? Coordination would mean that there is a frame of dialog or information exchange between transport and land-use planners in order to avoid conflicts and over lapping plans. While integration in land use transport planning would mean that the two elements will work together to serve each other under one planning process and there will be no separation in the implementing phases to achieve one shared goal and vision. The two method of work between land use and transport would lead to different outcomes.

The land use transport policy appears in some sources as: Transport integrated planning. The land use transport policy could be defined as: Integrating transport policies in the land use planning to facilitate the transition towards sustainable mobility. From the definition we could understand that the land use policy handle basically the issues of:

- How to facilitate growth in the region?
- Where to locate the growth?
- How to offer sustainable mobility for the coming growth?

2.2.3 Transition towards Sustainable Mobility

Transiting a community behavior is a long term complicated progress and the successful is not guaranteed. The society reactions could not be expected towards mobility transition. Such unexpected behavior creates many hypotheses for transition theories. Wilbur Zelinsky wrote about the hypothesis of mobility transition at 1971. Totally a part from sustainable mobility, the complicated progress and the players were described it as:

> *"The hypothesis of the mobility transition can be expressed most succinctly as follows: There are definite, patterned regularities in the growth of personal mobility through space-time during recent history, and these regularities comprise an essential component of the modernization process. But it is more useful, perhaps, to offer eight related statements that, taken together, more adequately elucidate the hypothesis."(Wilbur Zelinsky 1971)*

Zelinsky gave eight different statements as a guideline for the mobility transition. In these eight statements he is explaining the overlapping, interactions, inter-sectioning, engaging, complications, aspects and factors playing roles in different level and perspectives in the transition process. The eight statements are as it follows:

> *"(1) A transition from a relatively sessile condition of severely limited physical and social mobility toward much higher rates of such movement always occurs as a community experiences the process of modernization.*
>
> *(2) For any specific community the course of the mobility transition closely parallels that of the demographic transition and that of other transitional sequences not yet adequately described. A high degree of interaction may exist among all the processes in question.*
>
> *(3) There are major, orderly changes in the form as well as in the intensity of spatial mobility at various stages of the transition-changes in function, frequency, duration, periodicity, distance, routing, categories of migrants, and classes of origin and destination.*
>
> *(4) There are concurrent changes in both form and intensity of social mobility and in the movement of information, and under certain conditions the potential migrant may exercise the option of changing his locus in social space or of exploiting a superior flow of informa-tion rather than engaging in a territorial shift.*

(5) At a fairly high level of generalization, which dampens out minor spatial and temporal irregularities, we can recognize in mobility conditions coherent patterns that propagate themselves onward through time as successive periods and outward through space as concentric zones emanating from successful growth points.

(6) The processes in question tend to accelerate in spatial and temporal pace with time, apparently because of the steady accumulation and intensification of causative factors within any given community and because of information and effects transferred from more advanced to less advanced regions.

(7) Thus the basic spatiotemporal scenario of change may be preserved, yet be notice- ably modified when a region initiates its mobility transition at a late date, so that absolute dating is a significant consideration.

(8) Such evidence as we have indicates an irreversible progression of stages."

The transition process in itself is constructed by multi-level perspectives, gathering all these perspectives build a foundation of coherent understanding. The relation between transition and society secures that there will be unexpected behavior even against the logic.

"*A transition toward a more sustainable urban development is a matter of changing the composition of existing multi-segmented land use and transportation regimes. Those well-experienced forms of built environment and transport infrastructure that are in line with sustainability objectives should be strengthened while those that are not should be constrained and reduced.*"(Næss 2012)

In other words, a bus lane or bus priority scheme could be implemented with high efficiency but still, the travelers would not shift their modes. A bus priority scheme could be implemented but the efficiency of the service is not improved because other aspects.

One of the main challenges towards any transition process and especially towards sustainable mobility is the management of the process. The Netherlands have successes in transition management during the last five decades towards more non-motorized mobility. The amount of travelers by bikes, accounting for 27% all trips nationwide, and up to 59% of all trips in its cities(Walljasper 2010), is a proof of this success.

"The Theory of Transition Management and Innovation Systems Since the beginning of this century, transition management plays a role in Dutch policies aiming at decreasing persistent environmental and societal problems. A transition can be defined as a "gradual, continuous process of change where the structural character of a society (or a complex sub-system of society) transforms". Transition management is the approach in which long-term (societal) goals are used to steer shorter-term experiments and developments. At the heart of transition management lies the idea that implementing (radically new) environmentally friendly technologies is hampered by a multitude of factors, such as e.g., technological factors, cultural factors, regulatory factors and the fact that in many cases infrastructures need to be adapted or newly established."(Jacco Farla 2010)

Mobility transition as a long term vision/goal would not be achieved without dividing the long process into short term experiments and step-by-step plans. The sustainable mobility is not equated with sure outcomes but it basically about understanding the current situation, future scenarios and takes decisions fit to the understanding. Transition towards sustainable mobility is the unity of different phases of practice and evaluation of experiments over a long time. The evaluation of the practice for every phase empower that the next decisions is a step closer towards goals. The gap between the current pattern of mobility and the future goals is a challenge and this challenge called transition towards sustainable mobility.

"Sustainable mobility has proved to be a perennial challenge to realize. Scholars have argued that experiments could point the way forward towards sustainable mobility." (cf. Loorbach, 2007, Markard and Truffer, 2008)

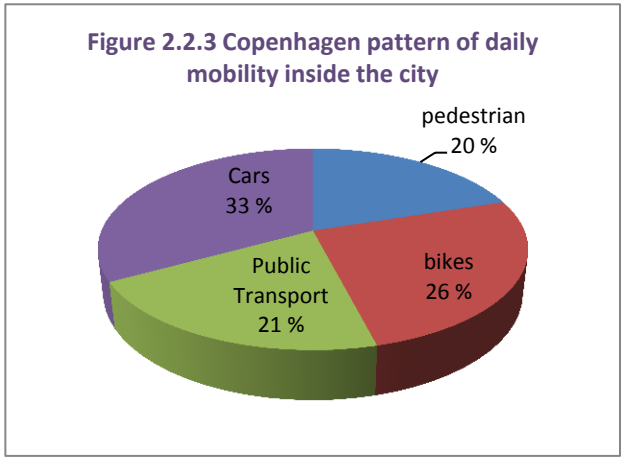


Figure 2.2.3 Copenhagen pattern of daily mobility inside the city

Is sustainable mobility achievable?

There is no such a way of saying that there is a city achieved full sustainable mobility. The road sustainable mobility never ends, since there is always more to do at least in one of the three pillars (environment, equity and economy); however there are cities with high efficient sustainable mobility like Copenhagen. Figure 2.2.2(Copenhagen 2013) shows the pattern of daily mobility inside the city of Copenhagen. As we can see non-motorized mobility is almost 45% of daily mobility pattern. Those two modes are equally reached but the inhabitants as far as bikes for free rent are available over the city to insure that the public access to such a travel mode is high especially for tourist and visitors. The green mobility in the city is 2/3 of the whole pattern of daily mobility. The car is low in mobility because of many restrictions in parking and accessibility policies in the city of Copenhagen. This policy is meant to be done to empower the

priority in travel mode to green mobility. Such description of mobility pattern would lead to deeper understand of the term: Copenhagenization.

Is Copenhagen a sustainable mobility city?

The answer to this question is related to the term sustainable mobility more than anything. Does Copenhagen's pattern of daily mobility meet the present needs without jeopardizing future generations' needs? Could Copenhagen do more? Is the access to the public transport guaranteed to all the residents of the city? Is the service offered by reasonable prices? Could all the inhabitants of Copenhagen purchase a bike? Is the public transport low in greenhouse gas emissions? Could Copenhagen shift to greenhouse gas free emissions public transport? Are the locals in Copenhagen satisfied with their daily mobility? Does the visitor to the city have the chance to experience the city from the same perspective?

The previous questions is not to jeopardize what Copenhagen has done, and this is not the goal of this research but it is to show how complicated to judge the transition towards sustainable mobility even in a city 2/3 of the pattern of daily mobility occurs in public transport or non-motorized modes.

3.0. Methods

The research methods are divided into two main methods: the method for the theoretical research and the methods of the survey (questionnaire). The questionnaire methods on selecting samples, modes of data collection, response formats and response reduction will be explained. In this chapter the terms and definition, used in the research, are included.

3.1. Research method

The aim of the research is to provide an evaluation study of a current situation and future forecasts based on understand foundation of the factors related to transition towards sustainable mobility at Northern-Jæren. The aim addresses the need to establish descriptions of mobility pattern and discover the underlying mechanisms of current pattern of urban mobility. The understanding foundation for the situation of current and future mobility needs, and mobility pattern in addition to the challenges (the gap between the plan and reality) would be done in both *Neo-realism* [5] and *Conventionalism*[6]. The use of these epistemologies would be through collecting data on the patterns, plans, actions, forecasts, visions and goals with description on the context and possible mechanism of public towards the transition process. At the end an evaluation will be provided for the mechanisms provides the best solutions and answering the research question about the feasibility of the plans and implementations.

The use of inductive and retroductive methods provides depth of understanding of pattern. There is neither need to use abductive method nor deductive method because the research does not aim to produce at the end a theory but it aims to evaluate facts, and there is no hypothesis to be tested according a theory but measures to assess current plans.

The method to simplify the research problem has been divided into 10 steps:

- Stating the fact about the current situation of the region regards population, working places, pattern of urban mobility and bus service
- Analyzing the facts and gather the puzzle pieces in order to create understanding foundation of current situation
- Stating different future forecasts in the fields of population, working places and pattern of urban mobility
- Stating Plans, visions and goals in the national, regional and local levels
- Define the challenges gap between the current/future situations and the plans
- State the conflicts in plans, visions, goals and actions in the region regards pattern of mobility

5 Neo-realism is reconstructing empirical theories. Its aim is to comprise all important aspects of an empirical theory in one formal framework. The proponents of this meta-theoretic theory are Patrick Suppes, Joseph D. Sneed, Wolfgang Stegmüller, Carlos Ulises Moulines and Wolfgang Balzer.
6 Conventionalism is the philosophical attitude that fundamental principles of a certain kind are grounded on (explicit or implicit) agreements in society, rather than on external reality.

- Surveying the students (the highest rate of users of bus service at Northern-Jæren) behaviors and opinions about the bus service
- Discuss and analyze the students behaviors and opinions about the bus service through the survey
- Case study: Evaluating plans and actions along Fv.44 where done to shrink the gap between what is meant to be done and what is going to happen
- Discuss the outcomes evaluations of Fv.44 and conclude the results of the evaluations.

3.2 Survey Method

The questionnaire was designed to observe both respondents' opinions and behaviors regard bus service at Northern-Jæren and Fv.44 bus priority scheme. The survey was also aimed to indicate future behavior, improve factors importance and the fields of improvements. The method of the questionnaire is divided into: selecting samples, the mode of data collection, cross-sectional surveys and response formats. The Survey is in digital form. The Norwegian website of SurveyMonkey® is the service provider.

The online surveys have both advantages and disadvantages:

Advantages:

- Sending and collecting data have a low cost.
- Respondents input their own data, and it is automatically stored electronically. Analysis thus becomes easier and can be streamlined, and is available immediately.
- Rapid deployment and return times are possible with online surveys that cannot be attained by traditional methods. If you have bad contact information for some respondents, you'll know it almost right after you've sent out your surveys.
- Samples can answer questions on their schedule, at their pace, and can even start a survey at one time, stop, and complete it later.
- Surveys can be programmed even if they are very complex. Intricate skip patterns and logic can be employed seamlessly. You can also require that respondents provide only one response to single-choice questions, which cuts down on error.
- Respondents may be more willing to share personal information because they're not disclosing it directly to another person. Interviewers can also influence responses in some cases.

Disadvantages:

- Certain populations are less likely to have internet access and to respond to online questionnaires. It is also harder to draw probability samples based on e-mail addresses or Facebook groups.
- Although online surveys in many fields can attain response rates equal to or slightly higher than that of traditional modes, internet users today are constantly overwhelmed by messages and can easily delete your advances.
- A lack of a trained interviewer to clarify and probe can possibly lead to less reliable data.

In this coherence, the reasons behind using an online survey were different. The questions were described and the reasons for each question were mentioned before the question in order to reduce the absence of the interviewer. One of the major benefits of this online survey is the ability to edit the survey quickly and cleanly. It is possible to send multiple versions of the survey. The survey has been experienced in a test edition, the question understanding and response alternatives were discussed with the supervisor twice before the official publish. The ability to send a reminder to the samples to answer the survey is easy. Time efficiency was one of the main reasons to make the survey online. The overall control encouraged the choice of online survey, bedsides the high confidentiality both for the respondents and the research.

The survey was done, published, answered and gathered back in the free edition of the website. The survey was published and writing by the two official languages of University of Stavanger (Norwegian Bokmål and English). The form of the questions and answers was Norwegian first and it was followed by English translation. The question explanations were provided only in English.

3.2.1 Selecting Samples

The bus service users as it was mentioned about are low-income, young and students (RvU 2005). That's why the selecting of the samples[7] was divided into two categories: Students at University of Stavanger and residents along Fv.44. Students as one of the main users of the bus in general would reflect their experience of using the service in the survey and state useful behaviors and opinions. The residents along Fv.44 are divided into two categories: Residents with access to car and residents without access to car.

The both targeted people are one of the main users of the service (as students and residents along Fv.44 without car access) or potential users in the future if parking policies will be restricted in their destinations.

The samples have been reached mainly by Facebook® groups. Facebook® is an online social networking service that is used as a platform for discussions, sharing information, gathering people with the same interests, etc. This social platform provided an easy access to groups of residents along Fv.44 and students at University of Stavanger distinguished by: The place of living (dormitories), the study and free-time interests. Those groups at Facebook® are restricted against public access, so it has only members who are currently involved, or were involved in those groups activity, so I had to ask a member of the group to publish the questionnaire link and the request to answer it. The

7 The targeted people

credibility of the groups might be questioned, but the questionnaire is not about the groups' credibility as much as their behaviors and opinions regards bus and Fv.44 bus priority scheme.

3.2.2 Cross Section Survey

The survey is a cross section, or by other words it is a one-time survey. The survey involved a questionnaire to be answered by individual sample one-time only. The improvements in bus service usually take time to be implemented and measured and the short time of the master thesis did not give the opportunity to have a longitudinal survey.

3.2. 3 Response Format

The survey was basically a close-ended questionnaire. This means that the samples have to choose from the choices with no ability to add their own answers; however there are a couple of question in the survey which had a comment box of 100 words.

Advantages of Closed Ended

- it is easier and quicker for respondents to answer
- the answers of different respondents are easier to compare
- answers are easier to code and statistically analyses
- the response choices can clarify question meaning for respondents
- respondents are more likely to answer about sensitive topics
- there are fewer irrelevant or confused answers to questions
- less articulate or less literate respondents are not at a disadvantage
- replication is easier

Disadvantages of Closed Ended

- they can suggest ideas that the respondent would not otherwise have
- respondents with no opinion or no knowledge can answer anyway
- respondents can be frustrated because their desired answer is not a choice
- it is confusing if many response choices are offered
- distinctions between respondent answers may be blurred
- clerical mistakes or marking the wrong response is possible
- they force people to make choices they would not make in the real world

Advantages of Open

- They permit an unlimited number of possible answers
- respondents can answer in detail and can qualify and clarify responses
- unanticipated findings can be discovered
- they permit adequate answers to complex issues
- they permit creativity, self-expression, and richness of detail
- they reveal a respondent's logic, thinking process, and frame of reference

Disadvantages of Open

- different respondents give different degrees of detail in answers
- responses may be irrelevant or buried in useless detail
- comparisons and statistical analysis become difficult
- coding responses is difficult· articulate and highly literate respondents have an advantage
- questions may be too general for respondents who lose direction
- a greater amount of respondent time, thought, and effort is necessary
- respondents can be intimidated by questions
- Answers take up a lot of space in the questionnaire

Regard the open-end and close-end understanding and the survey properties as an online survey so it is more relevant to have firm form of answers to choose between because of the absence of the interviewer and there is no such a way to answer each respondent. It is easier to interoperate the results and code it in close-end form. There might be a misunderstanding in case of open-end form. One point is a dilemma: the respondents might suggest a useful point, but it might be also improper or irrelative. This is a dilemma could be argue the use of close end form but in light of the survey is an online survey so the absence of the interviewer might encourage an open-end form.

In order to reduce the disadvantages, as it was mentioned above, the survey was reviewed twice with the supervisor and the survey method has been tested in a test survey (Appendix IV). The test survey has been published in the same way and the questions were reviewed with feedback by the respondents about understanding the question, the language, etc. The question with many choices or rating scales has not been following each other in order not to confuse the respondents.

It has to be mentioned that the open-end method have been used in couple of questions in the survey and it were wider used in the test survey and it gave low efficiency in the feedback.

The response scales were provided in three ways:

- Dichotomous: is where the respondent has two options.
- Nominal-polytomous: is where the respondent has more than two unordered options.
- (Bounded) continuous: is where the respondent is presented with a continuous scale.

3.3 Terms and Definitions

3.3.1 Public Transport Priority

Public transport prioritization is transportation planning and management involves countless decisions concerning the allocation of resources, such as money, road space, parking spaces, and priority in traffic. Current planning practices often allocate these resources inefficiently, such as devoting a relatively small portion of transportation funds to non-motorized modes, allocating parking on a first-come basis, and giving no priority to space-efficient modes in congested traffic. Public transportation prioritization explicitly allocates resources to favor higher value trips and lower cost modes priority over lower value, higher cost trips in order to improve overall transportation system efficiency and support strategic planning objectives.

3.3.2. Sustainable Development

The definition of Sustainable development has been into many phases and it could be defined in many texts, but the most frequently quoted definition is from *Our Common Future*, also known as the Brundtland Report(Press 1987):

> *"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:*
>
> - *The concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given;*
> - *The idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs."*

All definitions of sustainable development require that we see the world as a system—a system that connects space; and a system that connects time. When it comes to the world as a system over space, you grow to understand that air pollution from North America affects air quality in Asia, and that pesticides sprayed in Argentina could harm fish stocks off the coast of Australia. Hence when you think of the world as a system over time, you start to realize that the decisions will be taken today for the transport challenges will affect the coming generations towards 2040 and after that as well. Thus this study considers the future challenges in order to reach sustainable plans to face the future.

"Sustainable development stands for 3 constituent: Equity, Environment and Economy." In 1987, the economist Edward Barbier has used this term for the first time. Two years later this 3 main constituent have been interlinked by Pearce, Barbier and Markandya. Interlinking reflects deeper understanding of the whole report more than understanding the 3 main elements separately. Interlink between economic development, environmental degradation, and population pressure instead of three objectives. Economists have since focused on viewing the economy and the environment as a single interlinked system with a unified valuation methodology. Thus the three pillars of sustainable development are interlinked, intergenerational equity, and dynamic efficiency.

3.3.2.1. Sustainable Mobility

Sustainable urban transport is a "tool" to achieve the goal of sustainable development in cities based on reducing emissions of greenhouse gases by 80-90% by 2050 as the professional experts, in environment, now believe is necessary. If the goal of transferring car-based transport to alternative modes of transport such as public transport and non-motorized are met, there must be a paradigm shift in how we plan land use – and transport development in cities. This also implies a shift in how we manage our eco-friendly modes of transport such as public transport. A minimum requirement must be that such public transport is actually something environmentally friendly in many cases are not.

Mobility 2030: Meeting the challenges to sustainability[8] defined sustainable mobility as: *"Mobility that meets the needs of society to move freely, gain access, communicate, trade and establish relationships without sacrificing other essential human or ecological requirements today or in the future."*

Sustainable mobility could be defined also as: the transport modes which meet the needs of today without jeopardizing the needs of future generations. Transport modes based on reducing the green gas emissions and giving equal access for public based on reasonable prices.

8 Mobility 2030 is the final report of the WBCSD's Sustainable Mobility project. Twelve international companies – eight automobile, two oil and two large suppliers – are behind the initiative.

3.3.3. Urban Daily Mobility

Sustainable development constitutes a normative framework for thinking as much as for action (Hart, 2002), which sets the necessity for a control of the negative externalities of economic growth. As such, the question of daily ability proves to be crucial. The objective of "sustainable mobility" consists in protecting both environment and health without decreasing the need for travel. As cities stand as a pertinent scale for the application of sustainable policies (Camagni et al., 1998), reaching the goal of sustainable mobility supposes that the share of the automobile in urban daily travels is reduced.

3.3.3.1. Residential mobility

It is defined by definitions.net as: Frequent change of residence, either in the same city or town, or between cities, states or communities.

3.3.4. Greenhouse Gas Emissions (GHG)

A greenhouse gas is a gas in an atmosphere that absorbs and emits radiation within the thermal infrared range, which means the GHG traps heats in Earth atmosphere. This process is the fundamental cause of the greenhouse effect. The primary greenhouse gases in the Earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, and ozone. Greenhouse gases greatly affect the temperature of the Earth; without them, Earth's surface would average about 33°C colder than the present average of 14°C.

3.3.5. Park and Ride scheme

Park-and-ride (or incentive parking) facilities are car parks with connections to public transport that allow travelers and other people headed to city centers to leave their vehicles and transfer to a bus, rail system (rapid transit, light rail, or commuter rail), or carpool for the remainder of the journey. The vehicle is stored in the car park during the day and retrieved when the owner returns. Park-and-rides are generally located in the suburbs of metropolitan areas or on the outer edges of large cities. Park and ride scheme could be applied for bicycles as well. It could be defined also as:
The bus services designed to provide intermodal passenger trips between a private mode of transportation and a shared mode. The common model of bus based park and ride model is transfer from a private car to a public transport bus, although schemes may also be used by pedestrians and cyclists.

"*Park and ride*" commonly refers to permanent schemes operated as part of the public transport system, for onward transport from a permanent car park to an urban center. '*Park and ride bus*' can also be used to describe temporary and seasonal schemes, services operated for private or specialized users, and services that do not necessarily serve an urban center. Bus services can be permanent, seasonal, or only operate on specific days of the week, or for specific events.

Permanent public transport based park and ride sites are predominantly constructed, administered and financially supported by one or more of the local public authorities, although partial private funding also occurs, usually in partnership.

3.3.6. HQT

Hybrid Quality Transit is a term applied to a variety of public transport systems using buses, light rail and train to provide faster, more efficient service than an ordinary bus line. Often this is achieved by making improvements to existing infrastructure, vehicles and scheduling. Implementation of HQT requires pre-implement of bus priority scheme and Park and ride schemes.

According to merriam-webster.com dictionary a rapid-transit is: *underground, subway, elevated railway, metro or metropolitan railway system is a passenger transport system in an urban area with a high capacity and frequency, and grade separation from other traffic*. Rapid transit systems are typically located either in underground tunnels or on elevated viaducts above street level. Outside urban centers, rapid transit lines may run on grade separated ground level tracks. They are typically integrated with other public transport and often operated by the same public transport authorities. Rapid-transit is faster and has a higher capacity than trams or light rail (but does not exclude a fully grade separated LRT.

3.3.6.1. LRT

A local railway or tram system, sometimes capable of sharing roads with traffic and heavy railways.(Government 2008)

4.0. Current Situation and Challenges

The chapter is understanding foundation of the current and future situations in the region. The chapter is to state facts, plans and understand reflections for Northern-Jæren population, working places, pattern of mobility and future challenges. The chapter ends by stating the nowadays conflict in mobility.

4.1 Population and Working Places Growth

4.1.1 Population and Labor Forces

Northern-Jæren region has a population growth rate with 2.0%(SSB 2013) which is an exceptional rapid population growth in Norway. The Norwegian average population growth is 1.3%(KVU 2009, SSB 2013). In 2012, the population is approximately 201 000 inhabitants and it is distributed in the 4 urban areas as it is in the table (3.1.1)(SSB 2013)

Table 4.1.1 Cities of Northern-Jæren region distinguished by population, percentage, area (km) and density (res/km)

Region's cores	Population residents	Percentage %	Area km2	Density res/km^2
Sandnes	54 587	27.1 %	23.40	2 333
Stavanger	124 960	61.1 %	44.56	2 804
Sola	12 924	6.4 %	8.98	1 439
Randaberg	8 882	4.4 %	4.29	2 070
Total	201 353	100%	81.23	2 479

The table represents the continuous urban structure of Northern-Jæren region, which means that many residents in Sandnes and Randaberg are not counted. According to the SBB, Stavanger owns 61.1 % of the population of the area that gives an idea why it could be called in other sources, or media as Stavanger region. Sandnes is the second after Stavanger (27.1 %). Sandnes as a municipality has the largest area in the municipalities of Northern-Jæren with 303 km^2 but it shares only 23.40 km^2 in the current region. Sola and Randaberg has the smallest contribution in the population.

Forecasts of population growth expected population to reach 307 000 as Medium expectations and 365 000 in the highest expectations by 2040(SSB 2013). FDP stated population growth with 3 500 residents per year; However this annual expected growth has been accomplished since many years at Northern-Jæren and the new inhabitants growth has a higher rate. This state a new fact that the 380 000 residents might arrive in the area earlier than 2040 as FDP expected. 14 years ago the FDP was published for long term development in Jæren. Observing this 14 years it will be divided into 2 periods: Period one 2000-2006 is presented in table (4.1.2) and period two 2007-2013 is presented in table (4.1.3).

In period one the growth has not reach 3 500 inhabitants per year, but it started from 989 new inhabitants to reach in the maximum 3 006 inhabitants. The growth in total was 14 045 new inhabitants and the average was 2 006 new inhabitants per year.

Table 4.1.2 the population growth at Northern-Jæren region divided by cities during the period of 2000-2006(SSB 2013)

Cities	2000	2001	2002	2003	2004	2005	2006
Sandnes	52 998	53 860	54 929	55 729	56 668	57 618	58 947
Stavanger	108 818	108 848	109 710	111 007	112 405	113 991	115 157
Sola	18 915	19 023	19 231	19 538	19 555	19 832	20 138
Randaberg	8 773	8 762	8 880	8 998	9 076	9 099	9 304
Total	189 504	190 493	192 750	195 272	197 704	200 540	203 546
Growth	————	989	2 257	2 522	2 432	2 839	3 006

Period of 2007-2013 was over the expected average (3 500). This period reached a growth average of 4 381 inhabitant per year with total of 30 667 in 7 years. This draws a new situation which could mean that 2040's forecasts could be achieved before the expected time.

Table 4.1.3 the population growth at Northern-Jæren region divided by cities during the period of 2007-2013(SSB 2013)

Cities	2007	2008	2009	2010	2011	2012	2013
Sandnes	60 507	62 037	63 431	64 671	66 245	67 814	70 046
Stavanger	117 315	119 586	121 610	123 850	126 021	127 506	129 191
Sola	20 666	21 446	22 076	22 831	23 350	23 877	24 579
Randaberg	9 501	9 622	9 867	9 997	10 061	10 265	10 397
Total	207 989	212 691	216 984	221 349	225 677	229 462	234 213
Growth	4 443	4 702	4 293	4 365	4 328	3 785	4 751

In Facts, the population growth reached 4 751 new inhabitants in 2013. This rapid growth of population growth formed new forecasts that expect population to reach 330 000 by 2025 instead of 2040. The overall growth in the period of 2001 to 2013 is:

44 712 and the average annual growth is approximately 3500. The region's growth started with 989 new inhabitants to reach 4 751 with average annual growth of 36%.

It was expected by SSB that the average annual growth in population will be 3500 until 2040. However, according to these last 13 years of growth the possibilities for population growth are:

- In case of the growth average remain in 4 381 –the average of growth the last 7 years- this means in 2023 the growth would be expected approximately 44 000 new residents in the region with total residents of 278 000.
- In case of the growth average raise up by 335 each year as it happened in the last 7 years, then it is expected to reach 83 442 new residents by 2025. This means the total residents of Northern-Jæren would be 317 700 residents.
- In case of the growth average raising up by 316 each year as it happened in the last 14 years, then it is expected to reach 81 687 new residents by 2025. This means the total residents of Northern-Jæren would be 315 900 residents.
- KVU stated that 330 000 residents of the region will be reached by 2020-2025 without stating the methods of calculating.

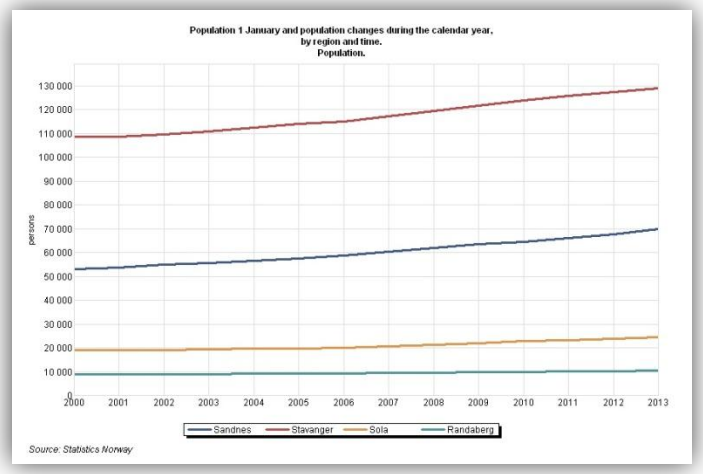


Figure 4.1.1 shows population growth in the region during the period of 2000-2013 distributed by cities. Source: SSB

In 2010, labor forces in the region are over 121 000 workers(FDP 2000, Statistics 2013), and this number is expected to rise up until 2040 as well. One of the direct results of the population growth is natural growth in the labor forces at Northern-Jæren region beside the rapid increase in labor forces that migrate or immigrate to Northern-Jæren. A closer look into table 4.1.4 describing the growth in Northern-Jæren cities shows that the rapid population growth is related to a rapid labor forces projecting. The population growth of the region between year 2000-2010 were 31 848 new inhabitants, while the employees residents of Northern-Jæren in the same period were 24 656. This means that 77.4% of the population growth was employees who are originally labor forces. Regards the cities, Sandnes has 27 501 employees resident in 2000 reached 35 564 in 2010. This means the net growth of labor forces was 8 036 with growth rate of 29.3%. The population growth in the same period was 11 673. This means that the labor forces growth of Sandnes as an urban core occupied 68.8% of the population growth.

Table4.1.4 Employees residents of: Sandnes, Stavanger, Sola and Randaberg.(Stavanger-statistikken 2013)

		Sandnes	Stavanger	Sola	Randaberg	Sum
Employees resident of	2000	27 501	54 650	9 765	4 624	96 540
	2005	30 199	58 416	10 170	4 666	113621
	2007	33 837	65 283	11 631	5 145	115896
	2008	35 020	66 932	12 134	5 312	119398
	2009	34 955	66 610	12 267	5 334	119166
	2010	35 564	67 750	12 609	5 300	121223
Net growth	Number	8 036	13 100	2 844	676	24 656
	percentage	29.3%	23.9%	29.1%	14.6%	

By reading table 4.1.4, it is noticeable the rapid growth in the labor forces. In 2000 there were in total (Sandnes, Stavanger, Sola and Randaberg) 96 540 employees, in 10 years the employees reached 121 223 with labor forces projecting percentage of 25.5%. If the growth rate will keep on this rate of growth so the region's labor forces will be grew up almost 75% by 2040. The most employees' growth happened in Stavanger with 13 100 employees while the highest percentages are at Sandnes 29.3% and Sola with 29.1%. Considering the area of Sandnes and Sola we understand that the growth where higher in Sandnes with 8 036 new employees, while it was only 2 844 in Sola. The whole net growth in Northern-Jæren of labor forces at the period of 10 years (2000-2010) are: 24 656 labor force The overall percentage of growth is (the total net growth of labor forces/ the total of labor forces in the region at 2010) (24 656/121 223)*100= 20.3% which is a rapid growth amount of labor forces according to Norwegian national aspects.

4.1.2 Working Places

The rapid population growth at Northern-Jæren is combined with working places rapid growth as well. Forecasts expect a continuously growth in working places at Northern-Jæren. In 2010, there were over 135 000 working places(Statistics 2013). Forus commercial park has around 40 000 of the working places nowadays as the highest concentrated working places. Stavanger Centrum owns approximately 33 900 according to KVU, 2009. The same source stated Sandnes Centrum as the third on the list with 9 100 working places.

Table 4.1.5 Working places in: Sandnes, Stavanger, Sola and Randaberg municipalities(Stavanger-statistikken 2013)

		Sandnes	Stavanger	Sola	Randaberg	Sum
Working places in	2000	25 798	63 811	12 573	3 015	105 197
	2005	28 171	66 877	14 031	3 149	112 228
	2007	31 840	77 989	16 200	3 596	129 625
	2008	33 897	78 608	16 942	3 698	133 145
	2009	34 105	77 732	17 403	3 875	133 115
	2010	34 961	78 655	18 296	3 760	135 672
Net growth	Number percentage	9 163 35.5%	14 844 23.2%	5 723 45.5%	745 24.7%	30 477

The amount labor forces are less than the working places in Northern-Jæren. The extra working places are covered by commuting labor forces from many places like: Time, Klepp, Gjesdal, Rennesøy, etc. In 2010 Northern-Jæren had approximately 135 000 working places, and there were over 121 000 employees living in the region. During a decade working places at Northern-Jæren added (working places in the region in 2010: 135 674- working places in the region in 2000: 105 197) = 30 477 new working places. This mean the growth rate was 28.9%. Meanwhile in Oslo working places growth rate was not over 4% in the same decade when working places grew up with 15 801. Bergen had working places growth rate of 17.9% where net growth reached 23 851 new working places. In table 4, Oslo reached 15 801 (17.9%).

Table 4.1.6 Employees residents of: Stavanger, Oslo and Bergen(Stavanger-statistikken 2013)

		Stavanger	Oslo	Bergen
Employees resident of	2000	54 650	271 205	116 305
	2005	58 416	278 959	121 170
	2007	65 283	307 456	131 776
	2008	66 932	316 389	135 134
	2009	66 610	314 847	135 737
	2010	67 750	319 883	136 623
Net growth	Number percentage	13 100 23.9%	48 678 17.9%	20 318 17.4%

In a national aspect, comparing Stavanger, Oslo and Bergen (as municipalities) it clear that the most growth in employees occurred in Oslo municipality border, but the highest percentage of growth occurred in Stavanger: 23.9%. It is noticeable that Bergen and Oslo are growing in the same rate 17-18%.

Table 4.1.7 Working places in: Stavanger, Oslo and Bergen municipalities(Stavanger-statistikken 2013)

Working places in		Stavanger	Oslo	Bergen
	2000	63 811	410 315	131 728
	2005	66 877	391 553	138 882
	2007	77 989	421 603	152 252
	2008	78 608	427 902	155 668
	2009	77 732	423 244	154 963
	2010	78 655	426 124	155 379
Net growth	Number percentage	14 844 23.2%	15 801 3.8%	23 851 17.9%

Based on the strong connection between population growth and working places, forecasts expected growth in working places in the region to reach 155 000 to 190 000 working places by 2040. FDP address the issue of uncertain forecasts for the working places:

> *"In assessing the required working places for a period of 40 years is probably uncertain than at forecasts. Therefore it is not placed substantial emphasis on in-depth studies of how could a person envision working life in about 40 years. It is only obtained theoretical figures as the basis for spatial considerations. Assuming that the total number of employed persons by place of work equals the number of jobs in the region, and that the relationship between population and*

the number of jobs will remain unchanged over the period to 2040, the need for growth in jobs related to the two population projections will be:

- *44,300 jobs in M1*[9]
- *68,500 jobs in H1*[10]

Other forecasts from other sources have been shown a need for 67,000 new jobs in the period 1996-2040."

It has to be mentioned that there were no further discussion about this issue at FDP-R, 2012.

The population, labor forces and working places growth in the region might be criticizing those 14 years old forecasts. The clear relation between the oil industry, welfare, population, labor forces and working places would cause rapid growth in all these fields. According to the previous experience from Northern-Jæren in the last 14 years it could be hard to trust the forecasts because it has been higher growths than what was expected in all fields, even when the world economic crisis hit in 2008 the growth in population, labor forces and working places were on progress.

[9] Medium national growth
[10] High national growth

4.2 Pattern of Urban Mobility

Northern-Jæren region has been shaped over time to be a polycentric urban area. The low dense land use policy contributed into the current private motorized transport modes based pattern of urban mobility. The main pattern consists of three pillars: Daily mobility, trips per day and the mobility modes. Analyzing the current picture which states large range of used of private motorized transport modes with high amount of daily trips.

Figure 4.2.1 shows the queues of cars at Northern-Jæren region. Credits: Stavanger Aftenblad

4.2.1 Daily Mobility

One of the three pillars of pattern of daily mobility and the main shaper of it is: daily mobility. It occupies a good space of the region's mobility pattern profile because of the dynamic traffic network. We can see, through facts and statistics of daily mobility, the dynamic relationship between the polycentric urban areas of Northern-Jæren.

Analyzing the data from the official statistics webpage of Stavanger municipality(Statistics 2013) we could see that cities into-daily travelers conquer the view in Stavanger, Sandnes and Sola as far as they own the main concentrated commercial parks and working places. While into- daily travelers still exists in Randaberg as well even it owns no main commercial area. In the year 2010, Randaberg has 3 760 working places and there is 2 134 employees travel daily into Randaberg for work. This means that over 56% of the working places in Randaberg were occupied by employees who travel from other urban cores at Northern-Jæren or from out of the region (Rennesøy as an example). According to table 4.2.1 and in the period 2000-2010, daily travelers rose up as an evidence of high daily mobility into the main urban cores in the region.

Table 4.2.1: Travelers into: Sandnes, Stavanger, Sola and Randaberg(2010)

Travelers into		Sandnes	Stavanger	Sola	Randaberg	Sum
year	2000	11999	24832	8716	1577	47 124
	2005	13531	25702	10168	1798	51 199
	2007	15713	31961	11939	2090	61 703
	2008	17087	32220	12350	2132	63 789
	2009	17058	31545	12676	2232	63511
	2010	17714	31935	13430	2134	65 214
Net growth	Number percentage	5 715 47.6%	7 103 28.6%	4 714 54.6%	557 35.3%	18 091

Urban cores into-daily travelers in the decade of 2000-2010 in Northern-Jæren region took the theme of positively growth overall except for 2008 when City of Stavanger's into-daily travelers negatively grew from 32 220 to 31 220 in the year 2009; However it rose up again at the end of the decade. Meanwhile in the capital of Norway recorded -7% of net growth in daily travelers into the city.

Table 4.2.2: Travelers into: Stavanger, Oslo and Bergen municipalities(2010)

Travelers into		Stavanger	Oslo	Bergen
Year	2000	24832	173801	28963
	2005	25702	156138	31502
	2007	31961	163496	35988
	2008	32220	163084	36326
	2009	31545	159948	34882
	2010	31935	160396	35000
Net growth	Number percentage	7 103 28.6%	-13 405 -7%	6 037 21%

Urban cores out-daily travelers in the decade of 2000-2010 in Northern-Jæren region took the theme of positively growth as well in the start of the decade but at 2008-2009 the growth curve went down in Sandnes, Sola and Randaberg. Stavanger had a slight increase of 121 new travelers; however it rose up again at the end of the decade slightly over 2008 registered amount of out-travelers.

Table 4.2.3: Travelers out of Sandnes, Stavanger, Sola and Randaberg(Stavanger-statistikken 2010)

Travelers out of		Sandnes	Stavanger	Sola	Randaberg	Sum
Year	2000	13 702	15 671	5 908	3 186	38 467
	2005	15 559	17 241	6 307	3 315	42 422
	2007	17 710	19 255	7 370	3 639	47 974
	2008	18 210	20 544	7 542	3 746	50 042
	2009	17 908	20 423	7 540	3 691	49 562
	2010	18 317	21 030	7 743	3 674	50 764
Net growth	Number percentage	4 615 33.6%	5 359 34.1%	1 835 31%	488 15.3%	12 297

Norwegian aspects in the national level, Stavanger in the period of 2000-2010 has slightly came behind Oslo and before Bergen regards the travelers out of Stavanger, Oslo and Bergen cities (inside municipalities borders not the regions)

Table 4.2.4: Travelers out of: Stavanger, Oslo and Bergen (Stavanger-statistikken 2010)

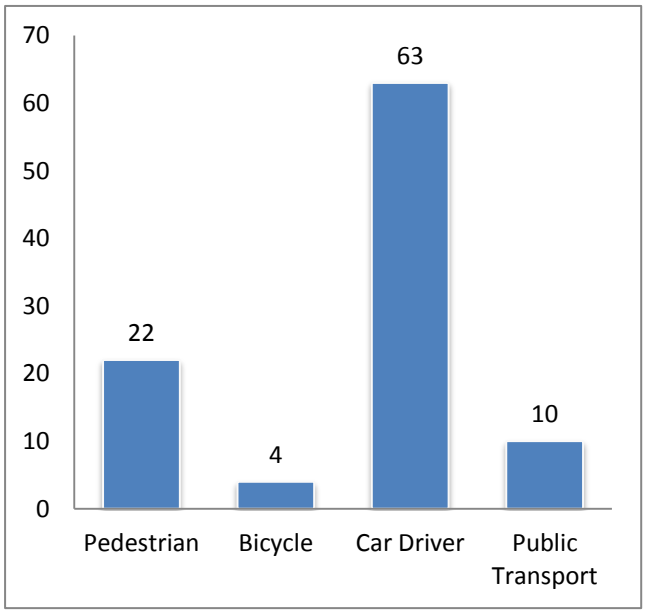
Travelers out of		Stavanger	Oslo	Bergen
Year	2000	15 671	34 691	13 540
	2005	17 241	43 544	13 790
	2007	19 255	49 349	15 512
	2008	20 544	51 571	15 792
	2009	20 423	51 551	15 656
	2010	21 030	54 155	16 244
Net growth	Number percentage	5 359 34.1%	19 464 35.8%	2 704 19.9%

Northern-Jæren region owns approximately 136 000 working places, while there are 116 000 resident employees travel to reach those working places; This states dynamic relation between the cores of the region, but at the other hand this also has an impact on the street network capacity, peak hours and general pattern of daily mobility of the region.

4.2.2 Travel Modes

"Travel modes" is the second pillar of pattern of urban mobility at Northern-Jæren. It is an important factor to understand the current situation and indicate major facts. The travel modes will be divided into 4 modes: pedestrian, bicycles, private cars and public transport. The Norwegian national Travel Survey 2009 stated an increase access to the cars in the national level.

> *Access to cars is one of the most important factors affecting choice of mode. In 2009, 85 per cent of the population belonged to a household with at least one car, one third had two cars and seven per cent had three cars or more. The percentage living in multiple car households increased from 38 in 2005 to 42 in 2009.(Liva Vågane 2009)*



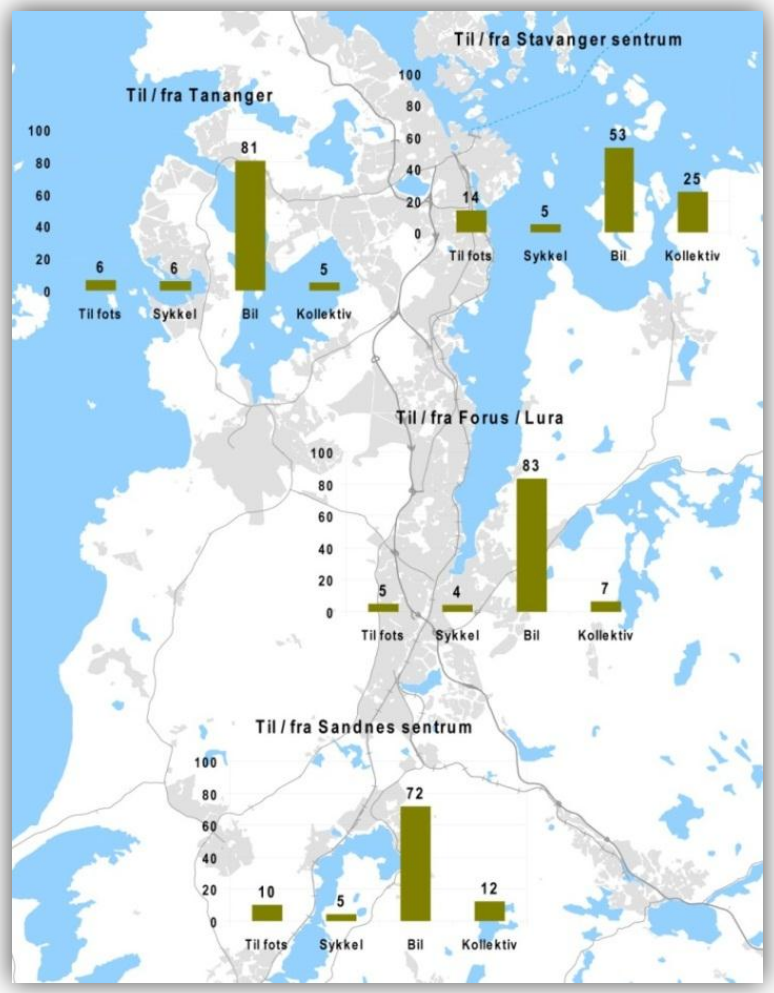
To the top: Figure 4.2.2 Travel modes distributed of Norway. Source RvU, 2009

In the National image of daily mobility categorized by transport modes the public transport occupies 10% and non-motorized modes are 26% (pedestrians and bicyclers) this stated 64% car/motorized modes travelers of the daily mobility all over Norway.

Northern-Jæren region area has five main destinations for everyday travels: Stavanger Centrum, University of Stavanger, Tananger/Risavika, Sola, Fours/Lura and Sandnes centrum. The university and Sola were ignored by the sources of the travel modes, thus they are not presented in this research.

When it comes to Northern-Jæren; according to KVU illustration there are difference between the national image of travel modes and the local image of the region. Travelers in the car mode (drivers or passengers) went over the national average from and to Sandnes, Tanager and Forus/Lura. Forus had the highest percentage with 83%, Tanager 81% then Sandnes Centrum 72%. Stavanger Centrum had been under the national average with 53% of travelers from and to centrum.

Non-motorized modes (pedestrians and bicyclers) have been under the national average in all the focus area of KVU. Stavanger Centrum is the highest with 19% of the travelers from and to the centrum. Sandnes has 15% of the transport modes to and from the centrum are non-motorized. Forus and Tananger have the lowest rate with 9 and 12 % in raw. The bicyclers all over the region from and to the main 4 mentioned cores by KVU were between 4-6% which is in the range of the national average, while pedestrians are lower than the national average (22%) with 6-14%.



To the left: Figure 4.2.3 shows the mobility modes at Northern-Jæren region to and from the urban cores. Source: KVU

4.2.3. Trips per Day

"Trips per day" is the last major factor indicates the current pattern of urban mobility of Northern-Jæren. Nowadays situation states approximately 765 000 trips every day in average. Weekdays has a higher amount of trips than the average to reach 1.1 million trips(Rogaland County 2009). Stavanger - Sandnes have the highest trips performance in weekdays. The national average rate of trips[11] per day is 3.3per day(TØI 2005). According to RvU, 2005 the regional average trips per day are 3.8 per day

By 2040, population might be in the range between 307 000 and 365 000 in the HHMH by 2040(SSB 2013). Trips per day it might be in the range of 3.3- 3.8-4.0 trips per day. This gives possibilities lays between 1 013 100 and 1 460 000 trips per day. It has to be mentioned as well, according what was mentioned in the population growth chapter 4.1that the population growth could reach the expected limits in 2040 before that, then it means that those trips per day could be arriving early as well and by 2040 it will be another situation could not be expected because of the behaving of population growth and the other factors playing the role of daily trips such as welfare, access to cars, transport, traffic, working places, oil industry, etc.

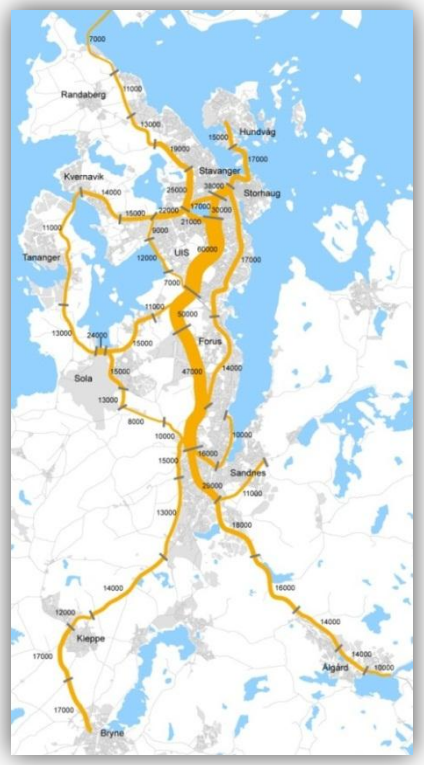
[11] Trips according to the TØI definition is: as any movement outside the lot where one lives, regardless of length, duration or purpose. Once the destination is reached, the trip is considered completed. One or more modes of transport may be used for a trip. Walking and cycling are reckoned as independent modes of travel on a par with motorized modes of transport.

4.2.4 Traffic Volume

The traffic volume is a result of the current situation and it is not a reason of the daily pattern mobility. The studying the traffic volume would gain more understands of the all aspects of mobility pattern in the region.

The travel volume per working days analysis shows that the main transport corridor in the area is the one connecting Stavanger to Sandnes. This corridor has been the main urban development corridor over time since the start of oil industry in the region. This corridor is divided into three areas: Stavanger Centrum-Mariero, Mariero-Lura and Lura-Sandnes. Secondary corridors in the region are: Stavanger Centrum-Stavanger west and Stavanger Centrum-Stavanger North. There is one main feeding corridor which is out of the region but has a visible impacts on the daily trips is to Ganddal, Klepp and Bryne. Sandnes Centrum-Sandnes Øst to be mentioned as a potential future corridor with great possibilities when Sandnes Øst is implemented.

Closer look to the illustration of Transport volume of Annual average of daily traffic *ÅDT(Rogaland County 2009)* would show that E39 is the backbone of traffic in the region with 175 000 daily traffic. Stavanger Centrum owns 119 000 daily traffic while Sandnes owns 55 000 daily traffic. Sola owns 39 000 and Randaberg with no data are the last on the list. Other cores like Tasta owns 19 000, Tananger, 11 000, Madla (madlaveien and madlasandnes) 56 000 and Forus-Lura-Gausel 61 000.



To the left: Figure 4.2.4 ÅDT illustration of traffic volume in the region. Source KVU

4.2.5 Public Transport Passengers and Travel Time

Bus service in Northern-Jæren in 2011 reached an average of 63 trips per inhabitants in the region. This means around a 12.6 million passengers took the bus in 2011. The amount of passengers has been through many up and down curves in the region from 65 trips per inhabitant in 2007, 61 trips per inhabitants in 2008, 64 trips per inhabitants in 2009 and 66 trips per inhabitant in 2010. The table 4.2.5 shows that in the main urban region of Norway only at Northern-Jæren the travel length has been in decreasing. The figure also shows that Bergen region had the highest increase all over Norway after the implementation of LRT service in the city.

Table 4.2.5 shows the bus annual travel length per residents in regions of Oslo, Northern-Jæren, Bergen, Trondheim and Tromsø

	2007	2008	2009	2010	2011
Oslo	94	94	101	112	114
Northern-Jæren	65	61	64	66	63
Bergen	91	88	84	83	99
Trondheim	91	93	95	101	103
Tromsø	107	106	103	108	112

According to the Norwegian Road Authority data bank, Stavanger-Sandnes corridor is the main daily mobility corridor in the region. 2.6 million Bus passengers have been traveled in this corridor in 2007 at the other hand 1.3 million passengers have traveled in the Stavanger Centrum –Stavanger west/Tananger corridor. Randaberg/Tasta – Stavanger centrum and University of Stavanger-Stavanger Centrum both have approximately 1 million passengers per corridor in the same year (2007). Sola and Hundvåg are 550 000-675 000 passengers in both corridors in a row.

In 2008 and before the implementation of bus lanes in Rv44, which is the main transport corridor (Stavanger-Sandnes) in the region, it is indicated that during rush hours are significant traffic jam problems resulting in delays. At the other side Rv509 where bus priority is implemented also certain amount of delay caused by a lack of cross-prioritization of public transport. There are sometimes significant deliverability problems in the city area.

However, other factors that are not related to the public transport work in the direction of less public transport use. As previously mentioned, the region's car-domain land use development in particular resulted areas with high vehicle accessibility and low public transport accessibility. Increased welfare and thereby increased car ownership (more than two cars each residential) also helps to keep the public transport usage at a low level.

4.3 Future Plans and Challenges

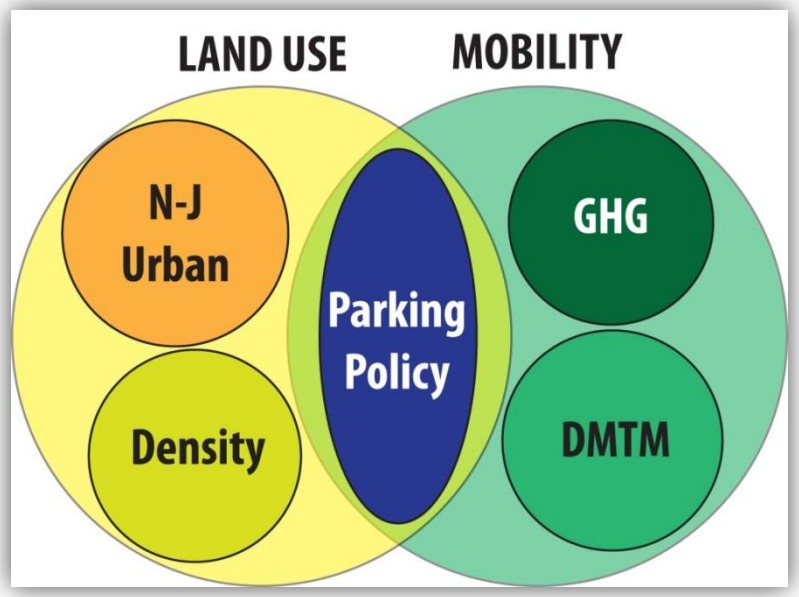
Northern-Jæren region, as it has been previously in this research described, has growth of population and working places. Those growths address need more mobility in the future for the coming population. The current pattern of mobility produce a future scenario where mobility is more based on cars at one hand; while at the other hand plans with goals of transition towards sustainable mobility are adopted in national, regional and local levels. Visions and plans of reducing greenhouse gas emissions in the region with 30% of today's emissions (20% of 1991 emissions), are adopted but the real practice addresses other facts.

The main challenge is how to achieve a sustainable mobility transition at the region. The gap between the expected scenario and the plans created this challenge. The challenge, as it was explained before, is related to two main issues:

- Sustainable mobility
- Land use policies

Those two factors play a main role in the equation of challenges in Northern-Jæren. Some related challenges to a factor could be a result of the other factor, or it is in the middle between them. Blending them together under a spot of understanding the urban area of Northern-Jæren would result out the following challenges:

- The absence of a plan for Northern-Jæren as an urban area
- Greenhouse gas emission
- Parking policy
- Land-use transport policy
- Transition of urban daily mobility



To the top Figure 4.3.1: Challenges inter-sectioning. N-J urban: Northern-Jæren as an united urban area, GHG: Greenhouse gas emissions and DMTM: Daily mobility transport modes (transition of urban daily mobility)

4.3.1 Sustainable Mobility Transition

The current situation challenges the plans of transition towards sustainable mobility. Recently, the car travel mode (63%) conquers the mobility of the region. the plans by FDP-R are to have almost as double bus passengers as today by 2040 (from 8 to 15%) and increasing the pedestrian and bicycles travel modes as well. This mean the main source of those three growths is car drivers.

> *It is a goal that the public transport use will reach at least 15% in 2040 for the planning area as a whole. That means higher use in the central urban areas and lowers in the outer parts of the planning area. The goal is to establish good accessibility for transportation circulation in a regional coherent with pedestrian and cycle networks. Pedestrians and bicycle transport modes will exceed 25% of the planning area in 2020. Bike share alone will be in the urban area over 12% by 2020.(Regionalplanseksjonen 2012)*

The regional plan has stated no mechanism of how to reach these goals out of implementing bus lanes between Stavanger-Sandnes and Gausel-Sola. (Regionalutviklingsavdelingen 2000, Regionalplanseksjonen 2012, Regionalplanseksjonen 2012)

The transition for sustainable mobility needs supporting policies in land-use. The density of the bus/public corridors is important. FDP-R states the plan as:

> *"Municipalities will plan a division of housing growth that contributes to reduced growth in cars usage and increased public transport accessibility, pedestrian and bicycle travel. Policy Direction in residential construction (Guidelines 5.6.4 - 5.6.6) applies municipalities Randaberg, Stavanger, Sola, Sandnes, Klepp and Time."(Regionalutviklingsavdelingen 2000, Regionalplanseksjonen 2012)*

The integration of land use and transport policy, goals, visions and plans is the key to achieve a transition towards sustainable mobility. The integration of the plans is not only in one level, but it has to go through all the levels in parallel. What will be presented in the coming sub-challenges is how the integration of plans is totally neglected between land use and transport planners in the region. Furthermore there will be presentation of how double face plans exists in the region, or how the plans are different from implementation of policies in the reality.

4.3.1.1 Northern-Jæren as Integrated Urban Area

Northern-Jæren is not taking into a high consideration as an urban area in the national, regional or local planning. The published plans for Jæren are based on administration borders. "*Northern-Jæren area*" has been widely used by KVU and LRT municipality plan; however the 2 documents deals with Northern-Jæren area as administrational area and based on the municipalities borders. The use of administrational borders is not so relevant in urban planning process, especially if we look to the map and find out that Sandnes as a municipality owns has a bigger area than the whole urban area of Northern-Jæren.

Plans for the integrated urban area would be different than plans for 4 different municipalities in cooperation. The first plan will focus on how to serve and implement plans for the whole urban area as one unit, while the other will focus more to find share goals between different municipality administrations with different interests.

> "*Regional plan for long term city development at Jæren will fulfill many goals. Many of those goals cooperate with each other's but other creates conflicts.*"(Regionalplanseksjonen 2012)

Understanding the properties of North-Jæren urban area would contribute for more efficient solutions for the challenges. Planning for the whole Northern-Jæren region as one urban area would reduce the conflicts of interests in the region, especially if the municipalities are going to share fairly the outcomes.

> *"Achieving integration in earlier phases of planning (for example, strategy development, goal orientation or visioning) can potentially produce shared policy goals, which would promote mutually reinforcing (instead of obstructing) land use and transport measures."(Bertolini 2009)*

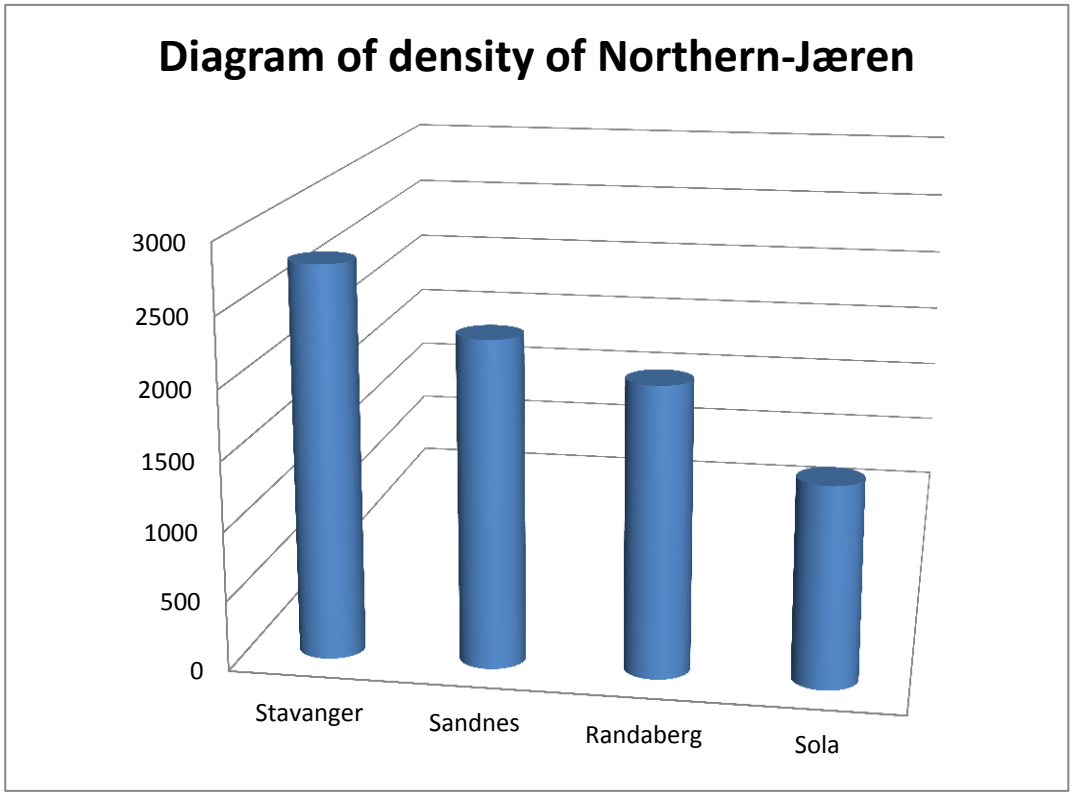
Deep understand of the urban pattern of the region would lead for: better land-use plans, better transition of patter of urban mobility and fewer goal conflicts in the region.

4.3.1.2 Land use-Transport Policy and Density

Northern-Jæren has an urban characteristic of polycentric urban area. The development occurred over time since the 1970s was maintained as car based region. The absence of integrated plan of land use-transport contributed into more trips per day by the car which reached higher limits at the start of the 3rd millennium in combination of higher wages/salary and welfare in the region. However, this described situation caused low dense residential corridors in the region. Northern-Jæren average density is 2 479 res/km^2 where Stavanger has the highest density with 2 804 res/km^2 and Sola has the lowest density with 1 439 res/km^2. Sandnes and Randaberg have 2 333 and 2 070 res/km^2 density in a raw. This draws a spatial image that the region has a close patterns, Sola is an exception, and this also make it easier to apply the same policy in density.

Table 4.3.1 Region's cores density

Region's cores	Density
Sandnes	2 333
Stavanger	2 804
Sola	1 439
Randaberg	2 070
Total	2 479 res/km^2



To the left: Figure 4.3.2 density of Northern-Jæren cities diagram

FDP-R addressed land-use policies to be used as:

> *"The goal of efficient land use involves facilitation of land-economization in existing building areas by planning for infill of demolished houses, reuse and revitalization. Furthermore, the new building areas given optimum density adapted centrality, distance to public transport and center structure, trade / culture and services."(Regionalutviklingsavdelingen 2012)*

Stavanger city is the 11th largest urban area in the list of the Nordic[12] urban areas. The density of the region is (2 479 res/km^2) lower than the other Nordic countries belong to the same list and lay around Stavanger on the list.

To the left: Figure 4.3.3 Perspective over of Sandnes.

[12] Nordic countries: Norway, Sweden, Iceland, Finland and Denmark

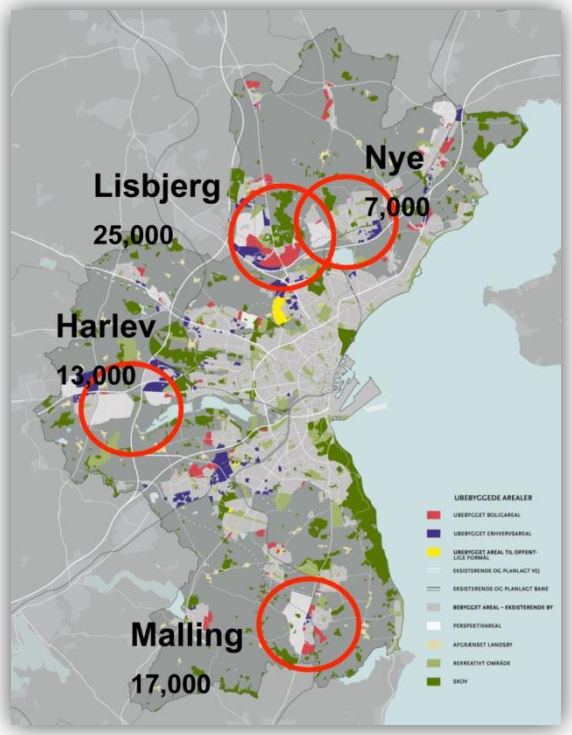
Rank	Urban area	Urban area residents	Notes
07	Malmö	280,415[13]	Municipality: 300,515. For the official statistical entity *Stormalmö* (Malmö Metropolitan Area): 658,704 and for the Oresund Region circa 3,500,000
08	Turku	252 468[14]	Municipality: 180,546.
09	Aarhus	252,213[15]	Municipality: 314,545[16]
10	Bergen	238,098[17]	Municipality: 267,150. Region: 377,116.
11	Stavanger	201,353[18]	Municipality: 128,830. Region: 297,569. Conurbation includes the neighboring municipalities Sandnes, Randaberg and Sola.
12	Reykjavík	201, 049	Capital of Iceland. Municipality: 118,898. Includes the neighboring municipalities Kópavogur, Hafnarfjörður, Garðabær, Mosfellsbær, Seltja rnarnes and Álftanes. Metropolitan area: 220,000 – 240,000 (30 minute / 1 hour commute) [19] (2011).
13	Oulu	185 440[20]	Municipality: 191,237
14	Odense	167,615[21]	Municipality: 190,245
15	Trondheim	167,598[22]	Municipality: 179,123. Region: 274,958.

Table 4.3.2 shows the Scandinavian urban areas ranking according population

[13] http://www.scb.se/Statistik/MI/MI0802/2012A01/mi0802tab3.xls
[14] Finnish CSB
http://pxweb2.stat.fi/Dialog/varval.asp?ma=160_vaerak_tau_340_fi&ti=Taajamat+v%E4kiluvun+ja+v%E4est%F6ntiheyden+mukaan+31%2E12%2E2011&path=../Database/StatFin/vrm/vaerak/&lang=3&multilang=fi
[15] http://www.dst.dk/pukora/epub/Nyt/2011/NR171.pdf
[16] http://www.dst.dk/da/Statistik/emner/kommuner-paa-landkortet.aspx
[17] http://www.ssb.no/beftett
[18] http://www.ssb.no/beftett
[19] http://www.statice.is/Statistics/Population/Urban-nuclei-and-zip-codes
[20] Finnish CSB
http://pxweb2.stat.fi/Dialog/varval.asp?ma=160_vaerak_tau_340_fi&ti=Taajamat+v%E4kiluvun+ja+v%E4est%F6ntiheyden+mukaan+31%2E12%2E2011&path=../Database/StatFin/vrm/vaerak/&lang=3&multilang=fi
[21] http://www.dst.dk/pukora/epub/Nyt/2011/NR171.pdf
[22] http://www.ssb.no/beftett

According to table 4.3.2 Aarhus occupies the 9th place over all Nordic urban areas in inhabitants. Aarhus is a Danish city with ambitious plans to reach a CO_2-neutral by 2030. The city is expecting almost the same growth like Stavanger in population and working places: 75 000 new inhabitants and 50 000 new working places by2030(Municipality 2009). The need for new towns in the city addressed in the municipal plan and they planned to house 62 000 out of 75 000 new inhabitants in the new four areas: Nye, Lisbjerg, Harlev and Malling. Planning the new areas Aarhus took into consideration many regulations:

- Balance between north, south and west
- Co-operation with neighbors
- Nature interest
- Drinking water interest
- Close to the city center
- Close to major roads
- Close to light-rail



To the left: Figure 4.3.4 shows the new cities in Aarhus area.

The new high dense towns, as mentioned in the municipal plan of Aarhus, are one of two acts hosting the new inhabitants. The other acts is infill and develop in the city itself to host 13 000 new inhabitants.

The key-role of the density by corridors has a contribution in an efficient planning. The urban metropolitan of Aarhus has a density of 2 669 res/km^2; then the question how could Aarhus, who has approximately the same rate of density, could still afford decrease in greenhouse gas emissions from mobility? Answering this question we have to look into the map of Aarhus which will show concentrated residential areas with large green and open areas around. This mean on the exactly building zones Aarhus has higher density but the green open areas is reducing it down, while in Stavanger the city is spread on earth with no concentrated residential areas, but most of the residential have their own small garden back or in the front of the house, in addition to main parks and green open areas.

It might be refers to the density as the helping tools to apply the high quality transport modes. Yet there are some North-European metropolitan areas out of the Nordic countries with low dense close to Stavanger and stating success in applying the HQT. Cities[23] like Strasbourg 3 488 residents/km^2, Rouen 5 192 residents/km^2 and Nantes city 4 342 residents/km^2 could apply the LRT in medium dense areas. The French cities apply a Land-use policy in order to concentrate the density in corridors where the LRT could offer a good service with large green, open and public spaces. So we can understand that density at the current moment is a challenge against applying any mode of HQT. It must be mentioned that there are different ways of calculating the density and it is different from a city to another of taking into consideration the water, green and other areas in to consideration, hence the numbers of density from different countries could be calculated in different methods so there is a small fail factor, still it could be a good example.

> *"National guidelines for coordination transportation and land use must involve both land pattern committed focus on the development and operation of an efficient public transport network. City pattern is planned to be operated by rail rapid and high frequency public transport"(Regionalutviklingsavdelingen 2000)*

The FDP 2000 is stating the cooperation/integration working in the previous plan in one side of the transition towards sustainable mobility: public transport service. The practice from other European cities state out that the transition have to be driven in parallel line between offering better efficiency in the public transport and confining the cars mobility(Lynn Devereux 2005).

The current situation along the public transport corridors is potential to create place development based on integrated policy of Land use transport. Creating places along the corridors will reduce the need to travel to commercial parks by travel along corridors with efficient bus service.
The new place development at Northern-Jæren have to be accomplish in high density (in the range of other North-European cities) with working places to be reached by walking, cycling or bus service. Such places would contribute into the transition of daily mobility towards sustainability

[23] The source of the French cities density is the city website. This mean the method of the calculating is unknown for the researcher.

4.3.1.3 Parking Policy

This is one of the sub-challenges presented in an advance position in most of the municipalities' plans. Parking policies is a share challenge between the main two factors: land use and mobility. It is a response for the need of all the cars mobility in the region. The process of place development over all the urban area created the current need for all this parking places in parallel with lack of transport service covers all the region daily destinations.

FDP Adopted guidelines states general parking policies as it follows:

> *"3.5 Restrictions on car use*
>
> *3.5.1 Municipalities must address the current parking standards for audit, in terms of reduced requirements for parking spaces in different areas and buildings. It must be planned for reduced parking in centers, hubs and other areas that have high accessibility by public transport. Municipalities are in such areas set maximum limits for parking.*
>
> *3.5.2 It shall develop a regional parking policy aiming to rationalize land use and reducing the availability of car in areas where public transport system is well developed."(Regionalutviklingsavdelingen 2000)*

The main three cities Northern-Jæren in this case are Stavanger, Sandnes and Sola because they divided the concentrated working places in the region and most of daily mobility's destinations in the regional. Stavanger and Sandnes stated regulars for parking but city of Sola has ignored out of the airport and Forus-Lura. Stavanger and Sandnes parking policies regulation are divided into 4 main areas:

1. Zone 1: Centrums
2. Zone 2: Public transport corridors
3. Forus-Lura special regulations
4. Rest of the 2 municipalities

The parking policies are to: restrict parking accessibility in the first 2 zone (centrums and PT corridors); give more accessibility in the rest of the region and Forus-Lura to be regulated in a separated plan as far as it is a shared area between Sola, Sandnes and Stavanger.

Stavanger Municipality Climate and Energy Plan states that:

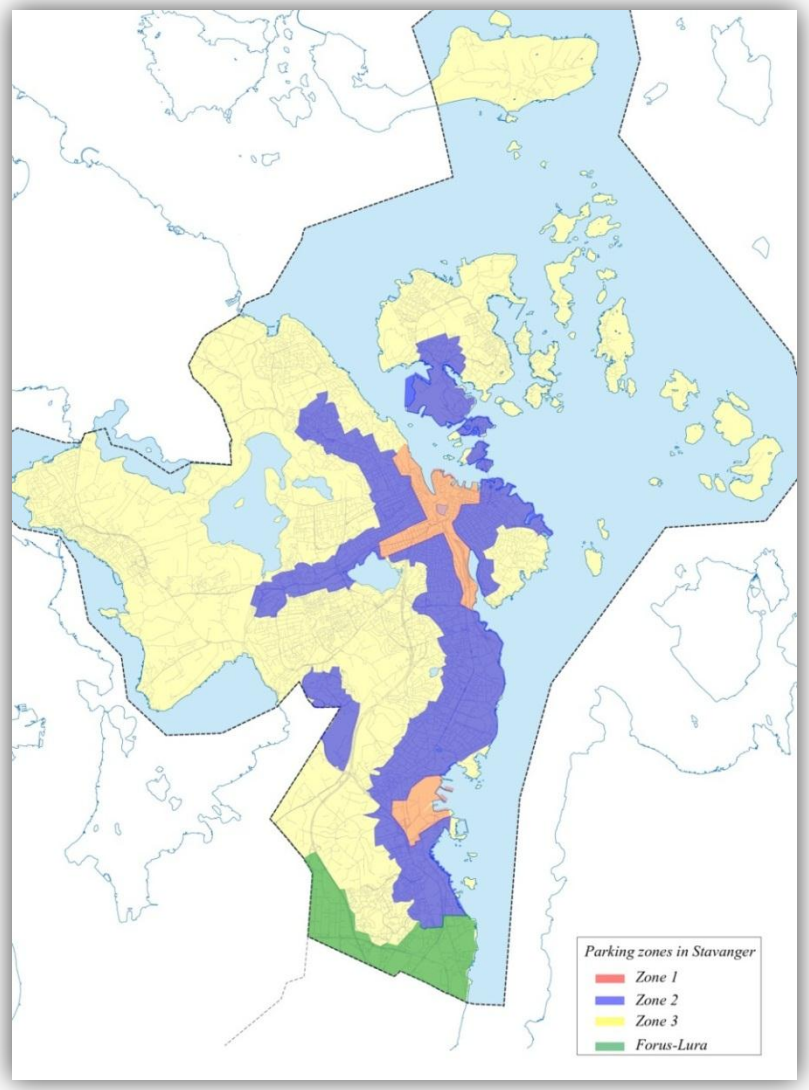
> *"Stavanger municipality shall maintain a more restrictive parking policy and rather encourage the public transportation, pedestrian and bicycle trips."(Municipality 2010)*

Stavanger municipality plan states:

> *"New norms for parking in planning and building applications are shown in the provision of municipal plan. To increase the use of environmentally friendly transport, it is essential that the current competitive advantage for private car changed. An important way to achieve this is deliberate use of parking requirements.*

The three zones in the municipal plan are:

- Zone 1: Stavanger centrum, Paradis, Madlakrossen, Hillevåg and Jåttåvågen
- Zone 2: All the urban area with 500
- m buffer zone of public transport corridors
- Zone 3: the rest of the municipal area



To the left: Figure 4.3.5 Parking Zones over Stavanger city. Source Stavanger municipal parking plan

The zones plan does not give any better solution as far as the destinations are still having high accessibility for parking. This will cause a problem for citizens in the blue zone (zone no.2) that they have a car, in order to reach their destinations in zone 1, but they have to own a private garage or they will pay for one.

However in the summer of 2012 new parking houses among F.v.509 have been opened for the new DNB arena and the new Ice-hockey arena, despite that F.v.509 has a bus lane in the two directions towards downtown.

Sandnes municipality Street Use Plan for Sandnes Centrum states:

> *Goal: All parking lots in the city have to meet the needs that are important to maintain and develop a vibrant downtown. Parking lots offer shall be developed so that it stimulated the transfer of trips to work and study places from car to other modes of transport (public transport, cycling, walking). Long parking lots shall be located in a way that they do not accuse unnecessary extra loads on roads network inside the city.(Sandnes 2010)*

The municipal plan for Sandnes divided the city into 3 zones like Stavanger: centers, public transport corridors and the rest of the municipality.

Sola Transport plan states: *Consideration of parking restrictions in combination with improved public transport. Parking ratio in office-based commercial reduced, often in collaboration with neighboring communities.(Municipality 2010)*

However the municipality is rising up the Parking house in Sola Airport and the commercial area around in area P3 and P4. *The objective is to permit utilization of undeveloped land for hotel, commercial, office and parking purposes.(Municipality. 2010)*

Forus as a shared area between Stavanger, Sandnes and Sola have a cooperation plan regulations for parking policy:

> *"Regulation for Forus Business Park allows today from 1.0 to 3.5 parking spaces per. 100 m^2 BRA. Forus area is primarily developed as a car-based industry. Parking regulations have their grounds partially in the case of public transportation coverage. Committee for Urban Development 8/25/10 Case 97/105 Preliminary surveys show that no companies have yet developed as much parking as regulations allow. "(Stavanger 2010)*

This fact states that the parking lots in Forus-Lura are even higher than the actual nowadays need, as far as they are not used. As it is stated in the municipalities' cooperation plan for Forus-Lura, reducing parking lots is not done at any level. Forus is under planning process to growth up to 150% to reach 100 000 working places in vision of Forus 2040(AS 2012). This means the gap between plans and reality would get bigger and achieving the goals will be even farther than ever unless, and only unless, fast actions is taken to reduce the car accessibility and parking lots in Forus-Lura area.

Finally, after spotting the lights in the region current parking policy we could understand that:

- The region previous place developments are challenging any changes in the parking policies
- The municipal parking plans are in lack of unity of criteria between the 4 urban areas
- The absence of efficient public transport service in the region assesses any restricting in the parking houses/lots as far there is no other alternatives in the current situation for cars. By other words, the possibility to restrict parking accessibility starts in parallel with regional improvements in public transport services

There is a dilemma situation if parking houses/lots are reduced without improving public transport service. The need to mobile will be jeopardized, and this would impact negatively the commercial activities in the region. Shopping centers, malls, downtowns, etc. representing the commercial activities will have less customers if the parking lots are going to be dropped at once. The shopping centers out of town will hold the current high rate of parking lots while centrums for example will lose more customers as far as people would like to shop from the centers where they could park their cars nearby. It has been mentioned in the questionnaire (Appendix II).

The people live in centrums or public transport corridors that have a job in Forus or out of the public transport cover will have a problem because they can't have enough parking accessibility and they need a car to travel to their daily destinations. At the current situation they have to move out of those two zones to where they could have more accessibility to parking which could be Sola, Randaberg or just out of the two mentions zones in Stavanger and Sandnes.

The solution might be in a rolling plan where the decreasing is done in parallel with increase of public transport services to the concentrated area with high parking House/lots.

4.3.1.4 Greenhouse Gas Emissions

The plans in national, county, regional and local levels address that greenhouse gas emissions have to be reduced. Norway signed Kyoto protocol and belongs to country list in Annex I with all the countries with binding targets. This commitment and other commitments stated national goals and guidelines of Norway. According to the *National Guideline for Climate and Energy Plan* for municipalities approved by 27th June 2008; the purposes of the national guideline are to:

- Secure that municipalities take steps towards reducing greenhouse gas emissions
- Secure more effective energy use and environment friendly energy restructuring in the municipalities
- Secure that municipalities use a wide range of their roles and instruments in order to reduce greenhouse gas emissions(Enviornmnet)

Reducing the greenhouses gas emissions is one of the goals of the FDP:

> *"If urban development should protect the overall objectives for energy and international agreements on emissions, city pattern add up to greater use of transport modes that are less demanding than the car."(Regionalutviklingsavdelingen 2000)*

Stavanger and Sandnes are part of the national project *Cities of the Future*[24] which aims for in one of the main goals in reducing greenhouse gas emissions and better mobility in the cities by improving public transport and non-motorized transport modes.

Stavanger Municipality Climate and Energy Plan 2010-2025 address:

> *"Stavanger will reduce the city's direct greenhouse gas emissions by 20% compared with the 1991 emissions. This entails a reduction of about 30% from present-day emission rates. In addition, the city aims to contribute to a reduction of greenhouse gas emissions outside the municipal borders, by means of policy instruments such as the city's energy and procurement practices."(Municipality 2010)*

Stavanger city vision:

> *"The City of Stavanger will be a pioneer/model municipality in the field of resources and energy consumption and greenhouse gas emissions. By 2050, the municipal energy consumption and greenhouse gas emissions shall be*

[24] "Cities of the Future" is a collaboration project between the Norwegian government and the 13 largest cities in Norway to reduce greenhouse gas emissions and make the cities better places to live. Source: Cities of the future official web-page.

approximately equal to the municipality's ecological share in a global perspective. The City of Stavanger will thus contribute to a fair distribution of the world's resources and prevent negative impacts from the greenhouse gas emissions."[25]

Stavanger city plan in order to achieve the goal of 20% reduction of 1991 level of greenhouse gas emissions is:

"The targeted 20% reduction in greenhouse gas emissions from 1991 to 2020 means a total reduction of 85 000 tons and will be distributed as shown in figure 2.4
We aim to reduce emissions as follows:

- *35 000 tons from stationary energy use*
- *5 000 tons from the processing industry and agricultural sector*
- *45 000 tons from the transportation sector, of which 40 000 from road traffic."(Municipality 2010)*

The plan states further explanation of the transport and traffic situation in relationship to the current land use:

" Transportation is clearly the biggest source of direct CO2 emissions in Stavanger and where we face the biggest challenges. Key priority areas here are further development and densification of built-up areas along major public transport routes, self-sufficiency of urban districts, improved public transport and bicycle lanes, plus new technologies such as electrically powered vehicles."(Municipality 2010)

Finally the table 4.4.2.1shows the planned cut of greenhouse gas emissions by city of Stavanger in the *Stavanger Municipality Climate and Energy Plan 2010-2025:*

[25] Climate plan vision as adopted in 2002

Areas of focus	Target	Assumed CO_2 reduction (ton)	Comments
Improved vehicle technology	Reduce emissions per km driven	20 000	**Improved combustion engine, smaller cars, electric cars and biogas**
Concentrated land development	Reduce number of km per trip	15 000	**Build along axis of public transport and in self-supporting parts of the city**
More environmentally friendly transport	Reduce emissions per km driven	5 000	**Give public transport high priority. Better conditions for cycling and walking.**
Transport efficiency improvement	Reduce number of km by car	5 000	**Improved logistics. Intelligent transport systems and services (ITS).**
		45	

Table 4.3.3 Stavanger municipality plan to cut down 30% of greenhouse gas emissions

Despite the plans in different levels (regional, municipality or locally) the greenhouse gas emissions was not reduced in the region, although there were a growth in the greenhouse gas emissions achieving new records. Situation in city of Stavanger at 2009 holds 279 million tons of greenhouse gas emissions rose by 12% of 1991 (the benchmark for emissions) which was 256 million tons.

Sandnes, the second core is size of population, and the second in greenhouse gas emissions, situation has not improved as well; at 2009 it was 255 million tons of greenhouse gas emissions while it has been 203 million tons at 1991. This mean the increase reached 25.6% instead of -20%, thus all the results went in the wrong direction. The following table and diagrams showing the fact of how much traffic and land-use transport occupy o the emissions in the region. They show the whole image of emissions and the contribution of road traffic, land-use and transport.

Table 4.3.4 Green Gas emissions 2009 in Stavanger /Sandnes municipalities distributed by the source of the emission(SSB 2013)

	total	Road traffic	Percentage Traffic/total *100%
Stavanger	279	148	53%
Sandnes	255	128	50.1%
Sola	175	41	23.4%
Randaberg	38	14	36.8%

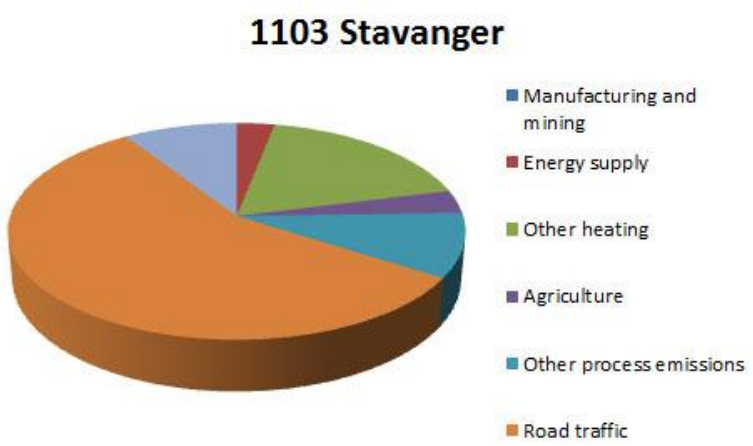


Figure 4.3.6: shows that road traffic occupies 53% of Stavanger's green gas emissions.

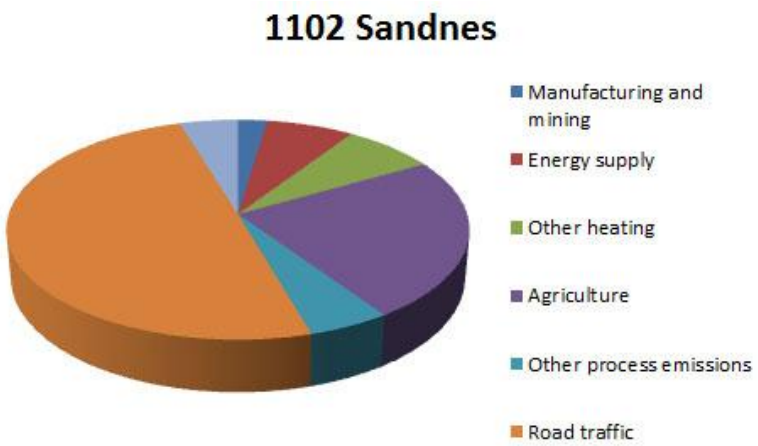


Figure 4.3.7: shows that road traffic occupies 50.1% of Sandnes' green gas emissions.

Table 4.3.5 Green gas emission to Air distributed by the source(SSB 2013)

	Current CO2 emissions (%equivalent) In 2006	1991 emissions in tones		2006 emissions in tones		20% reduction in current rate is equivalent to(tons)	
		Stavanger	Sandnes	Stavanger	Sandnes	Stavanger	Sandnes
Land use and transport	67%	171 000	110 000	192 000	129 500	38 000	26 000
Stationary energy consumption	19%	72 000	35 000	62 000	26 000	12 000	5 000
Consumption and waste	14%	14 000	57 000	14 000	55 000	3 000	11 000
total Stavanger/ Sandnes	100%	256 000	203 000	268 000	210 000	53 000	42 000
Total of both		459 000		478 000		95 000	

Land use and transport has the responsibility of 67% of the greenhouse gas emissions in Stavanger and Sandnes which are the main two cities of the region. Approaching the goal for 20% reduction starts from acting towards this important item in the table.

The greenhouse emission is result of many factors and a cause for others. The cause of this current situation, which expected to be darker in the future, is the main two factors created challenges in the region: Land use policies, and mobility modes. Northern-Jæren region's land use policy in previous phases contributed to low dense-spread urban areas. Transport service also contributed into more private motorized transport modes as far low dense corridors are not efficient in economic benefits. So population of Northern-Jæren has open accessibility to their cars on a car based urban area for their daily mobility.

4.4 Conflicts

Northern-Jæren region has conflicts at different levels and aspects. Administrations of Northern-Jæren cities suffer a miss-cooperation into plans and field works when it comes to Land-use transport policy. Distributing the responsibility in different administrational levels from the government, Fylkesmann, county, municipalities and other local committees in different 4 cities with different visions for each causes a direct conflict in interests, needs, plans and services. Each of the administrations wants to have the most population to be located in their administrational borders so they could get higher taxes.

Another aspect of the conflict is what is in the plans and what is implemented in reality. The parking plans are different between implementations and plans. Some other plans are in conflict with other plans (double face plan) and other are in conflict with other on progress plans. The plans to implement a bus lane along Fv.44 to achieve better competitiveness for the bus against cars has a conflict with plans to extend street networks and build more tunnels and streets. The transition towards sustainable mobility goes in conflict with many other on progress plans in the region especially in land use policies.

The FDP-R plans to increase bus passengers from 8% to 15% among Northern-Jæren are challenged before the bus service is improved and car accessibility is confined. The new plans along E39 might lead towards more cars driving through E39 as a ring road and take the closest exist to their destinations instead of driving through Fv.44, Fv.509 or Fv.510. Thus some queues will shrink and advances to buses during peak hour will be reduced.

Northern-Jæren area has a conflict in the management of transition towards sustainable mobility. The adopted plans by the official levels are doubled faces. A plan to extend the street network and rising street capacity, and the other plans to reduce the greenhouse gas emissions by raise the bus competitiveness and improve the bus transport service. The Norwegian road authority, Stavanger office published plans to develop the motorway between Stavanger-Sandnes and further north. Plans to develop sections: E39 Eiganestunnelen, E39 Hove-Sandved, E39 Rogfast, E39 Sandved-Stangeland and E39 Smiene–Harestad. Most of the plans are in planning phase. Another plan published to develop Fv. 443 Stokka-Skadberg between Stavanger and Randaberg. Those mentioned development will contribute to reduce the queues under the peak hour in the region especially that those sections are main section in daily mobility in the region.

According to what mentioned above from the FDP and municipalities plans in the focal areas, the implementation of advance parking policy in working areas, centrums and attractive nodes is required. Here comes the dilemma of the parking policies; if

the car trip takes 10 min from A to B and the same traveler to travel by bus had to walk 5 min. from point A to the bus stop, and wait 5 min. for the bus to catch the bus which takes 10 min. to reach the bus stop by the destination, and then he/she walks 5 min. to reach final destination of the trip B. Then the trip by bus took 20 min. as double time as car. Thus bus is not attractive for these travelers. If we take into consideration that in rush hour the buses lose the punctuality, then the waiting time at point A' would be extended and the whole travel time will be further increased. If the passenger have a connection , Passengers with connections are around 38% (Questionnaire, 2013 Appendix II), which might he lost because the first bus is late and the connection bus itself might be late as well which result a long travel time, and then the public transport are absolutely not competitive with private motorized transport modes in this case. Another dilemma is the Parking lots/houses by main malls which is private and provided by the malls and no regulation could be implement so the public will drive a longer distance to reach malls with parking lots/houses in order to have their car with them instead of going to a mall without parking service as far as public do not want to walk home or to take the bus with shopping bags.

5.0 Case Study Fv.44

This chapter is about the plans, actions and evaluation of implementation of bus priority scheme along Fv.44. The chapter also holds the survey about the bus service along Fv.44

5.1 Bus Priority Scheme of Fv.44

Fv.44[26] runs between Stavanger and Flekkefjord through Sandnes and Jæren parallel to the E39[27], but by the coastline. The road is part of the North Sea road (Nordsjøveg). The North Sea road is consisting of state road 47 and county road 44 and going between Haugesund and Kristiansand. Before 1 January 2010, the road portion of state road 44, along with the present state road 44.

Fv.44 in the area under study is the main transport corridor in the region and it connects the largest two cities in the region: Stavanger and Sandnes. This advance position has been supported by bus lanes in both directions between Stavanger centrum and Mariero/Gausel with further implementation in the future. The FDP-R stated the plans for the bus lanes and bus priority scheme as it follows:

> *"5.7.1 Public Transport*
> *5.7.1.1 In residential zones in urban areas the priority in the period 2010 to 2020 shall be to establish bus lanes between Stavanger, Sandnes and Sola centers."*(Regionalplanseksjonen 2012)
>
> "5.7.1.2 From residential zones in urban areas in the period 2020-2030 would public transport maneuverability ensured through the use of bus lanes or bus priority scheme to Stavanger and Sandnes and Forus."(Regionalplanseksjonen 2012)

The street has been divided by Norwegian Road Authority, Stavanger office into sections in following with implementing bus priority scheme. Sections are Hillevågtorget, Mariero, Diagonalen-Gausel, Gausel –Hans og Gretestein and Hans og Gretestein–Stokkaveien. The Norwegian Road authority website shows facts about the plans of the whole street as it follows:

- The length of these sections in total is 6 950 m and it distinguished as it follows in table:5.0.1

26 The shortcut Fv. means a county road
27 Europe high way

Table 5.0.1 Length of Sections of Fv.44 bus lanes

Section	Length in meters
Hillevågtorget (Hillevågveien[28]+Sjøhagen[29])	800 + 400
Mariero [30]	650
Diagonalen-Gausel [31]	2000
Gausel–Hans-Gretestein [32]	1900
Hans og Gretestein–Stokkaveien[33]	1200

- The source of the fund is different from section to another; however the road toll, the state, the county and the municipality are the source for the fund of this project. The total budget of the sections is 599 million NOK[34] and it distinguished as it follows in table 5.0.2:

Table 5.0.2 Total cost for each section

Section	Total Cost in million NOK
Hillevågtorget (Hillevågveien+Sjøhagen)	185+179
Mariero	60
Diagonalen-Gausel	No estimation until now
Gausel–Hans-Gretestein	No estimation until now
Hans og Gretestein–Stokkaveien	175

The next page Table 5.0.3 is showing the information of goals, length of sections, fund source, project package, total costs, national transport plan relation to the project, start time, end time, current phase and appropriations. The source of the information is the website of the Norwegian road authority.

28 http://www.vegvesen.no/Fylkesveg/fv44hillevag/Fakta: accessed 09.06.2013
29 http://www.vegvesen.no/Fylkesveg/fv44skjaringen/Fakta: accessed 09.06.2013
30 http://www.vegvesen.no/Fylkesveg/mariero/Fakta: accessed 09.06.2013
31 http://www.vegvesen.no/Fylkesveg/fv44gauselnord/Fakta: accessed 09.06.2013
32 http://www.vegvesen.no/Fylkesveg/fv44gauselsor/Fakta: accessed 09.06.2013
33 http://www.vegvesen.no/Fylkesveg/forussletta/Fakta: accessed 09.06.2013
34 Norwegian Krone

Table 5.0.3 the information of goals, length of sections, fund source, project package, total costs, national transport plan relation to the project, start time, end time, current phase and appropriations of sections of Fv.44

	Fv.44 Sections					
	DIAGONALEN–GAUSEL STASJON, BUS LANES	GAUSEL STASJON–HANS OG GRETESTIEN, BUS LANES	HILLEVÅG-VAULEN, KOLLEKTIVFELT		MARIERO, BUS LANES	STOKKAVEIEN–HANS & GRETESTIEN, BUS LANES
			HILLEVÅG BUS LANES	SJØHAGEN–ZETLITZVEIEN BUS LANES		
Goals	Congestion for buses and pedestrians will be improved for this route.	Congestion for buses and pedestrians will be improved for this route.	The purpose of the project is to provide better accessibility for public transport. It should also be made for future light rail.	The purpose of the project is to reduce road congestion for cars. Bus lanes will be added in the middle of possible light rail. It will be built a 120 m a long culvert to bind together greenery.	The purpose of the project is to reduce road congestion for transit. Bus lanes will be added in the middle for possible light rail.	The purpose of the plan is to improve congestion for public transport in establishing bus lanes and improve intersections. Bus lanes should be centered.
Length of the Section	2000 m	1900 m	800 m	400 m	650 m	1200 m
Fund Source	Road Toll	Road Toll	Road Toll, State, County	Road Toll, State, County	County, municipality, Road Toll	County, Road Toll
Project Package	Northern-Jæren Package	Northern-Jæren Package	Northern-Jæren Package	Northern-Jæren Package	Northern-Jæren Package	Northern-Jæren Package
Total Cost	No estimation until now	No estimation until now.	185 mil. NOK	179 mil. NOK	60 mil. NOK Part of the project Fv. 44 Skjæringen-Breidablik road	175 mil. NOK
National Transport Plan	mentioned in NTP 2010-2019	mentioned in NTP 2010-2019	Not mentioned	Not mentioned	No information were provided	Not mentioned
Start	2015	2015	May 2010	October 2011	Spring 2012	Fall 2013
End	2018	2018	November 2011	September 2013	September 2013	Spring 2015
Current Phase (09.06.2013)	Plan phase	Plan phase	Open for use	On progress	On progress	Offer phase
Appropriations	Not mentioned	No information were provided	No information were provided	No information were provided	Not mentioned	No information were provided

Bus priority scheme is the right of preferential treatment on the shared road between different travel modes for buses to give them priority over cars. This covers the physical measures in the street only. There are mainly two reasons to implement such a priority: better future opportunities of land use development along the public transport corridor and more efficient public transport operating and service. At the other hand there are disadvantages of the bus lanes such as: costs (investment and maintenance) and Impacts on the urban environment, i.e. tree removal.

The shorter trip time might attract more passengers to the buses, therefor the bus priority scheme's missions to achieve are:

- An attractive travel time in compete with private travel modes
- The lowest waiting time in the peak hours
- Better connection travels

Norwegian Road Authority, Stavanger office has studied a proposal of bus priority scheme at Fv.44 consists of 2 main alternatives. Both alternatives are based on separated lanes for buses, bikes and cars. The separation has been in two forms: separation of lane with and without segregations as it follows:

> *"The criteria are essentially a public transport measure, while making a general improvement of the road section for pedestrians and cyclists. It is also planned restructuring of some intersections, closure of access roads, demolition of buildings and a functional/visual upgrade from road to street."(Authority 2010)* It considered two cross sections:

Alternative 1

The alternative 1 is divided into two phases (1A and 1B) the phase 1A is the current situation of bus priority scheme from Stavanger centrum to Hillevågtorget. The other alternative would modify the current street structure.

Alternative 1A, as it shows in figure 5.0.1 below, is the current situation of the street with the bus priority scheme. Road structure consists of a symmetrical cross section with sidewalks (3.5 m including 1 m of trees raw), bicycle lanes (1.5 m), bus lanes (3.0 m), lane (3.25 m) and central reservation (2.5 m).

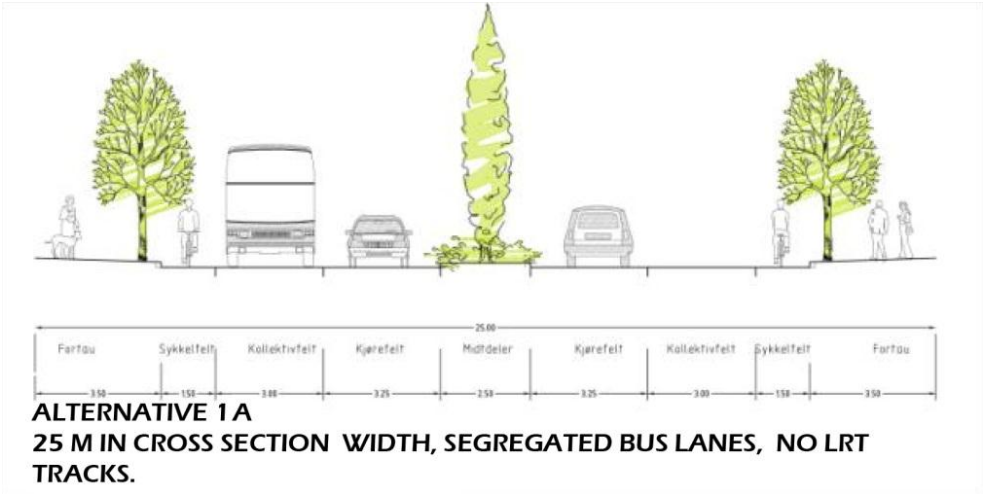


Figure 5.0.1 Alternative 1A cross section

Alternative 1B, as it shows in figure 5.0.2 below, will be implemented at the arrival of LRT, where the lane would be shared between buses and LRT. Public transport lane will be moved to central reservation with no segregation from traffic, but still the middle island will remain to segregate the direction of the traffic in along the road.

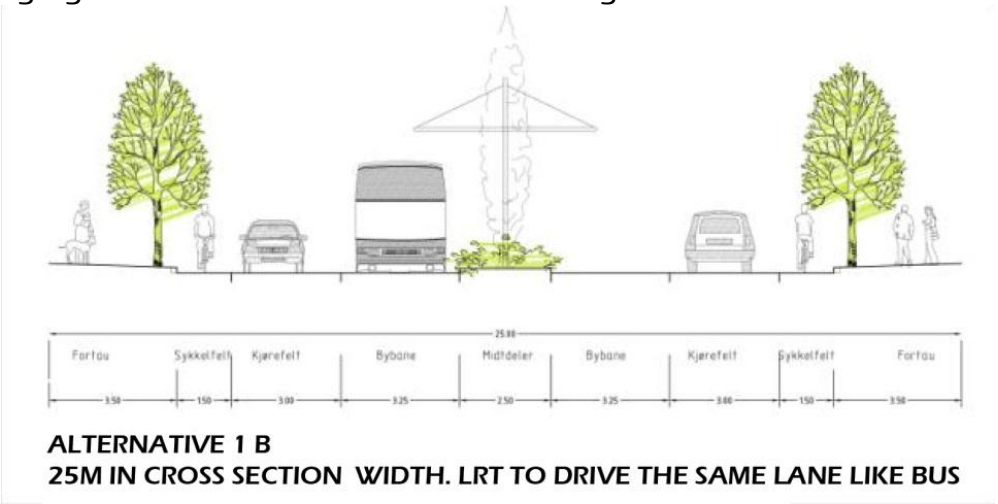


Figure 5.0.2 Alternative 1B cross section

Alternative 2

Road structure consists of a symmetrical cross section with sidewalks (2.5 m), cycle lanes (1.5 m), traffic lane (3.5 m), trees (2.0 m) and bus lanes (3.25 m). When a future LRT comes, it will use public transport lane as they are planned in this plan."

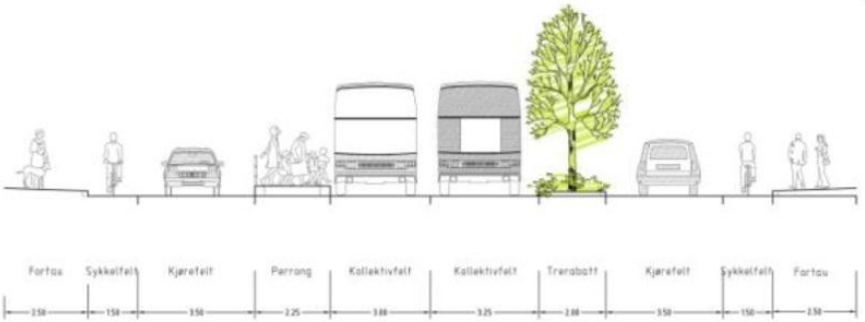


Figure 5.0.3 Alternative 2 cross section shows the four different zones of mobility. Figure 5.0.4 Alternative 2 cross section shows the boarding process

Both of the alternatives shared some measures as: main structure of the alternatives is separated lanes for each transport modes, symmetrical structure and tree raw as barriers. The road structure is divided into lanes for public transport, bikes, pedestrian and other traffics.

Alternative 1 (A and B):

Alternative one as it shows in the figures 5.0.1&5.0.2 is divided into two stages: buses, and buses/LRT. The current structure of the road is relevant for alternative 1A but the structure of Fv.44 will be modified in the arrival time of LRT. The cross section is a side single track of public transport lane for each direction, tree raw as a barrier to appear in the middle of the road. The function of the tree raw is to separating the traffic directions, other trees to be by the sides on the pedestrian sidewalk to separate pedestrians from the traffic. This cross section layout will be reformed to become a middle side public transport lanes separated in between according to directions with stops in the middle island. There will be no physical segregation along the road between the travel modes in the same direction.

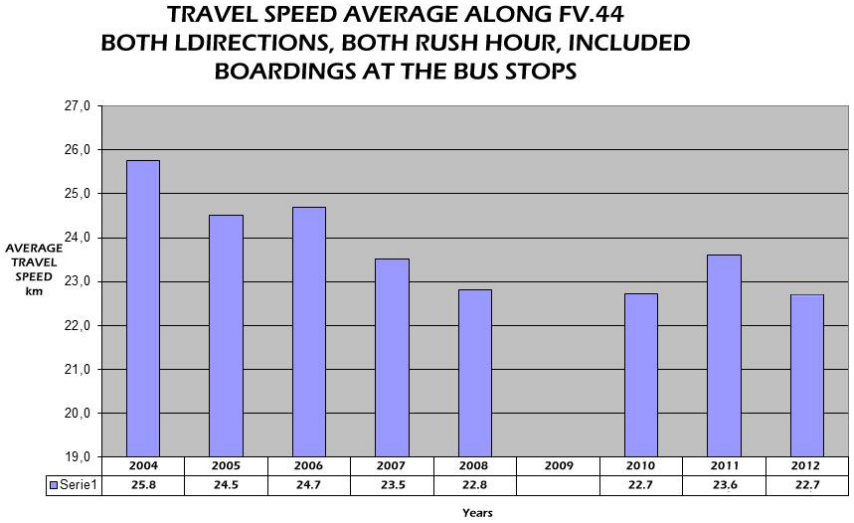
Alternative 2:

Figures 5.0.3 & 5.0.4 show that alternative 2 is one phase solution both for buses and LRT. The structure of the street is to be modified in the start of the implementation. The structure is a double middle track of public transport lane. The lane is separated from other transport modes lanes by a continuous segregation, trees as a barrier and noise reducing screen to appear by the sides of the bus lanes. No other trees to be implemented by the sides on the pedestrian sidewalk. Bikes and private transport motorized modes share the rest of the street.

5.2 Bus Travel Time at Fv.44

The Norwegian Road authority, Stavanger office has surveyed the travel time and travel distance on Stavanger-Sandnes transport corridor (Fv.44). The travel time survey results have shown the gap between the car and the buses in travel time. Morning trips from Stavanger to Sandnes showed that:

- The travel distance for buses in Fv.44 was 15.9-16.5 km and the car is 15.3-15.6 km. This increases the competition abilities against the bus for the private cars
- Taking into consideration that there is an extra travel time to be added to and from the travel time by the bus to reach the bus terminal in Sandnes or Stavanger then the bus is not in a compete position against car to travel between A to B



To the right: Figure 5.2.1 shows the travel speed average along Fv.44 both directions, both rush hour and included of boarding at bus stops. Source Norwegian Road Authority, Stavanger office

The travel speed along Fv.44 has been through increase-decrease phases during the last 8 years. The figure 5.2.1 shows that the implementation of bus lanes at 2009 slightly increased the travel speed between Stavanger and Sandnes at 2010 and 2011 but it decreased at 2012 to reach below the levels before the implementation of bus lanes.

5.2.1. Morning travel between Stavanger - Sandnes and the other way around

5.2.1.1 Morning Travel between Stavanger -Sandnes

The morning travel average speed of buses Stavanger - Sandnes is 23.8 km/h to travel 16.5 km which means the average of the travel time is 00:44:58. At the other hand, the average car travel speed is 31 km/h for 15.6 km which means the average travel time is 00:37:33.

Table 5.2.1shows the morning travel time, length and speed of the travel between Stavanger-Sandnes both by bus and car

Morning Stavanger - Sandnes Bus average	Travel time	length	km/h
	00:43:58	16.5	23.1
Morning Stavanger - Sandnes cars average			
	00:37:33	15.6	31

Bus fastest trip recorded in the survey in the morning was 35 min. and the longest trip recorded at 60 min. the travel time difference is approximately 25 min. This travel difference from a trip to another of the same route in the rush hour made the travel mode untrustworthy. This means if a passenger took the bus in the morning to Sandnes he/she might be on time at work and the other day he/she is 25 min. late. The average travel time (approximately 44min) is more close to the fastest trip than the longest one.

5.2.1.2 Morning Travel between Sandnes -Stavanger

The same trip from Stavanger centrum to Sandnes centrum in the same time by the private motorized mode recorded 29 min. and the longest trip took 43 min. The travel difference is approximately 14 min. which is almost the half of the time difference of the bus in the same time of the day between the two points.

Table 5.2.2shows the morning travel time, length and speed of the travel between Sandnes-Stavanger both by bus and car

Morning Sandnes - Stavanger Bus average	Travel time	length	km/h
	00:44:33	16.3	22.7
Morning Sandnes - Stavanger cars average			
	00:34:07	15.3	27.5

The morning travel average speed of buses Sandnes - Stavanger is 22.7 km/h to travel 16.3 km which means the average of the travel time is 00:44:33. At the other hand, the average car travel speed is 27.5 km/h for 15.3 km which means the average travel time is 00:34:07.

Bus fastest trip recorded in the survey in the morning was 39 min. and the longest trip recorded at 52 min. the travel time difference is approximately 13 min. it is lower difference than in the same trip but in the other directions. The average travel time (approximately 45min) it is in the middle between the longest and fastest trip.

The same trip from Sandnes centrum to Stavanger centrum in the same time by the private motorized mode recorded 27 min. and the longest trip took 43 min. The travel difference is approximately 17 min. The average of the trip is 34 min which is closer to the fastest trip.

5.2.2. Afternoon travel between Stavanger - Sandnes and the other way around

5.2.2.1 Afternoon Travel between Sandnes -Stavanger

The afternoon travel average speed of buses between Stavanger and Sandnes is 22.4 km/h to travel 15.9 km which means the average of the travel time is 00:42:51. At the other hand, the average car travel speed is 25.3 km/h for 15.6 km which means the average travel time is 00:37:48.

Table 5.2.3shows the afternoon travel time, length and speed of the travel between Stavanger-Sandnes both by bus and car

Afternoon Stavanger - Sandnes Public transport-Bus average	Travel time	length	km/h
	00:42:51	15.9	22.4
Afternoon Stavanger - Sandnes Private motorized transport mode average			
	00:37:48	15.6	25.3

Bus fastest trip recorded in the survey in the afternoon was 38 min. and the longest trip recorded at 46 min. the travel time difference is approximately 9 min. The average travel time (approximately 43min) it is almost in the middle between the longest and fastest trip.

5.2.2.2 Afternoon Travel between Sandnes -Stavanger

The same trip from Sandnes centrum to Stavanger centrum in the same time by the cars recorded 32 min. and the longest trip took 45 min. The travel difference is approximately 13 min. The average of the trip is 37 min which is closer to the fastest trip.

Table 5.2.4shows the afternoon travel time, length and speed of the travel between Sandnes-Stavanger both by bus and car

Afternoon Sandnes - Stavanger Public transport-Bus average	Travel time	length	km/h
	00:43:26	16.3	22.7
Afternoon Sandnes - Stavanger Private motorized transport mode average	00:35:31	15.3	26.6

The afternoon travel average speed of buses between Sandnes and Stavanger is 22.7 km/h to travel 16.3 km which means the average of the travel time is 00:43:26. At the other hand, the average car travel speed is 26.6 km/h for 15.3 km which means the average travel time is 00:35:31.

Bus fastest trip recorded in the survey in the afternoon was 39 min. and the longest trip recorded at 50 min. the travel time difference is approximately 13 min. it is lower difference than in the same trip but in the other directions. The average travel time is approximately 43min. it is closer to the fastest trip.

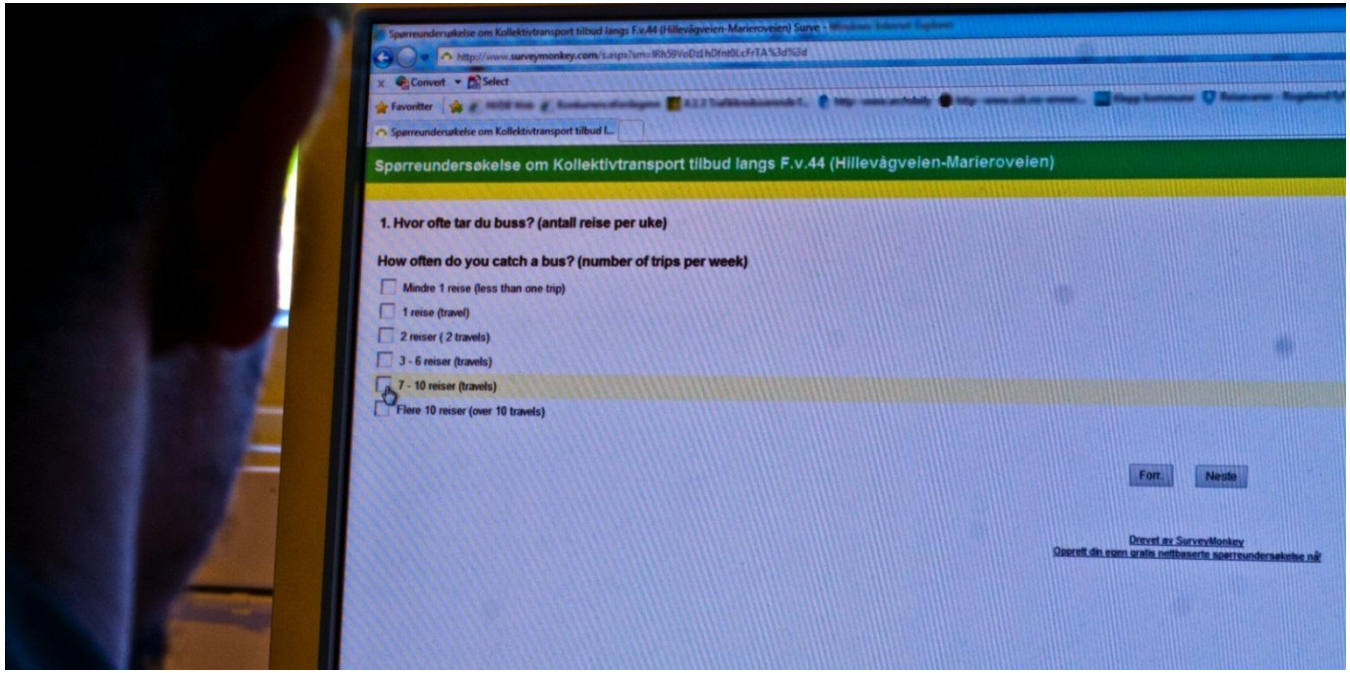
The same trip from Sandnes centrum to Stavanger centrum in the same time by the private motorized mode recorded 27 min. and the longest trip took 43 min. The travel difference is approximately 16 min. The average of the trip is 34 min which is closer to the fastest trip.

The fastest trip between Stavanger centrum and Sandnes centrum by the bus in the rush hours recorded in the survey was 36 min. while cars traveled the same trip was 27 min.

5.3 The Survey

Buses are public service and the users of this service, passengers, are an important factor in the evaluation process. The passengers' opinions might contribute to improve the service. A survey respondents' list of improving factors is a source to be taken into consideration in any evaluation /improvement /developing plans as far as the operating company aims to increase passengers. This survey indicates passengers' and public's opinions about the current bus service at Northern-Jæren and Fv.44. This survey was a digital survey and based on a questionnaire.

The questionnaire consists of 9 questions in 9 slides (welcoming page, 7 pages of questions and a thanking page at the end). Each question was in a page except questions 3, 4 and 5 were in one page because they were related to each other. It took in average 7 min to be answered.



To the right Figure 5.3.1 shows a respondent during the survey process Credits: Gamaal M A El-Attar

5.3.2 The Questionnaire

The survey consists of 9 questions. The questionnaire's mission is to question samples behaviors and opinions about the bus service in general and bus priority scheme along Fv.44 especially.

Question 1: **How often do you catch a bus?** (Number of trips per week)
The question objective is to define the sample according to their relation/behaviors to buses in general. Later in the conclusion we could use this question to distinguish the respondents of priority between: current everyday users (over 10 trips per week), current working days user (7-10 trips per week), current medium users (3-6 travels per week), current low users (1 and 2 travels per week) and potential future users (less than one travel per week)

Question 2: **Where do you catch a bus to?** (You can pick more than one)
The question defines the behavior of samples regard destinations of travel by buses. The purpose of the question is to indicate accurate destinations by buses. This might indicate if current routes cover passengers' destinations (The samples are not presenting all the passengers' destinations but it indicates it in a general picture), and where the buses might have more frequencies. The question might also indicate the future needs in field of improvements in case of new urban areas (where the routes might need to cover and where the buses might need to travel more).

Question 3: **How long is your travel time in average?** From A to B
Question 3, 4 and 5 were in the same slide because they are hanging together in coherence. The travel time (door to door) is the core of this question. The length of the travel time is a factor plays a role in efficiency of bus service. The travel time would reflect if the bus service provides long routes serving the urban sprawls of Northern-Jæren.

Question 4: **Do you have a connection in your trip?**
The travel time is linked to connections in the questionnaire. The point is to find out in case of improvement in travel time along Fv.44 how that impact in the travel time of the whole region, as far as Fv.44 is the main public transport corridor in the region.

Question 5: **How long do you wait for the bus in the connection?**
The waiting time in connections effects the travel time, especially in the rush hour. If the waiting time is long and the bus arrives late, this would not be an attractive travel mode for the passengers.

Question 6: **In scale from 1-5; what are the most important factors for you regard public transport?**

The question is about the priority of factors of bus services in the region in general and Fv.44 especially. Some factors are in relation with any operative bus service and some are in relation with a main transport corridor (i.e. bikes park and ride scheme).

Question 7: **If you have accessibility to a car, would you take the bus? Why?**
The question is about the sample behavior towards the public transport. How many people would take the bus even they have a car. The respondent's comments about this question are interesting to study.

Question 8: **How long does it take you to reach the nearest bus stop?** (From your daily journey start point)
The bus stop distance is one of the factors influences the decision to take the bus. If the inhabitants live in a place out of bus service they will have no choice than driving their own cars.

Question 9: **In scale from 1-5; which of these factors could improve the current public transport service along Fv.44?**
Question 9 is about samples opinion about what to improve in the current service. The question indicates fields of vulnerability and low efficiency service, and also it marks out fields of satisfaction by the samples along Fv.44. the samples have the choice of adding a comment or other factors if it does not exist in the list

5.3.3 Who Answered

The Questionnaire has reached out to 47 respondents. Most of the respondents fulfilled the entire questionnaire, but there are 3 respondents have answered only the first question (those 3 answers to be deleted). The questionnaire has been answered by different category of samples: students at university of Stavanger, alumni and residents along Fv.44. The students are mainly residents of the dormitory at Marieroveien at the end of the current implemented bus lanes, so those respondents are mainly experiencing the bus service and there travel to university of Stavanger must go into a connection. There are responses also from other students who live along the road Fv.44 or other places in the city.

The residents along Fv.44 have got the access to the survey by a link sent by e-mail or Facebook® groups.

5.3.4 Results

The door to door travel average time is 25-35 min, taking into consideration waiting time at bus stop between 5-10 min. this means that increasing up punctuality might reduce bus door to door travel 3-8 min. That's why when it comes to respondents' opinions; they addressed the need to improve the bus punctuality by the transport corridors as a first priority. The buses arrive late than it is scheduled in the rush hour.

The respondents addressed that they want a service that: buses arrive at the scheduled time and drive often. The prices have been rated as the third important factor, and one of the respondents wrote a comment that the prices of public transport are high (Question 9, 5.3.4); this might be in compare with the service itself. Travel time from A to B was rated as fourth. Waiting time was explained as the whole waiting time in the travel, in case of connections, and it was rated as fifth. The respondents set importance of information (was defined as: time table, digital information plate, etc.) in the sixth place. Walking distances to bus stops, comfort in the trip and bicycle measures were seventh, eighth and ninth in a raw.

The current service regularity is in need for improvements according to the same questionnaire. The regularity is basically frequencies of the service in the corridor. The respondents also pointed out another face of regularity in the comments, they mentioned that the buses are often arriving in boxes "bus crowdity", and then there is long time of no provided service. So the regularity here is about the buses frequencies both in time table (how many departures per hour) and the actual arrival time at the bus stop.

The respondents rated waiting time as third priority in improving in the public transport service. The cause behind waiting time to become foreword in the list might be the previous two points: Punctuality and regularity. If the service suffers low efficiency in those two points, this would mean indirectly that the waiting time at the start point or connections are longer than it is expected and then the accuracy of time planning for passengers relaying on public transport is low.

Travel fares and travel time were too close to each other in the rating scale of to be improved factors by the questionnaire's respondents. Travel fares were pointed out by many respondents as expensive in compare to the current service offer.

As an example: the ticket is usually used by passengers who do not have a monthly paid card, most likely because they have access to car, and they want to go to Stavanger downtown for entertainment, shopping and visiting friends. 55% of the respondents of the questionnaire pointed out that they usually take the bus to downtown for those purpose. Almost the half of

those respondents (24% of the questionnaire respondents) have access to cars but because of the restriction against private motorized transport modes in Stavanger centrum they prefer to take the bus.

Even if high rate of the responds take the bus, they preferred to own and drive their own cars to all destinations. This reflects the samples' behaviors and indicates the current mobility culture.

The survey supports the research in the importance of bus priority scheme and its impacts in the travel time. This concludes that the bus lanes are a necessity to provide better punctuality and shorter travel time. It also point out that regularity is an important factor and it is one of the main attractive point about the service. The survey concludes also the importance of changing the culture of mobility

5.4 Case Discussion Fv.44

5.4.1 Bus Priority Scheme Alternatives Evaluation

Evaluating of bus priority scheme's cross section alternatives at Fv.44 shows that alternatives 1A and 1B are poor in the method of providing bus priority scheme. Methods of providing such a priority were ignored, methods like: Solid barriers between traffic lanes, Non continuous barrier between traffic lanes, Change of height between traffic lanes, Lane markings, Surfaces that cannot be used by other traffic, Surfaces that discourage use by other traffic, Bus gate, Bus ramp, Signage, Providing lay-bys for delivery vehicles and off street parking, "Head start" traffic signaling and lane arrangements, Vehicle recognition and Vehicle charging. We could see poor implementations with only lane markings. This is a cheap-cost implementation but it is lower in efficiency. The alternative 1 A and B requires the least width of streets. Implementing the LRT in the future will have an impact in the cost; leaving the track free of barriers will lead to interruptions into the lane in the peak hours which could lead to less punctuality and longer travel time for the LRT and buses.

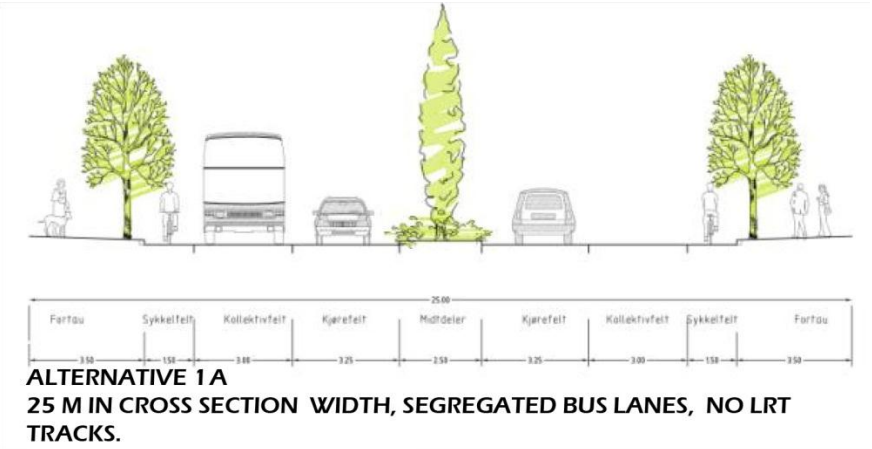


Figure 5.4.1 Alternative 1A

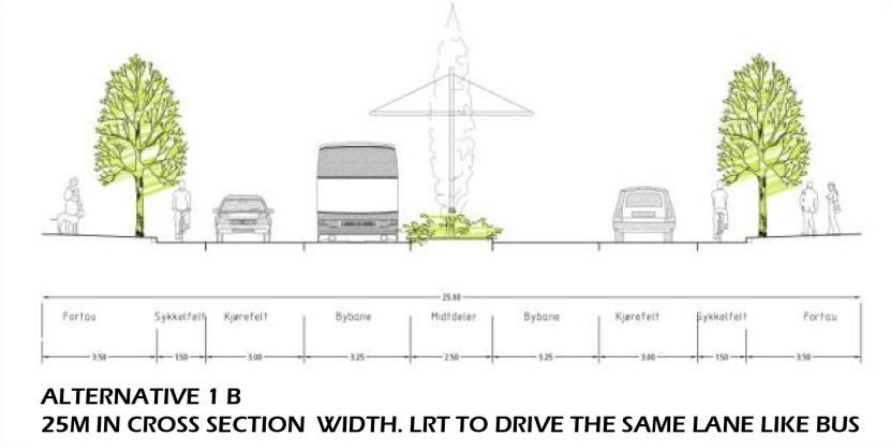


Figure 5.4.2 Alternative 1B

These alternatives (1A and 1B) could be criticized as it follows:

- Bike lane has a conflict with buses in alternative 1A at bus boarding process. This will make it less attractive for the bikers and has a direct impact on the travel time because of the speed decreasing and waiting for bikes each time the bus has to stop. This might be prevented by two different methods:
    1. Modifying the bike lane to go behind the bus stop so the bus will have a direct relation with the stops but then the bikes will have a conflict with pedestrians and passengers who want to take the bus
    2. Moving the bike lane away from the motorized lanes with segregations or barriers which will help to raise the safety feelings for the bikers

    Both solutions have to be implemented together with some pre-enters by floorscapes or signs for the bikers each time they get close to a bus stop so they slow down and give priority to passengers to reach the stops,
- Bike lane has a conflict with private motorized lane in alternative 1B each time a car will stop to load, reload, temporary parking, or emergency technical problems. Those conflicts would be added to each junction when bikers have to reduce their travel speed to give priority for cars to cross their lane
- Alternative 1 in the 2 suggestions A and B has a lack of calming down the traffic in order to give more advantage for the public transport in the travel time
- In alternative 1B there is low direct accessibility to the bus stops and the passengers have to cross 3 lanes (bike, cars and public transport to reach the stops. This process reduces the safety along a road with trees at two sides give a signal for the car drivers to raise the speed
- cars might use the public transport lane to reach the junctions faster in the peak hour and temporary parking in bus stops
- The speed of the public transport vehicles in alternative 1A will be lower than alternative 1B because of the lane position in the side instead of the middle
- The absence of barriers among the bus lanes lane had double impact as it is mentioned in the two points mentioned above
- There is neither ticketing machines nor waiting tubes (like Curitiba, Brazil). This will be counted against the public transport service as far as it will have impacts in the travel time

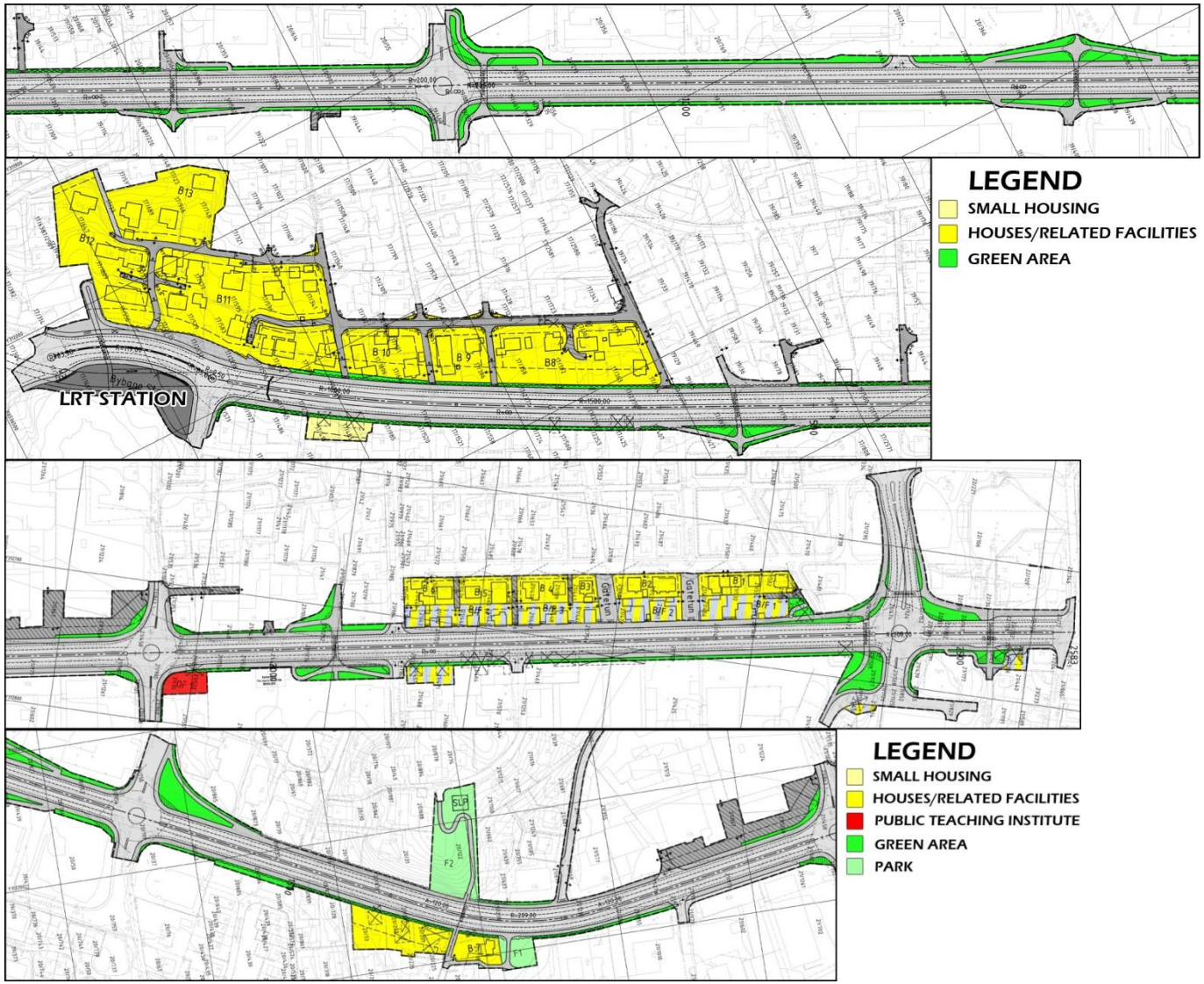


Figure 5.4.3
Alternative 1A&B
Street's layout
Marieroveien

Figure 5.4.4
Alternative 1 A&B
Street's layout
Hillevågveien &
Sjøhagen

Alternative 2 is richer in priority methods than alternative 1A or 1B; still that does not mean that there are great divers of methods. The proposal of alternative 2 suffer luck of either bus gates to prevent cars from driving into the bus lane, bus ramp, signage, surface that cannot be used by other traffic, or surface that discourage use by other traffics. There is a 0.5 m modification of the width of the street in the cross section. The trees raw have been moved from middle islands and sidewalks to the side of the bus lanes; the trees main function is to reduce noise but it building a visual barrier as well. The following figures **** and ***** show the street section of alternative 2(to the right along the road when bus is driving and to the left it shows the relation to bus stops)

Figure 5.4.5 Alternative 2

This alternative could be criticized as it follows:

- Passenger's direct accessibility to the middle lines is low and is limited by the pedestrian crossings along the Fv44. There are many methods used to secure accessibility for passengers without meeting traffic like ramps under and over the streets but this solution reduces the pedestrian circulation speed and could be considered as unsafe passages for the ladies in the night
- High speed vehicles in the bus lanes will cause noise along the road. The trees in the barrier would reduce the noise but it is not enough. The noise report by Norwegian Road Authority, Stavanger office recommends implementing noise reducing screens in 4 different places after a noise analysis

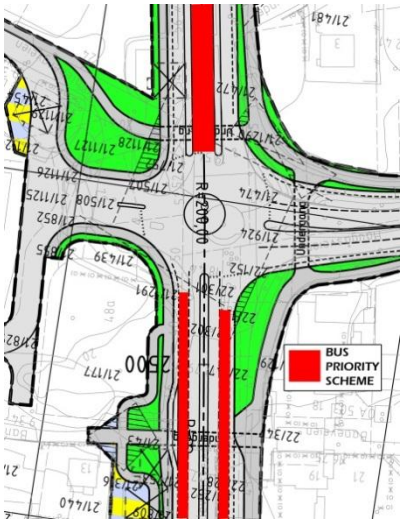
- Trees will act as a visual barrier dividing the street into 3 zones. The barriers will contribute to isolate the two sides of Fv.44 and might cause a visual distortion and limited road visual size. The plans also included many tunnels to connect the two sides and one landscape bridge to secure accessibility of the two sides but those tunnels has no accessibility to the bus lane
- There is neither ticketing machines nor waiting tubes (like Curitiba, Brazil). This will be counted against the public transport service as far as it will have impacts in the travel time

Evaluating bus priority scheme's street layout alternatives at Fv.44 we could find out that the street plan for alternatives 1(A and B) and 2 published by The Norwegian Road Authority, Stavanger office shows two different locations of bus lanes along Fv.44 (side and middle tracks). The bus might suffer a delay at shifting lanes and at the roundabouts (Figure 5.4.7).

Neither lane gates, lane ramps either unfriendly floorscapes are implemented. The lane's entrances are open and not restricted against cars. Those absences would lead for some cars to drive into the bus lane; although the lane markings along the two planned areas are poor, they might cross the street carelessly which might cause accidents. So it is recommended to have a traffic signal stopping the traffic in the road as far as the bus is in the range of the bus stop.

Calming down the traffic schemes were discussed in the Risk and Vulnerability analysis of bus lanes implementing in Fv.44 by pressing the motorized and non-motorized transport modes in the bus/LRT stops, but this disappeared from the plans' layout.

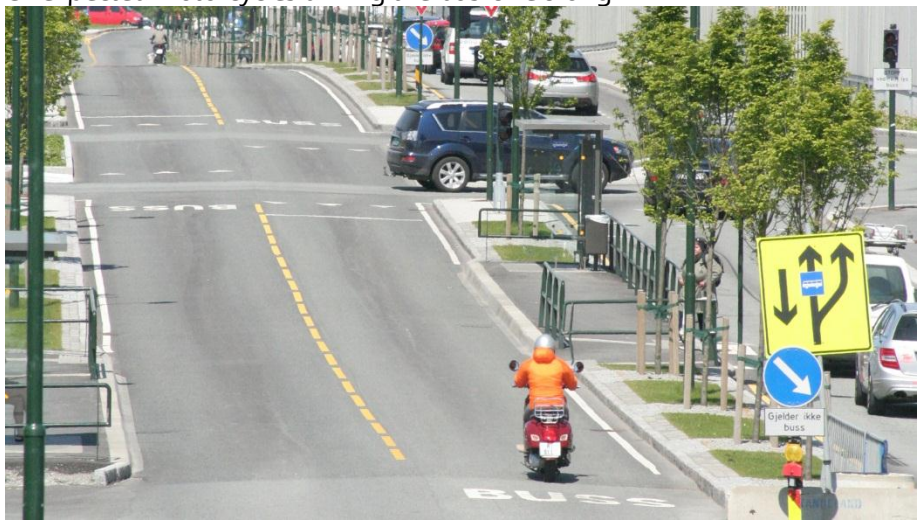
To the top: Figure 5.4.6 Bus stops along the Bus Rapid Transit system, Curitiba, Brazil. Credits: Mario Roberto Duran Ortiz



To the left: Figure 5.4.7 the shifting between middle to side bus lanes along Fv.44 Hillevågtorget.

Unexpected veicle driving through the bus lane along Fv.44

Unexpected motorcycles driving the bus lane along Fv.44



Passengers unexpected behavior at the arrival or departure of the bus

Pedestrian crossing the bus lanes

All pictures credits are for: Gamaal El-Attar

5.4.2 Junctions and Crossing Bus Priority Scheme

Fv.44's junctions and crossing structure relays on roundabouts than traffic signals. Junctions with no priority for bus cause low punctuality, and longer travel time. Rush hour analysis at 2008 by Norwegian Road Authority, Stavanger office rated Fv.44 bus delay as "Significant". The figure **** shows the delay percentage of the total trip in each area along Fv.44. There are no data offered about the current delay after the new bus priority scheme. The red line indicates 100% delay in travel time in the section, blue is 50% and green means no delay. Along Fv.44 from Stavanger Centrum to Sandnes Centrum there are two street sections with 50% delay and the rest of the road is 100% delay. This information might not be relevant in the sections where bus lanes are implemented bus the whole bus lanes length is 26% of the whole street.

One of the current roundabouts among Fv.44 is implementing bus priority in the main junctions. The bus lane crosses the roundabout in the middle instead of joining the cars movement. This solution based on the proposed alternative two where the bus lane is in the middle of the street and segregated from the other travel modes in the road. There are more to tell, the roundabouts has a traffic light to stop the cars to give priority in crossing to buses.

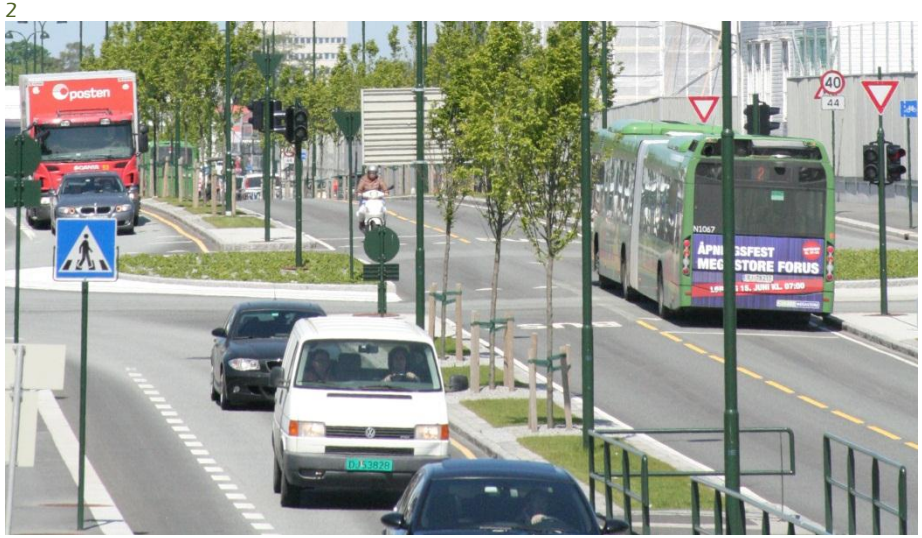
The layout shows different methods of connecting the sides of the road with each other's and with the bus lane. The connection methods are pedestrian crossings and tunnels; however the tunnels are only used to connect the two sides with no access to the bus lane. Some pedestrian crossing is supported with traffic signals, in order to increase the safety, and most of them are without signaling. In the figure **** it is showed the communication method from the two sides of Fv.44 and the middle bus lane.

To the left: Figure 5.4.8 Fv.44 recorded delay time percentage by Norwegian Road Authority. Source: Norwegian road authority
Red: 100% delay of the expected travel time
Blue: 50% delay of the expected travel time

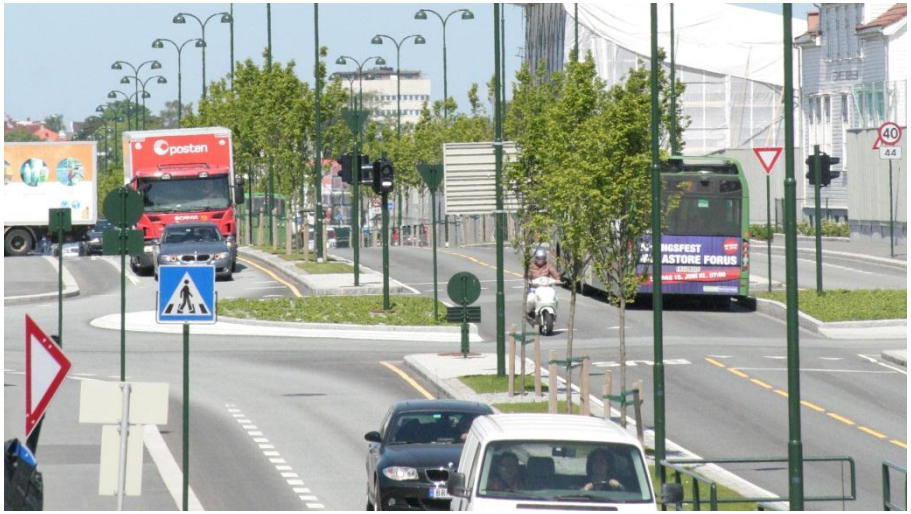
Figure 5.4.9 Bus priority scheme at a junction along Fv.44 All pictures credits are for: Gamaal El-Attar

1

2



3



4

To the bottom: Figure 5.4.10 shows the relation between the two sides of Fv.44 by pedestrian crossing and tunnels. Credits: Bing Maps, 2013

To the top: Figure 5.4.11 Bus priority scheme roundabout along Fv.44 Hillevågveien section Credits: Bing Maps, 2013

5.4.3 Door to Door Travel

The travelers usually are not moving from the Stavanger centrum to Sandnes centrum. There are other trips to be counted from the start travel point (home as an example) to the bus stop, waiting time at bus stops and waiting time at connections, if there is any, travel time in the bus and finally the walking time from the bus stop to the final destination. The cars travel is simpler; it travels directly from start point to the end time.

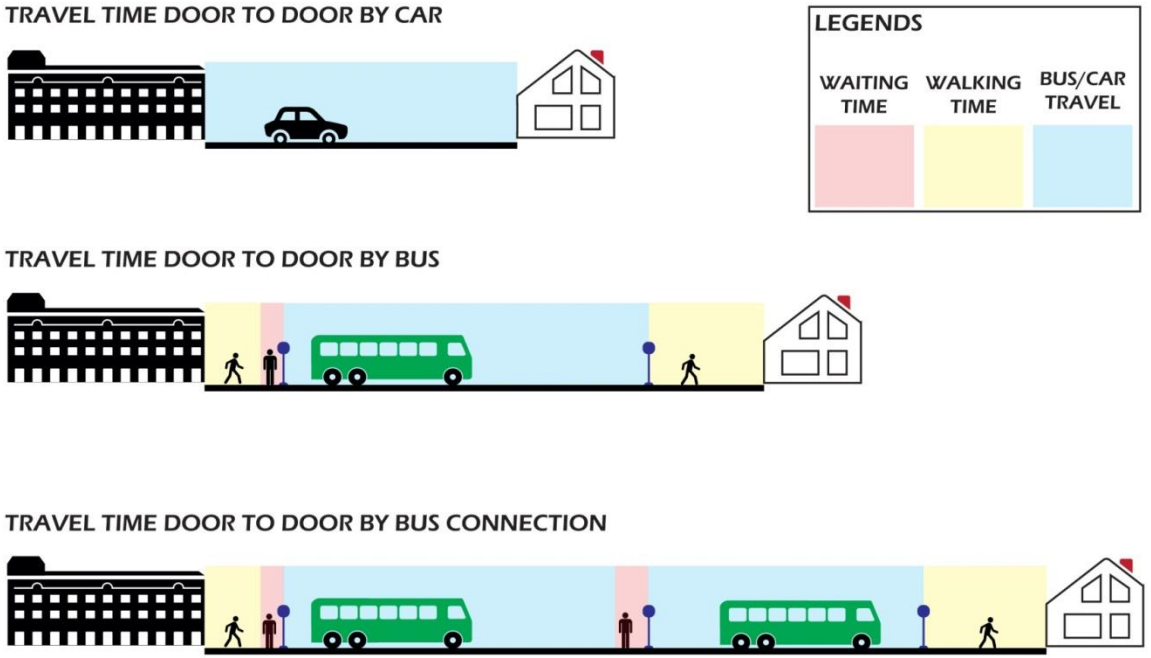
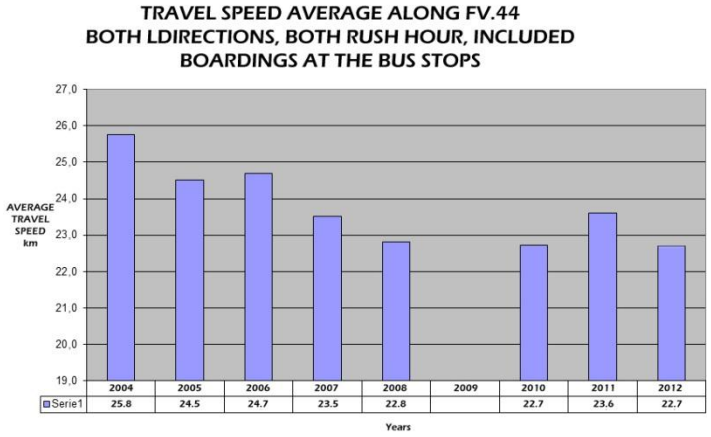


Figure 5.4.12 Travel time distribution between driving (riding) waiting and walking time among travels by car, direct bus and connections

In light of the previous explanation, there are 4 main elements in door to door travel: distance to bus stop, waiting time(s), boarding, and bus travel time(s). The bus priority scheme effects on: Travel time and waiting time. Those two elements will be discussed first under this section. The other two elements are independent from the scheme, still they effect the door to door travel time.

5.4.3.1 Bus Travel Time along Fv.44

The peak hour travel time lately (2012) has been decreased under the level before any implementation of bus lanes. The travel speed decreased after couple of years (2010-2011) slight increasing. This might be a result of increase of the users along the line (longer boarding time), the increase of cars on the street at peak hour, and construction of the landscape bridge over Sjøhagen and building the street lanes at Mariero. This fact is against the theory of implementing a bus lane will increase the travel speed and attract travelers. A look into the number of passengers in the region we could see that passengers' number decreased by 2011 in the same year the travel speed increased, at year 2010 the travel time slightly decreased while the passengers increased.



To the right: Figure 5.4.13 shows the travel speed average along Fv.44 both directions, both rush hour and included of boarding at bus stops. Source Norwegian Road Authority, Stavanger office

Table 5.4.1 shows the bus annual travel length per residents in regions of Oslo, Northern-Jæren, Bergen, Trondheim and Tromsø

	2007	2008	2009	2010	2011
Oslo	94	94	101	112	114
Northern-Jæren	65	61	64	66	63
Bergen	91	88	84	83	99
Trondheim	91	93	95	101	103
Tromsø	107	106	103	108	112

The bus travel time along Fv.44 is an important factor in improving the door to door travel along the road and the whole region. In the rush hour, the bus travel time is 2/3 of the travel speed of cars in the route along the road; in other word the car travelers save 1/3 of the bus travel time in addition to walking and waiting times. So decreasing travel time is a priority to achieve more competitiveness against cars. The bus priority scheme contributed a slightly faster bus travel[35] in peak hour along Fv.44.

5.4.3.2 Waiting Time along Fv.44

Bus priority buses contributed in a shorter travel time in peak hour along Fv.44, which support higher punctuality in the service. Despite the fact the lack of any waiting time survey along Fv.44, but the shorter travel time contribute in reducing waiting time were because the bus arrivals and departures are closer to the scheduled time.

5.4.3.3 Bus Stop along Fv.44

The short distance between bus stops create possibilities and options for the passengers live along the Fv.44; however these small distances have disadvantages by causing delay in the travel time because of many boarding stops along the trip. The short of information platform, weather protection, bicycles parking and ticketing machine.

5.4.3.4 Bus Boarding along Fv.44

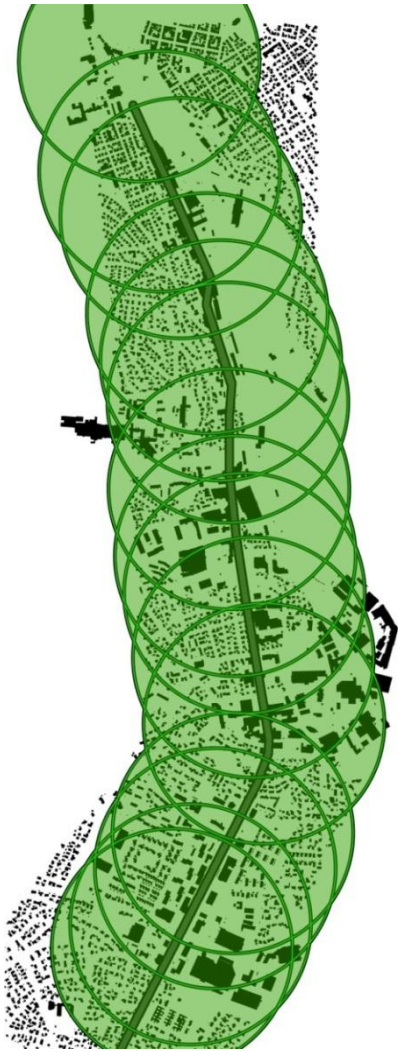
The boarding along Fv.44 and the whole region are less accurate than in other places and there are many opportunities to develop it. As it was mentioned before the ticketing system and bus stops in the same level like the bus doors would subside to shorter boarding.

35 Referring to 5.2 Bus travel time

5.4.4 Bus Stops

The bus stops cover in a good range the bus lane in Fv.44. the bus stops are located in the range of 173m to 458m. This length between bus stops make more possibilities and options for the passengers live along the road and make the bus stops cover looks like a buffer zone instead of separated circles; but it has disadvantages if we consider that it cause delay in the travel time because of many boarding stops along the trip.

Bus stops along Fv.44, and the whole region, are poor in the provided information for passengers waiting for the bus. There is no more information provided by the stop than the scheduled arrival time of the bus. There is not digital screen informing about the arrival time, delays, or even showing the time. Some bus stops are in short of weather protection. The region is known as a rainy area and the not all the stops along Fv.44 are with a roof shelter or it is designed/located in the wrong direction with the rainy wind. This contributes into fewer passengers in the bad weather occasions. The stops at Fv.44 and along the whole region are in lack of ticketing system. This reflects on the boarding stopping time and travel time. The stops along Fv.44 suffers from short of bicycles parking although that this is the main transport corridor in the region. Some main stops are not enough at the rush hour, and passengers could wait out of it, this would be even worst with the weather disruption above.



To the left: Figure 5.0.14 shows bus stops buffer zone of 500 m along Fv.44 between downtown and Marieroveien

5.4.5 Future improvements in bus service along F.v.44

In light of understanding the previous case discussion, Travel time is an important factor with impact on bus service competence. Punctuality, bus travel time and boarding are in short of efficiency in the rush hour at Fv.44. thus the first priority is to apply bus priority scheme on Fv.44 to increase the punctuality and reduce travel time. Boarding needs improvements in many levels like: the bus stops formation (in the same level like the bus and connected to the bus by a ramp), ticketing machine (to be located in the bus, in the bus stops, Kiosk and daily shopping stores) and bus doors. The following aspects of public transport in Jæren tend to diminish the possibilities of achieving higher public interests:

- Travel times compared to most destinations and over longer distances are not competitive in terms of traffic. It often takes twice as long by bus as by car[36]. Buses remain in the same queues as cars.
- Lack of prioritization of public transport in the major corridor routes through the inner parts of the downtown area are occasionally cause significant delays, i.e. in Klubbgata and Verksgata in the Stavanger centrum and Oalsgata in Sandnes.
- The organization of the operation of bus service, such as the stop structure and time consuming ticketing tend to diminish travel time fraction.
- Lack of regularity and safe transition bus / bus and bus / train. This is due to congestion situation of public transport, especially in the morning rush hour, causing problems for the transition between different bus routes and bus / train.
- Insufficient information (especially in not regular situations).
- Partly worn and inadequate infrastructure, i.e. Size and standard stops and terminals. For example, most stops in Stavanger waiting shed with insufficient capacity and inadequate protection in bad weather.

The frequency of bus trips is an important factor for improving bus service. The passengers would prefer more alternatives to reach one place. More frequency means more buses drive the same route, so if a passenger misses the bus, he does need to wait one hour before the next departures. Also under Frequency the importance of shuttle buses between Fv.44 to main destinations and urban cores of the region. Buses stops in specified stops instead of every single stop along Fv.44. Routes, as well, are in need for improving to reach working places in Forus and other commercial parks.

[36] Look at Public transport travel time survey by The Norwegian road authority annex III

Information has to be presented in a higher rate in the stops, inside the bus, internet, and the social media. The bus stop needs digital plates showing when the bus arrives and if there is any delay and the new expected arriving time. Inside the bus there is a need for a route plan, and information of the delay and peak areas and alternative routes for jamming traffics.

A trip planer is also helpful application for smart phones and internet users. This service enables the public transport passengers to set the right way to travel through real-time and accurate information to determine the most accessible bus route according to the passenger's location, destination and trip time. Such a service allows passengers to see the schedules trips (Buses, train, boats) through the website, As well as the ability to print a copy of these tables and the ability to print maps of Routes planned by the client after the necessary information Where the date and time. Passengers can also access through the service on the actual time of arrival of buses, and any person shall be entitled to use the service. The client can see through this service to all locations in Northern-Jæren attractions and locations of the customer service centers of service operator, Kolumbus recently, and all the street names and area name at the region.

One of the recommendations to get it out from the survey is there is a good amount of passengers who take the bus for downtown in the evening and weekends. The current service is going low in the evening and weekends ignoring these passengers. This might lead them to take a taxi instead of walking to a bus stop where the service is low in frequency and punctuality.

6.0 Results, Discussion, Conclusion

The chapter 6 is to deliver the final word of this research, results for the whole research, discussing it and the reflection of those results, conclusion and recommendations.

6.1 Results

Northern-Jæren region is rapidly growing in the population, business and mobility. The current mobility pattern is highly based on car mobility. The car mobility accuses long queues at peak hours beside its effects on the greenhouse gas emissions. The current situation and actions of the local administrations among the four cities of Northern-Jæren challenge the long-term regional plans for Jæren and the transition towards sustainable mobility.

The transition process faces different challenges at different levels. The transition management suffers luck of integrated plans of land use and transports accuse double faced plans and conflicts. The plans are not enough and there is a need to do more.

The bus priority scheme at Fv.44 provided two years of improvements in travel speed in the corridor (2010-2011) and then the travel time sink again at 2012. The travel time influenced the passengers' numbers after the implementation of the bus lane. The passengers' number increased up but the service has not cope with the new growth, thus the passenger number decreased again. The middle bus lanes according to the evaluation are the best of the three alternatives studied by the Norwegian road authority, Stavanger office. The count against point could be improved in the future through the practice. It is hard to present a full package solution without experiments. The previous experiments have to be evaluated, as this research does, and to solve the negative and improve the positive measures. Bus priority scheme is an important factor in transition towards sustainable mobility at Northern-Jæren; however the implementation of bus priority scheme is not enough. There should be more actions towards the cars mobility to attract the travelers towards sustainable mobility.

The bus passengers suffer from the lack of routes to their destinations, frequency and punctuality in the service. The routes and frequency is not related to bus priority scheme and it would not be improved by the current plans.

The coming land use policies have to be integrated with transport plans and have to reach the win-win situation by offering high dense corridors for public transport (the new population and business growth to be located along transport corridors instead of commercial parks) and the bus service will offer better efficient among travel time, frequency, and routes to function as urban development tool in the future.

6.2 Discussion

Northern-Jæren region, as it was described, has rapid growth and potential growing rates in population, labor forces, working places and urban mobility. Meeting current situation, growths and mobility pattern to the plans of transition towards sustainable mobility is a challenge.

The foregoing presented results of the research proved that the theory of the research is applied. Integrating land use and transport policies is an important key to achieve transition towards sustainable mobility. This integration would reflect also actions towards cars accessibility and parking policies to the attractive destinations. Management of the transition is complicated in general and it is more complicated at Northern-Jæren. The absence of integrated urban plan for the region and the divided responsibility in different levels (National, regional and local) affects in increase the policy conflicts. Also the results proved the point at transition of mobility pattern is not a one-step plan, but it is a long term commitment consists a non-stop sequence of experiments and evaluation of each experiment. One more theory have been proved, there is no such a way to expect people reactions towards transition in a society and there is no certainty that implementing bus priority scheme only will secure transit towards sustainable mobility

Transition management of the process at Northern-Jæren shows the lack of one integrated vision of the region as a first aspect. The leadership of the process had high expectation from one step experiments, to increase the passengers but the transition process is a long term commitment.

Plan integration between land use and transport is missed. The plans to raise the density in the public transport corridors are in conflict with building two new cities: Sandnes Øst and Bybåndet Sør. The land use plans in the cities and car accessibility to attractive destinations are not integrated with the vision of the region. The different level of planning and implementing plans accuse such a conflict.

Transition process in the region took only a first phase (the bus priority scheme) and might be extended to the whole region but the transition plans usually are poly-phases. The sequence of the experiments in the transition is a key-role process towards sustainable mobility and evaluation the experiments are other key-role. The sequence of transition experiments towards sustainable mobility took other cities around the North-Europe (i.e. Copenhagen and Amsterdam) between 30-50 years to be achieved.

People culture and behaviors are one of the hard factors to guess and expect in transition process in general. Transition towards sustainable mobility is even harder and more complicated. The social and cultural aspects of the public play a role towards their responsibility but according to practice from other cities, if the public got a choice they could not move to the other mobility.

In accounting the previous statement we can understand that the bus priority scheme is important factor but it might never secure, alone, the transition process towards sustainable mobility. Still the bus priority scheme is building the foundations for efficient bus transit.

So, bus priority scheme could be used as a tool for city developments as sustainable mobility transition or what could be called: *"Kill two birds with one stone".* This would never be achieved unless the regional and municipal administrations engage into a long term commitment for sustainable mobility transition. This commitment would be interpreted in plans to stretch the bus priority scheme over all the region's bus corridors supported by policies to reduce the car use and accessibility. This low accessibility for cars in centrums and attractive destinations in parallel with improving all the factors of bus service might contribute in lifting the bus competitiveness. Then, transition of sustainable mobility would start. Still as it is mentioned the mobility culture has to be changed by encouraging and educating.

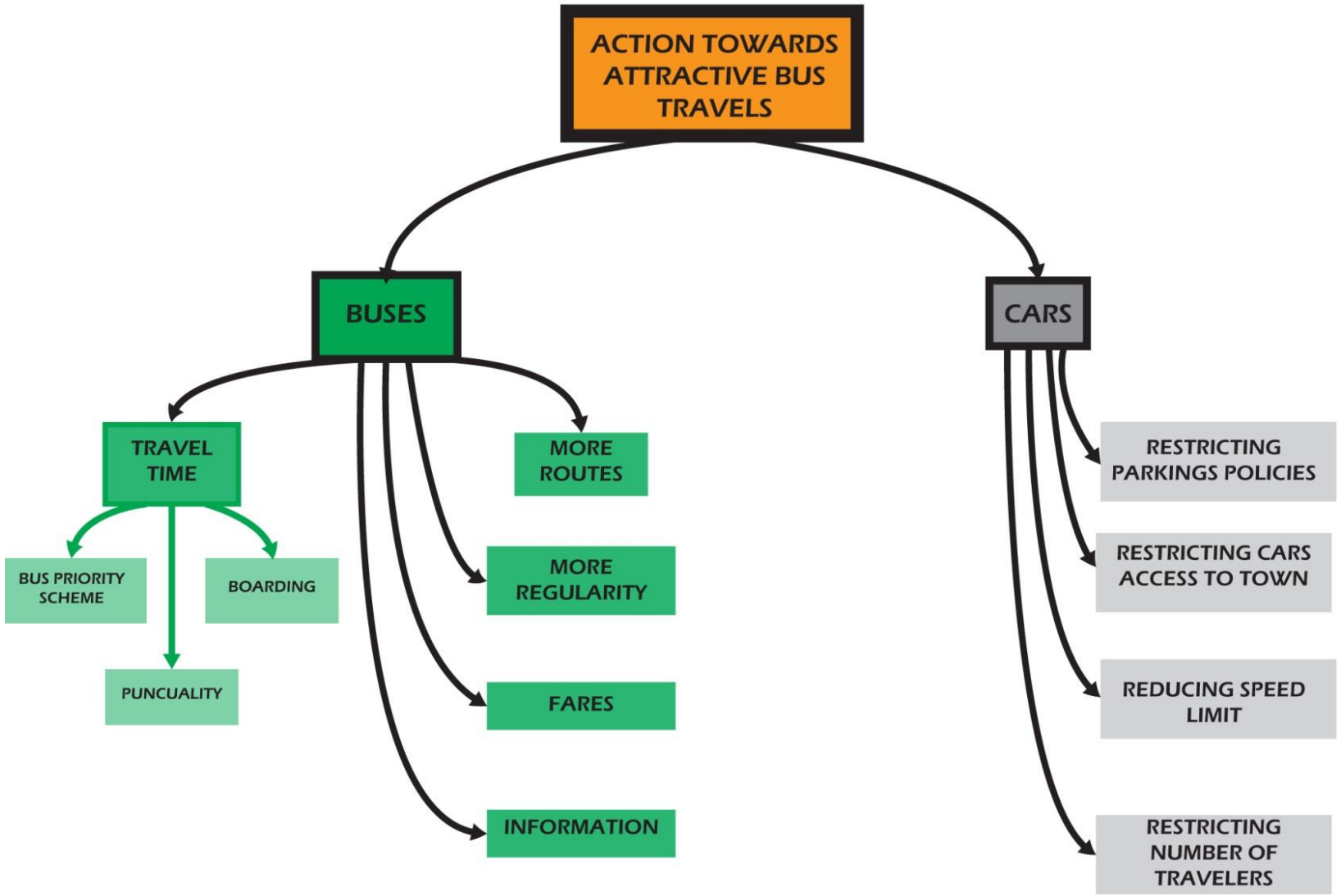


Figure 6.0.1 shows the distribution of process towards transition of mobility for more sustainable mobility

6.3 Conclusion

The main public transport corridor of Northern-Jæren is Fv.44 and it holds approximately 50% of bus travel volume during working days, hence improving the service at Fv.44 impacts bus service in the whole region. The current queues at peak hour show a need for a better transport schemes along Fv.44. As shown, the bus priority scheme improved the travel time along bus lanes at the start of the implementation. The lack of coping with the increase of the passengers contributed negatively to decrease passenger. So it encourages stretching the scheme the whole way between Sandnes and Stavanger but with providing better coping policies towards passengers' needs.

On the basis of these local findings on significant road sections, this scheme might be implemented with similar results on regional basis. This is because the scheme secures that buses skip the queues. Also bus priority would obtain higher bus punctuality, in arrivals and departures, and faster trips along the sections and therefor improving its competitiveness against cars.

By increasing the competitiveness against cars, region mobility might move in the direction of more sustainable mobility at Northern-Jæren. To achieve this, there should be applied two parallel processes: Improving bus service and restricting policies against cars. Improving the bus service starts with faster punctual trips, more routes to cover passengers' destinations, higher frequency, cheaper fares, better provided information and bigger buses capacity at peak hour. To restrict cars on the road you have to limit the number of parking lots, reduce accessibility to attractive destinations (free car zones and limited car hours), lowing travel speed limit and bound number of travelers in the vehicle.

This study revealed a small part of the whole picture. The limitation in range and applicability of the thesis would mark the necessity for further studying the rest of the parallel process mentioned above. Further studies would help to achieve better transition towards sustainable mobility through evaluating the phase and implementations.

Recommendations

Through the current/future situation and challenges understand foundation, and in cooperation with the focus study of Fv.44 I hereby recommend:

- Regional new integrated land use-transport policy. The new plan phase to re-regulate the whole land use plans according to a land use transport policy for Northern-Jæren. The new policy has to concentrate the coming population, working places and service along transport corridors.
- Transition towards sustainable mobility
    - Actions towards more efficient bus service: higher frequencies routes with shuttle buses in the rush hour, expanding routes to reach all the attractive destinations, smart phone and internet application to provide information, trip planner and digital ticketing, cheaper fares for traveling and more discount campaigns and more collective mobility to service companies in Forus with discount and could drive the bus lanes
    - Actions towards cars confining policy to support the bus competitiveness and encourage the public to transit their mobility towards environment friendly. Actions like: limit the number of parking lots, reduce accessibility to attractive destinations (free car zones and limited car hours), lowing travel speed limit and bound number of travelers in the vehicle
    - Public culture and education the research survey and other sources confirmed the need for efforts to be done towards the public to convince them about the importance of the public transport and the problem of greenhouse gas emissions.
    - Management of transition process needs a revision and evaluation. There is a need to gather the responsibility in one unit to work towards sustainable mobility transition. The unit to provides evaluation in annual reports and actions every 3rd year for example
    - Further studies and following up for the situation and transition process. The coming studies have to follow up first with the coming bus priority schemes along Fv.44 and to evaluate the experiments, other studies to study confining the cars confining impacts on the transition process. I would like to study confining cars impacts on the transition towards sustainable mobility at Northern-Jæren.

References and Bibliography

(2010). Travelers into: Sandnes, Stavanger, Sola and Randaberg.

AS, F. N. (2012). "Forus Næringspark AS." Retrieved 02.04, 2013.

Authority, N. R. (2010). "R&V report."

Authority, N. R. (2012). "Transport volume." Retrieved 02.03, 2013.

Berg, T. (2006). RvU Rogaland: 34,36 and 37.

Undersøkelsen er basert på telefonintervjuer med i alt 7500 personer som var 13 år eller eldre ved intervjutidspunktet. Innholdsmessig er 2005-undersøkelsen i hovedsak lik 1998-undersøkelsen. Realisert reiseatferd er vektlagt i form av spørsmål om respondentenes reiser dagen før intervjudagen. Når en sammenligner kjennetegn ved utvalgene i 1998 og 2005 er det særlig den høye inntektsveksten i løpet av disse 7 årene som er framtredende. Dette, sammen med høy befolkningsvekst, utgjør viktige rammer for utviklingen i regionens tilgang til transportressurser, reisemønster og reiseomfang. Resultatene når det gjelder tilgang til transportressurser viser en moderat økning i førerkortinnehav og en kraftig vekst i bilhold representert ved en 10 % økning i andelen husstander med eie/tilgang til mer enn 1 bil. Endringene fra 1998 til 2005 varierer i ulike grupper av befolkningen. De viktigste resultatene i så måte er den utjevningen som er på gang mellom kjønnene ved at veksten i kvinners biltilgang er størst, og det generasjonsskifte som er på gang med tanke på kraftig vekst i biltilgangen blant de over 60 år og en klar reduksjon i førerkortinnehav blant de under 30 år.
Økt inntekt, økt førerkortinnehav og økt bilhold har resultert i en klar økning i befolkningens biltilgang. Dette viser også igjen i økt reiseaktivitet i regionen. Gjennomsnittlig antall reiser pr person har steget fra 3,6 til 3,8, og fordeling på ulike transportmidler viser at mer bilbruk forklarer det meste av denne veksten. Vekst i sykkelhold og en svak økning i bruken av sykkel bidrar likevel også til noe av den økte reiseaktiviteten. Bruken av kollektivtransport er noenlunde stabil, mens derimot nedgangen i turer til fots er foruroligende og så markert at den tilsvarer en reell nedgang tross en befolkningsøkning på rundt 10 %. Fordelingen av reiser etter formål tyder på at flere arbeidsreiser er av stor betydning for den totale økningen i reiseomfang.
Reiseaktiviteten i ulike grupper av befolkningen speiler delvis endringene i tilgangen til transportressursene. Menn reiser ikke mer enn i 1998 og det er kvinners økte mobilitet som dermed forklarer all den totale økningen i det regionale reisevolumet. Aldersfordelingen viser igjen tegn på et generasjonsskifte, med synkende mobilitet blant de yngste og kraftig økende mobilitet blant folk over 60 år. Geografisk ser en bl.a. at Sandnes og Sola passerer Stavanger og er de kommunene med høyest mobilitet.
Bilbruken stiger i de fleste grupper og er klart høyest blant menn, middelaldrende, grupper med høy utdanning og grupper med høy inntekt. Kvinner og yngre bruker kollektivtransport oftest, og disse transportmidlene har sammen med turer til fots også en klar lavinntektsprofil. Sykkelbruken er høyest blant de aller yngste, men i motsetning til de andre transportmidlene eksisterer det for sykkel ikke et skille basert på inntekt. Det er også betydelige geografiske forskjeller i hvordan reisene fordeler seg på de ulike transportmidlene. Bilbruk til jobb er klart høyere i Sandnes enn i Stavanger og de andre kommunene (slått sammen). Kollektiv- og sykkelbruk til jobb er derimot mye lavere i Sandnes, og sykkelandelen i Sandnes er faktisk bare to tredjedeler av tilsvarende andel i Stavanger. For reiser generelt, ikke bare arbeidsreiser, er det et tydelig skille mellomStavanger og resten. I Stavanger er det en klart større andel fotturer, men samtidig har reduksjonen i fotturer fra 1998 vært mye kraftigere her. Også for bilturer er nivåforskjellen mellom Sandnes og Stavanger markert, og selv om økningen er større i Stavanger er det fortsatt en stor avstand opp til samme bilturandel som i Sandnes.

Kollektivreiser utgjør en større andel av reisene i Stavanger og består hovedsakelig av bussreiser. Båt og tog har naturligvis en større andel utenfor Stavanger. Totalt sett tegner undersøkelsen et bilde av en forskyvning fra reiser til fots og over til private, motoriserte transportmidler. Forskyvingen kombinert med økningen i reisevolum siden 1998 antyder at den delen av økt biltrafikk i regionen som ikke er knyttet til befolkningsveksten er et resultat av både økt reising som trend på tvers av transportmidler og skifte av transportmidler.

Bertolini, M. t. B. o. a. L. (2009). A Transition Towards Sustainable Strategy Making: Integrating Land Use and Transport Knowledge Types

Copenhagen, C. o. (2013). Copenhagen Bicycle report 2012. Copenhagen, Denmark, Copenhagen municipality. 1: 9.

Enviornmnet, M. o. Retrieved 05.03, 2013, from http://www.regjeringen.no/en/dep/md/Selected-topics/planning.html?id=1317.

FDP (2000). "Fylkesdelplan for langsikt utvikling på Jæren." 1(1): 11.

Fuglestvedt, I. (2009). Phenomenology and the pioneer settlement on the Western Scandinavian Peninsula

Government, U. (2008). Planning Portal Glossary.

Herzog, T. (2009). World Greenhouse Gas Emissions in 2005. WRI Working Paper. Washington, DC, USA, World Resources Institute (WRI): 2.

Jacco Farla, F. A., Roald A.A. Suurs (2010). "Analysis of Barriers in the Transition toward Sustainable Mobility in the Netherlands." 1260–1269.
The transition toward a sustainable transportation system in the Netherlands takes place in the context of the Dutch "Transition management policy framework". We study four technological routes that the "Platform Sustainable Mobility" has selected for this goal: (1) hybridization of vehicles, (2) liquid biofuels, (3) natural gas as a transportation fuel and (4) hydrogen as a transportation fuel. These technological routes all envision large-scale changes in vehicle propulsion technology and fuel infrastructure. Furthermore, they compete for the scarce resources available to invest in new (fuel) infrastructures, which implicates that these 'transition paths' are also interdependent at the level of the mobility system. The main outcome of the analysis is the identification of barriers that are currently blocking the transition toward sustainable mobility. Barriers are classified as being related to (1) technology and vehicle development, (2) the availability of (fuel) infrastructures, and (3) elements of the institutional infrastructure. The transition management framework currently misses guidelines for coping with (competing) technologies that each require large infrastructural investments. We further argue that avoiding undesired lock-ins and creating a beneficial institutional context for sustainable mobility cannot be pursued at the transition path level. Therefore, we recommend that a more systemic approach should be taken to the transition to sustainable mobility, in which the interdependencies between the transition paths are critically assessed and in which the possibilities to legitimize sustainable mobility as a whole should be used.

KVU (2009). "KVU." 1(1): 16.

KVU (2009). "Transportsystemet på Jæren med hovedvekt på byområdet." 16.

Liva Vågane, I. B., Randi Hjorthol (2009). National RvU. Oslo, Norway, TØI. 1.

Lynn Devereux, R. v. d. B., Ian radbone (2005). HiTrans Best Practice Guide.

Municipality, A. (2009). Aarhus municipal plan 2009.

Municipality, S. (2010). Climate and Energy Plan, Stavanger Municipality: 8.

Municipality, S. (2010). Climate and Energy Plan, Stavanger Municipality: 9, 11, 15.

Municipality, S. (2010). Sola Municipality Climate and Energy Plan. saks nr 09/76 sak 100/10, .

Municipality, S. (2010). Stavanger Climate and Energy Plan 2010-2025, Stavanger Municipality: 8.

Municipality, S. (2012). Retrieved 11.06, 2013, from http://www.stavanger.kommune.no/publikum/Divsvg.nsf/SVGbyhistorie/3952B80210417C4EC12568E30035DD1D?OpenDocument&referer=byhistorie&sub=3

Municipality., S. (2010). "Plan Program for Part of Terminal Area, Sola Airport."

NSB (2013). Retrieved 11.06, 2013, from http://www.jernbaneverket.no/no/Jernbanen/Stasjonssok/-S-/Stavanger/.

Næss, V. (2012). "Sustainable urban development and the multilevel transition perspective."

Press, O. U. (1987). "World Commission on Environment and Development (WCED). Our common future. ."

Press, T. N. A. (2011). America's Climate Choices. Washington, , The National Academies Press D.C.

Regionalplanseksjonen, R., Rogaland Fylkeskommune (2012). Regionalplan for Jæren. R. f. Jæren. Revisjon av fylkesdelplan for langsiktig byutvikling på Jæren: 14.

Regionalplanseksjonen, R., Rogaland Fylkeskommune (2012). Regionalplan for Jæren. R. f. Jæren. Revisjon av fylkesdelplan for langsiktig byutvikling på Jæren: 16.

Regionalplanseksjonen, R., Rogaland Fylkeskommune (2012). Regionalplan for Jæren. R. f. Jæren. Revisjon av fylkesdelplan for langsiktig byutvikling på Jæren: 27.

Regionalutviklingsavdelingen, R. (2000). "Regional Plan for Long Perspective of Urban Development at Jæren Region
": 27.

Regionalutviklingsavdelingen, R. (2012). Regional Plan for Long Perspective of Urban development at Jæren region, Revision Edition: 16.

Rogaland County, N. (2009). KVU for Transportsystemet på Jæren med hovedvekt på byområdet. Stavanger, Norway, Bybanekontor. 1: 34.

Rogaland County, N. (2009). KVU for Transportsystemet på Jæren med hovedvekt på byområdet. Stavanger, Norway, Bybanekontor. 1.

Sandnes, B. (2010). Gatebruksplan for Sandnes sentrum 2011-2025 (Street Use Plan for Sandnes Centrum).

Skudal/Ottesen., H. R. (1966).

SSB (2013). Retrieved 11.04, 2013, from www.ssb.no.

SSB (2013). Retrieved 23.02., 2013, from http://www.ssb.no/beftett.

SSB (2013). Retrieved 28.02., 2013, from http://www.ssb.no/beftett.

Statistics, S. M. (2013). "Prices for person mobility." Retrieved 13.04, 2013, from http://statistikk.stavanger.kommune.no/

Stavanger-statistikken (2010). Travelers out of: Sandnes, Stavanger, Sola and Randaberg.

Stavanger-statistikken (2013, 13th May 2013). "Employees residents of: Sandnes, Stavanger, Sola and Randaberg ". from http://statistikk.stavanger.kommune.no/.

Stavanger-statistikken (2013, 13th May 2013). "Working places in: Sandnes, Stavanger, Sola and Randaberg municipalities." from http://statistikk.stavanger.kommune.no/.

Stavanger, S. a. S. M. (2010). Municipalities Parking Policy for Forus and Lura.

TØI (2005). National Transport Plan. Oslo, Norway, TØI.

Walljasper, J. (2010) Yes magazine: How to Make Biking Mainstream: Lessons from the Dutch.

Wilbur Zelinsky (1971). Hypothesis of Mobility Transition.

(2010). Travelers into: Sandnes, Stavanger, Sola and Randaberg.

AS, F. N. (2012). "Forus Næringspark AS." Retrieved 02.04, 2013.

Bertolini, M. t. B. o. a. L. (2009). A Transition Towards Sustainable Strategy Making: Integrating Land Use and Transport Knowledge Types

Enviornmnet, M. o. Retrieved 05.03, 2013, from http://www.regjeringen.no/en/dep/md/Selected-topics/planning.html?id=1317.

FDP (2000). "Fylkesdelplan for langsikt utvikling på Jæren." 1(1): 11.

KVU (2009). "KVU." 1(1): 16.

KVU (2009). "Transportsystemet på Jæren med hovedvekt på byområdet." 16.

Liva Vågane, I. B., Randi Hjorthol (2009). National RvU. Oslo, Norway, TØI. 1.

Lynn Devereux, R. v. d. B., Ian radbone (2005). HiTrans Best Practice Guide.

Municipality, A. (2009). Aarhus municipal plan 2009.

Municipality, S. (2010). Climate and Energy Plan, Stavanger Municipality: 8.

Municipality, S. (2010). Climate and Energy Plan, Stavanger Municipality: 9, 11, 15.

Municipality, S. (2010). Sola Municipality Climate and Energy Plan. saks nr 09/76 sak 100/10, .

Municipality., S. (2010). "Plan Program for Part of Terminal Area, Sola Airport."

Regionalplanseksjonen, R., Rogaland Fylkeskommune (2012). Regionalplan for Jæren. R. f. Jæren. Revisjon av fylkesdelplan for langsiktig byutvikling på Jæren: 14.

Regionalplanseksjonen, R., Rogaland Fylkeskommune (2012). Regionalplan for Jæren. R. f. Jæren. Revisjon av fylkesdelplan for langsiktig byutvikling på Jæren: 27.

Regionalplanseksjonen, R., Rogaland Fylkeskommune (2012). Regionalplan for Jæren. R. f. Jæren. Revisjon av fylkesdelplan for langsiktig byutvikling på Jæren: 16.

Regionalutviklingsavdelingen, R. (2000). "Regional Plan for Long Perspective of Urban Development at Jæren Region
": 27.

Regionalutviklingsavdelingen, R. (2012). Regional Plan for Long Perspective of Urban development at Jæren region, Revision Edition: 16.

Rogaland County, N. (2009). KVU for Transportsystemet på Jæren med hovedvekt på byområdet. Stavanger, Norway, Bybanekontor. 1.

Rogaland County, N. (2009). KVU for Transportsystemet på Jæren med hovedvekt på byområdet. Stavanger, Norway, Bybanekontor. 1: 34.

Sandnes, B. (2010). Gatebruksplan for Sandnes sentrum 2011-2025 (Street Use Plan for Sandnes Centrum).

SSB (2013). Retrieved 11.04, 2013, from www.ssb.no.

SSB (2013). Retrieved 23.02., 2013, from http://www.ssb.no/beftett.

Statistics, S. M. (2013). "Prices for person mobility." Retrieved 13.04, 2013, from http://statistikk.stavanger.kommune.no/

Stavanger-statistikken (2010). Travelers out of: Sandnes, Stavanger, Sola and Randaberg.

Stavanger-statistikken (2013, 13th May 2013). "Employees residents of: Sandnes, Stavanger, Sola and Randaberg ". from http://statistikk.stavanger.kommune.no/.

Stavanger-statistikken (2013, 13th May 2013). "Working places in: Sandnes, Stavanger, Sola and Randaberg municipalities." from http://statistikk.stavanger.kommune.no/.

Stavanger, S. a. S. M. (2010). Municipalities Parking Policy for Forus and Lura.

TØI (2005). National Transport Plan. Oslo, Norway, TØI.

Authority, N. R. (2010). "R&V report."

Regionalplanseksjonen, R., Rogaland Fylkeskommune (2012). Regionalplan for Jæren. R. f. Jæren. Revisjon av fylkesdelplan for langsiktig byutvikling på Jæren: 27.

Appendix

(I, II, III, IV, V, VI)