Reducing Car Use on Texel

13-04-2023

Course:
Consultancy Project Global Sustainable Science
(GEO3-2423)

Client:
Texlabs

Contact Persons:
Pepijn Lijklema
Alinda Wiering

Supervisor:
Javanshir Fouladvand

Subgroup Infrastructure:
Guus Kloos - 4642703
Renske de Boer – 3059864
Timo Schortinghuis – 6775799
Wessel van Elzakker – 6878865

Subgroup Policy:
Agnese Salazzari – 7045344
Esmee de Haan - 7052596
Philip Wehry – 7059582
Ruth Soede - 3160139

Word Count Whole Report: 12,434
Word Count Integrative Chapter: 4,273
Word Count Policy Chapter: 4,136
Word Count Infrastructure Chapter: 4,025

Table of Contents

1. Integrative Executive Summary 2
2. Integrative Advice 3
2.1. Introduction 3
2.2. Advice 1 – Incentivising Sustainable Travel: Texel Access Pass 4
2.3. Advice 2 – Discouraging Cars: Infrastructural and Regulatory Changes 6
2.4. Discussion 7
2.5. Methods 7
2.5.1. Data Collection 8
2.5.2. SWOT Analysis 9
2.5.3. MCDA 10
3. Policy 14
3.1. Introduction 14
3.2. Policy Recommendations 14
3.3. Policy Instruments 15
3.3.1. Regulatory Approach 15
3.3.2. Economic Instruments 17
3.3.3. Information and Education 19
3.3.4. Public Goods and Services 20
3.3.5. SWOT Analysis 21
4. Infrastructure 24
4.1. Introduction 24
4.2. Infrastructure Recommendations 25
4.3. Infrastructural Measures 26
4.3.1. Improving Walking Infrastructure 27
4.3.2. Improve Cycling Infrastructure 27
4.3.3. Improving Public Transport 29
4.3.4. Discouraging Car Usage 30
4.3.5. SWOT Analysis 31
5. Reference List 33
6. Appendices 40
6.1 Interviews 40
6.1.1. Interview Questions 40
6.1.2. Interview Summaries and Stakeholder Group Justification 42
6.2. MCDA 47
6.2.1. Rating of MCDA criteria 47
6.2.2. Ranking of Recommendations with MCDA Criteria 48
6.2.3. AHP Analysis 54

1. Integrative Executive Summary

Tourism can be a great source of revenue for the economy, especially for small islands. However, it can also lead to unfortunate situations if, for example, tourists are not properly managed in the available space. This is the case for Texel, in the North-Holland province of the Netherlands. Here, tourists often vastly outnumber the local population, bringing a great stream of revenue to the local economy. However, as most tourists travel to and around the island by private car, it results in traffic congestion, making the situation frustrating for both locals and tourists, as well as unsustainable for the ecosystems of the island. As of now, there exist different obstacles which discourage tourists from using more sustainable modes of transport.

This paper, commissioned by Texlabs, an organisation that strives to connect people with each other to create networks to contribute to a more sustainable Texel and future, explores different possible solutions to the problem of tourism-based car traffic on Texel. This research has been conducted separately in policy and infrastructure fields, which are then integrated to answer the research question: *What infrastructural and policy interventions can improve mobility on Texel by reducing the car usage of tourists on the island to make it more sustainable?*

To answer this question, three types of data were used: scientific literature, grey literature and interviews conducted with stakeholders involved in the tourism and transport sectors on Texel. Stakeholders were categorized into four groups: private actors, users, public actors, and knowledge institutes. In the policy and infrastructure sub-chapters, relevant literature is combined with information derived from stakeholders. The advice for Texel derived from this is analysed using a SWOT analysis, which allows for spotting strengths, weaknesses, opportunities, and threats for introducing new measures in the current situation on the island. The integrative advice is analysed through a multi-criteria decision analysis (MCDA), involving an Analytical Hierarchy Process (AHP) analysis, based on nine criteria relevant for mobility on Texel. The criteria used are; Accessibility, Cost, Sustainability, Speed, Capacity, Integration, Reliability, Comfort and Safety.

The result of this research is given in two pieces of advice, which integrate the policy and infrastructure sector recommendation. It is to be noted that the collaboration between the policy and infrastructure sectors is key given their complementarity in the traffic and tourism issues. In both sub-chapters, the advice aims to encourage tourists to reduce the use of their cars by making other alternatives more accessible and appealing. This leads to the first advice; the implementation of a Texel Access Pass. This is an all-in-one service that would make alternative mobility more accessible to tourists. It would include a return ticket for the TESO ferry, unlimited access to public transport on Texel, including bicycle rental. On the other hand, the second advice focuses more on reducing car use by both infrastructural means and municipal policies to encourage other modes of transport, while also discouraging car usage by making private vehicles less convenient. Such measures include separate biking, walking, and car lanes to improve safety for bikers and pedestrians, reducing the availability of parking spaces, and improving the overall public transport capillarity.

2. Integrative Advice

2.1. Introduction

Figure 1 - Map of Texel (History Extra, 2021).

Texel, one of the Wadden Islands and part of the province of North-Holland in the Netherlands, is a popular tourist destination with yearly more than a million visitors (VVV Texel, n.d.a.). A map of the island can be seen in *Figure 1*. Tourists mainly come from the Netherlands and Germany for its nature, relaxation, beaches, towns, and physical activities, and the average grade tourists give Texel for vacation is 8.8 (Texel monitor, 2022). The tourism industry accounts for most of the revenues of Texel (VVV Texel, n.d.a).

However, there are also complications regarding the tourism sector. Firstly, in the year 2022, there were 13,687 inhabitants on Texel (VVV Texel, n.d.a.), which is a small share compared to the number of tourists as mentioned before. Tourists often reach Texel via the ferry from TESO, and this company transported many cars, 700,000 in 2022, which puts pressure on the island with congestion as one of the outcomes (TESO, 2022). Currently, the island is rather car-friendly with accessible parking options, in line with the welcoming character of the island (Gemeente Texel, 2015), while the use of other transport options can be improved. In addition, efforts to improve sustainable transport do not always lead to positive results due to miscommunication between parties. A good example of this is the Emmalaan, which should be a safe and deficient shared space for all kinds of transport but, in reality, felt chaotic and unsafe (Sitalsing, 2022).

As part of the Consultancy Project course of the Bachelor's in Global Sustainability Science at Utrecht University, the research team, consisting of eight students with both social and natural sciences backgrounds, investigated tourist mobility on Texel. This report has been prepared for the client, Texlabs, an organisation that strives to connect people with each other to create networks, especially through education, that can contribute to a more sustainable Texel and a bright future (Texlabs, n.d.). The aim of this research is to advise the client on interventions to reduce car use by tourists on Texel as there exists a knowledge gap in how to approach this issue. The focus will be on the mobility on the island itself, rather than the option of limiting car use by preventing tourists from coming to Texel by car. Two perspectives are considered and explored in this research; those of policy, and of infrastructure interventions. This is suitable because policies can be targeted specifically at tourism and mobility issues and infrastructural changes are effective in either improving other modes of transport or reducing the attractiveness on the private car. In order to address the mobility issues on Texel, the following research question will be answered:

What infrastructural and policy interventions can improve mobility on Texel by reducing the car usage of tourists on the island to make it more sustainable?

The answer to this research question will be presented in the integrative section, which will include two recommendations for reducing car usage by tourists on Texel based on both the policy and infrastructure perspective, and a Multi-Criteria Decision Analysis (MCDA). These recommendations are supported by two sub-chapters, one for policy and one for infrastructure, both presenting their results using a SWOT analysis. The sub-chapters centre around the following research questions respectively:

How can current policies on mobility and tourism of the municipality of Texel be changed to reduce car usage by tourists?

What is the current infrastructure situation on Texel and how can it be improved to encourage walking, cycling, and the use of public transport by tourists instead of the car?

Consequently, the report will start with an integrative chapter, including the advice, discussion, and methodology within which the MCDA and SWOT analysis will be explained. This will be followed by the two sub-chapters, first policy and then infrastructure. Both subchapters introduce the sub-topic and provide recommendations of improvements on Texel based on literature review and stakeholder interviews. See *Figure 2* for a schematic overview of the report.

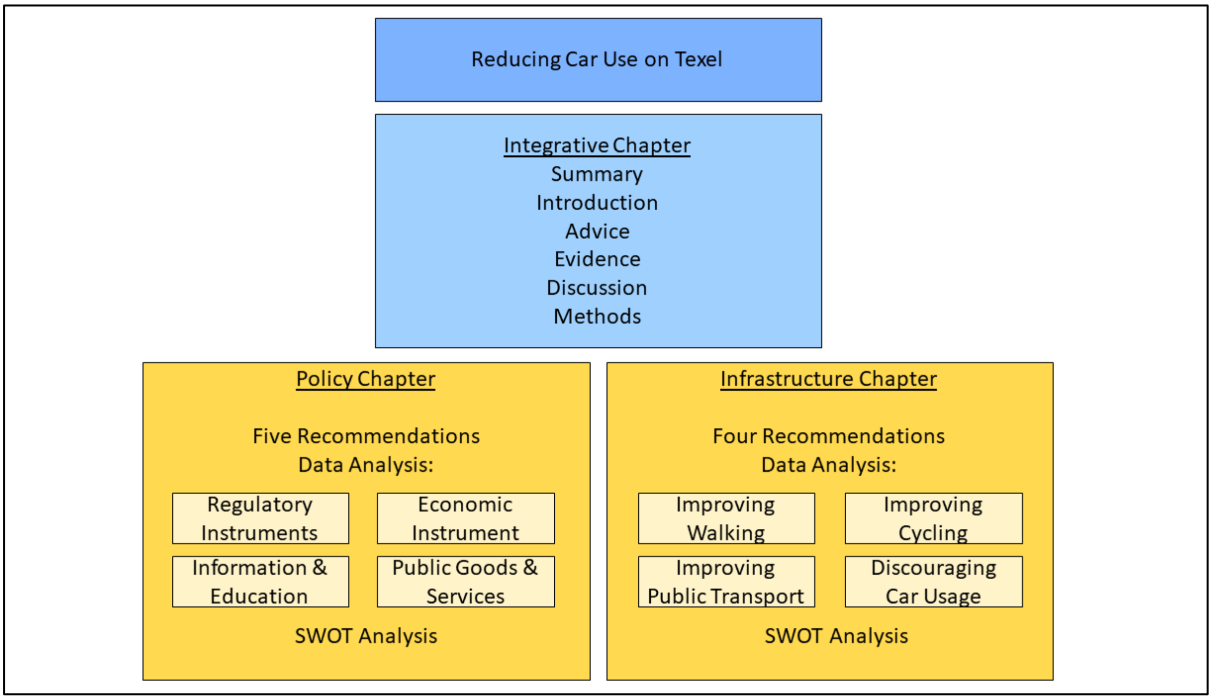


Figure 2 - Report Structure

2.2. Advice 1 – Incentivising Sustainable Travel: Texel Access Pass

The integrative advice is based on research done on policy and infrastructure to reduce car use. An overview of the integrated advice can be seen in *Figure 3*. The first advice that follows from the research done on policy and infrastructure incentives, which will be discussed in the next chapters of this report, is to implement a Texel Access Pass. This advice aims to incentivise tourists to use cycling, public transport, or other micro-mobility modes of transport to get around the island instead of cars. The Pass would combine several transport options available to and on the island. This would facilitate tourists by providing easy access to information about all the options and make it easy to make sustainable choices. The boat ticket could be included, as well as a public transport pass and bike rental. This way, the choice for sustainable transport is easier to make and more beneficial in comparison to buying separate tickets for tourists.

The Texel Access Pass can be accompanied by an app, including a map with useful and interesting points on the island. Practical points include bus stops, bike rental locations, bicycle paths, e-bike charging points, bike parking areas, and other locations that could be of use to cyclists or pedestrians. To make the app more entertaining to use, tourist locations such as museums, restaurants, beaches, and nature areas can be included as well. With the cooperation of companies in the tourist industry, a loyalty point system can be set up. When traveling by bike, for example, tourists can collect points in the app for the kilometres cycled. These points can then be used for discounts at museums or hospitality facilities. This rewards tourists for using sustainable modes of travel while making it easier to use as well. A third use for the Texel Access Pass and app is that it can track the number of tourists on the island and their needs. This way, for example, the public transport system can respond to demand by driving buses more often when it is desired. Tracking can also be used to decide how many bikes are needed at a certain location. Passes should be available for diverse groups of tourists. Some people only visit for a day, others for a week. There could be passes made for 1-day use, 3 days, 5 days, and a week to accommodate all kinds of visitors. Furthermore, there could be discounts for families with a family pass or for young or older visitors.

2.2.1. Argument 1.1 and Evidence

From the nine recommendations provided in chapters *3 – Policy* and *4 – Infrastructure*, recommendations *1.4 Micro-mobility incentivisation* and *2.1 Improve public transport by optimizing connectivity and frequency* have an overall high score on the MCDA, the results of which can be seen in *Appendix 6.2.* These solutions are considered good in all criteria, and therefore it is important to focus on them when thinking about advice. Additionally, these recommendations score highest on accessibility, one of the most important criteria. Implementing a Texel Access Pass includes both recommendations as micro-mobility is incentivised by facilitating and promoting bike rental and cycling in general. It also helps improve public transport as information can be gathered on the needs of tourists, and tourists have more information about bus stops and schedules. More information about the recommendations can be read in *3.2 – Policy Recommendations* and *4.2 – Infrastructure Recommendations*.

2.2.2. Argument 1.2 and Evidence

Stakeholders on the island do not want to punish tourists for using a car, but instead, reward them for choosing

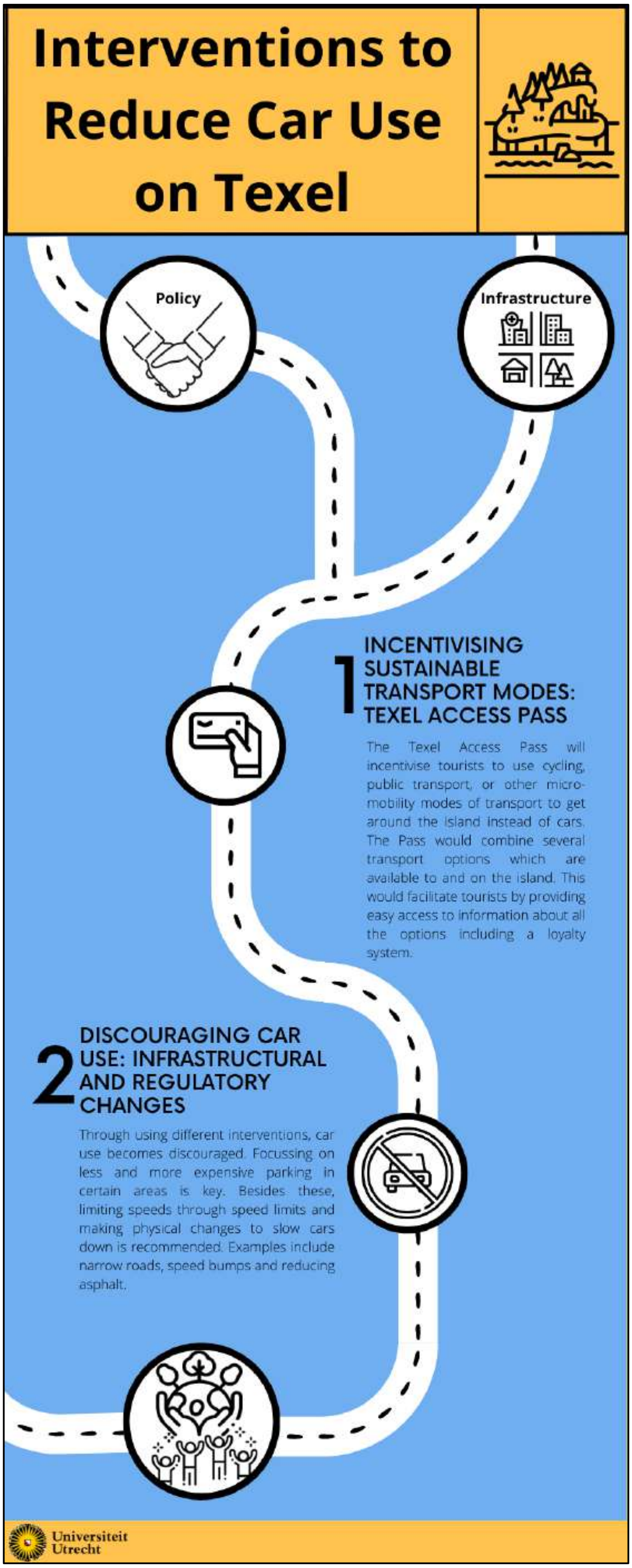


Figure 3 - Infographic Advice to Reduce Car Use on Texel.

a more sustainable method (Interviewee D, G). Some stakeholders interviewed also mentioned combining multiple modes of transport into a single ticket (Interviewees B, D). This advice can help achieve a practical solution. By using the app, tourists can access all the information they need for sustainable transport modes, making them more accessible, and rewarded with discounts for using them. This is a form of positive reinforcement that does not diminish the island's hospitality culture. Tourists will still feel welcome and will want to use the bike or bus as they know it provides them with a unique experience on Texel.

2.3. Advice 2 – Discouraging Cars: Infrastructural and Regulatory Changes

The second piece of advice aims to reduce car usage on the island through regulations and infrastructural measures. Multiple methods to achieve a reduction in car usage are found in this report. In this section, the methods expected to be most effective are combined into one strategy to improve the likelihood of success.

Firstly, it is important to improve the safety and accessibility of the road network to encourage the use of alternative sustainable modes of transport. Tourists prefer biking and walking paths that are separated from the roads. In urban areas, it is essential to focus on enhancing the walking experience. This can be achieved by strategically placing crossroads, traffic lights, and creating separate walking paths. These measures contribute to improving the continuity of the walking paths, a factor that tourists value highly.

Secondly, the public transport system needs to be made more attractive and convenient. Increasing the capacity of bus services during the high season can help tourists to travel easily to and from the ferry harbour. To improve the connectivity and range of public transport, an extra bus line can be added that covers the main points of interest on the island.

However, when trying to reduce car usage, improving alternative modes of travel is not enough. The use of private cars should actively be discouraged. The first step is to limit parking spots at popular destinations. This will reduce the use of private cars on the island as it makes it less attractive for tourists. The freed-up space from the parking spaces can then be used to create bike parking spaces. The bike parking spaces should be built closer to the destinations than the car parking spaces. Moreover, several municipal policies have been identified, such as speed limits and access-restricted areas for cars in the busy towns.

2.3.1. Argument 2.1 and Evidence

Improving alternative and more sustainable modes of transport will discourage tourists from using their cars. We are confident that the proposed measures will effectively create this result. These measures are derived from the recommendations outlined in Section 1.3, which aims to make cars inconvenient, and Sections 2.1 and 2.2, which focus on improving public transport by optimizing connectivity and frequency, as well as separating bus and bike lanes and enhancing the walking experience. The recommendations have scored highly in the MCDA we conducted (*Appendix 6.2.3, Figure 12*). By combining the strongest recommendations from these sections, we have developed a solid package of measures that covers all aspects of the solution.

2.3.2. Argument 2.2 and Evidence

By using different interventions, car usage becomes less convenient. Focusing on limited parking availability and more expensive parking in certain areas is key. Additionally, limiting speeds through speed limits and making physical changes to slow down cars, such as creating narrow roads, installing speed bumps, and reducing asphalt, are good policies to incentivise reducing the use of private cars. The free space created by these policies, such as narrower roads and less parking space, can be used to provide more space for other modes of transport, such as bicycle or bus lanes. Sections *3.2 – Policy Recommendations*, *4.2 – Infrastructure Recommendations*, and *4.3.4 – Discouraging Car Usage* provide information on how these policies can discourage the use of private vehicles for tourists while still offering safe and convenient transport options around the island.

2.4. Discussion

This section will discuss the limitations of our research and possible improvements. Firstly, during the interviews, the criteria were listed one by one without first presenting the entire list, resulting in an incomplete assessment of criterion weights in comparison to others. As a result, the AHP analysis led to uniformed results for weighting and pairwise comparison, possibly overlooking crucial criteria for informed decision-making. ANP analysis, which presents all criteria together and weighs each based on importance relative to others, would enable a comprehensive and systematic assessment for more reliable decision-making.

In addition, although the interviews mainly focused on stakeholders in positions of power on the island, it would have been beneficial to conduct additional interviews with inhabitants and tourists who may be impacted by the measures and changes but lack decision-making power. Conducting more interviews would have yielded more comprehensive results and a better understanding of the effects that the proposed strategies could have. It would also have improved the community of Texel's acceptance of the proposed policy and infrastructure measures.

Moreover, owing to limitations in time and resources, we could not conduct research on the island ourselves and relied on remote methods. Given that the situation on Texel is unique, it is therefore difficult to provide tailored recommendations and advice if the problems and solutions have only come from second-hand case studies and literature, potentially generalising results.

Also, this research can serve as inspiration to address similar situations in other small islands and popular tourist destinations elsewhere. However, generalisation might be difficult as the research is specific to Texel.

Finally, the policy and infrastructure recommendations were developed separately. This lack of integration led to the MCDA and AHP analyses producing results that treat policy and infrastructure as separate entities. It may have been better if the two sections were integrated before conducting the AHP analysis to create solutions that are inherently related when later developing the integrated advice, rather than ranking policy and infrastructure solutions separately and combining the highest-ranked recommendations. This would have had a nuanced effect on the outcome of the results and reduced the polarization of one perspective (e.g., infrastructure) over the other perspective (e.g., policy).

Therefore, for future research, if time and resources allow, researchers should consider these limitations and provide more inclusive and comprehensive advice by conducting deeper studies on the perception of the public. This can be achieved through interviews and questionnaires with the local population and regular tourists. Additionally, a pairwise comparison of the criteria should be done more effectively to create a larger distinction between the importance of one criterion over another. Lastly, to improve the integration of advice, the fusion of recommendations from both perspectives should be done before the AHP analysis to reduce polarization.

2.5. Methods

This section explains and justifies the methods used in this report. The advice above is based on an MCDA analysis. The information behind the advice is analysed according to a SWOT analysis, which is used in both sub-chapters. Therefore, the SWOT analysis and then the MCDA analysis are explained below in this integrative chapter, rather than in the sub-chapters. Before explaining these methods, data collection will be discussed.

2.5.1. Data Collection

The data used for this research comprise scientific literature and grey literature. Scientific literature was studied to identify possible interventions to reduce car use, while grey literature was used to provide missing information on Dutch transport policy. This included information from websites of organizations involved in mobility on Texel and policy documents of the municipality of Texel. The policy documents used were primarily found on the website of the municipality.

In addition to written literature, interviews were conducted with relevant stakeholders on this topic. The summaries of the interviews can be found in *Appendix 6.1.2.* Although there is literature on related topics by Global Sustainability Science students who preceded us, including interviews, conducting our own interviews provided the research team with specific insights into the research topic.

As defined by Noori, Hoppe & Jong (2020), stakeholders can be categorized into four stakeholder groups, see *Figure 4*. These categories are based on research focused on Smart City Development and specifically come from an Amsterdam case. This project aims to connect ideas between stakeholders regarding smart solutions around several topics, including mobility (Noori, Hoppe & Jong, 2020). Finding smart solutions around mobility on Texel is the goal of this research; thus, the four stakeholder groups are relevant to our study, despite the differences in the specific context.

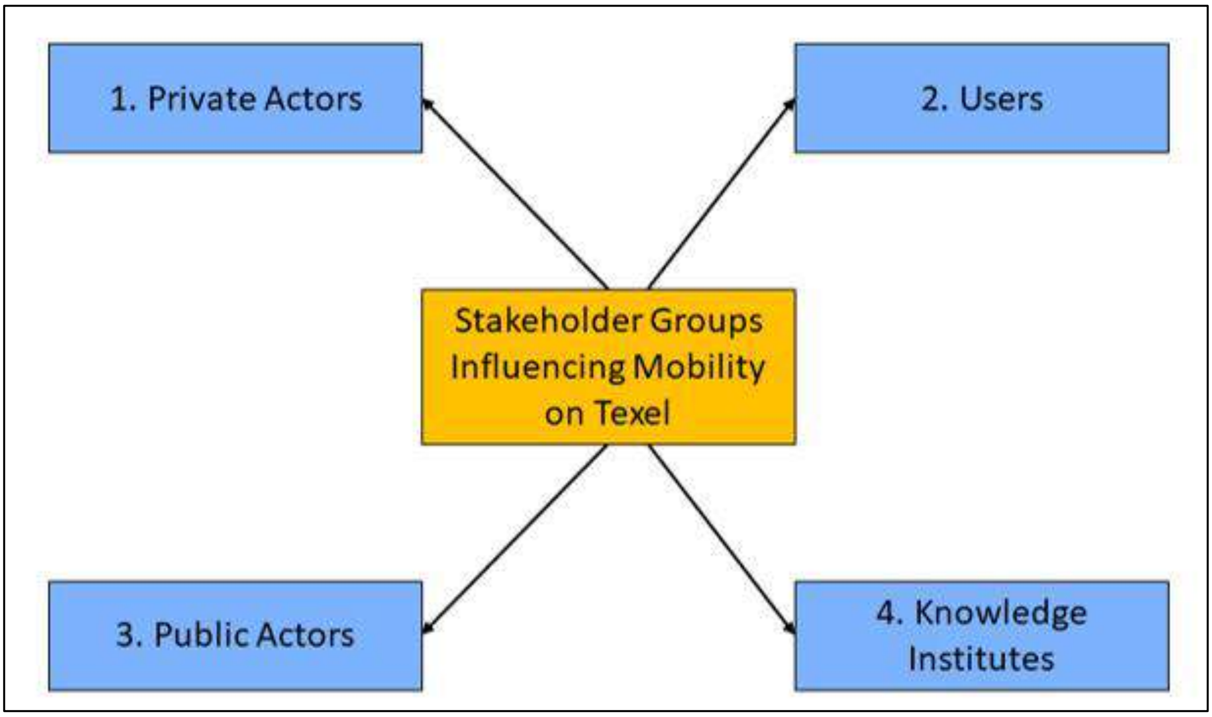


Figure 4, Stakeholder Groups (Noori, Hoppe & Jong, 2020).

Eight interviews were conducted with representation from all stakeholder categories. Furthermore, most stakeholders are residents of Texel and can thus be categorized as 'users'. *Table 1* provides an overview of the stakeholders interviewed. The interview summaries include the explanations behind the categorization.

Table 1 - Stakeholders Interviewed.

Interviewee	Name	Organisation	Stakeholder group	Interviewed by	Date
Interviewee A	Cees de Waal	TESO	1	Timo	08-03-2023
Interviewee B	Han Brezet	Fietsersbond (Cycling Association Texel)	2	Renske	14-03-2023
Interviewee C	Don Boot	Municipality of Texel	3	Esmee & Ruth	15-03-2023
Interviewee D	Martijn van der Linde	Van der Linde Fietsen	1	Renske & Wessel	16-03-2023
Interviewee E	Bart de Vries	Texelhopper & TBO	1	Guus & Timo	16-03-2023
Interviewee F	Jan Boon	Stichting Texelse Kernwaarden	2	Esmee & Ruth	17-03-2023
Interviewee G	Frank Spooren	VVV	3	Agnese & Philip	21-03-2023
Interviewee H	Will Steenhof	Stichting Kado Texel	4	Philip & Timo	23-03-2023

2.5.2. SWOT Analysis

The information presented in the integrative section was analysed in the sub-chapters on policy and infrastructure, using a SWOT analysis. SWOT analysis is a well-established tool used in various fields for strategic planning, which evaluates strengths, weaknesses, opportunities, and threats. The term "strengths" refers to internal elements that contribute to goal attainment, while "weaknesses" are internal factors that may impede success. "Opportunities" and "Threats" are external factors that may facilitate or impede progress (Benzaghta et al., 2021).

As a SWOT analysis is a useful tool for identifying and evaluating options that can facilitate decision-making (Tormo-Lancero et al., 2022), it is suitable for this research, which aims to provide advice on policy and infrastructure interventions to reduce car usage by tourists on Texel. It also helps to understand the current state of mobility and tourism (Tormo-Lancero et al., 2022). The SWOT analysis has been used in other studies to provide input for decision-making and/or in the context of mobility. For instance, Tormo-Lancero et al. (2022) examined mobility measures to reduce car usage and increase public transport, cycling, and walking in several universities, using a SWOT analysis to develop roadmaps for sustainable mobility on university campuses elsewhere. Another example is Lyonel's (2015) study on formulating a travel awareness campaign plan to promote e-bike use, using a SWOT analysis to evaluate the plan and improve it before implementation. As these studies are similar in their focus and aim, the SWOT analysis is a suitable method for our analysis.

To analyse the policy interventions and infrastructural measures identified to reduce car usage, we categorised them based on the four components of the SWOT framework. *Table 2* below shows the operationalisation of this process.

Table 1 – SWOT Operationalisation for Analysing Policy Interventions and Infrastructural Projects and Transport Modes.

Criteria/Factor	How to measure it	
	Policy	Infrastructure
Strength	What policies are currently incentivizing the use of non-car transport in Texel?	What infrastructural elements are contributing to a reduction in car usage by tourists?
Weakness	What policies are incentivizing the use of cars (e.g., parking availability/price)?	How is the current infrastructure incentivizing the use of cars by tourists on Texel?
Opportunity	What policies or social situations are favorable to reducing traffic on the island (pressure from residents, ecotourism, etc.)?	In what ways can the infrastructure be changed or improved to reduce car usage by tourists?
Threat	What factors pose a threat to beneficial policies related to non-car transport (e.g., people's aversion to change, etc.)?	What are the infrastructural barriers for reducing car use by tourists in the future?

2.5.3. MCDA

To analyse the integrative advice, a multi-criteria decision analysis (MCDA) will be used. The MCDA is a tool that aids in decision-making by providing a structure for choice dilemmas within a framework and generates specific preferences against other options through a set of techniques. The list of criteria used in this report was developed by Awasthi et al. (2018), who researched "ideal-solution-based multicriteria decision-making techniques for sustainability evaluation of urban mobility projects under uncertainty." The proposed criteria were developed by three academic researchers and four transport experts and divided into four categories: Economic, Environmental, Social, and Technical. From all four categories, a total of nine criteria were chosen, which represent the main factors that people may find important when deciding on a type of transport. The nine factors are:

1. Accessibility
2. Cost
3. Sustainability
4. Speed
5. Capacity
6. Integration
7. Reliability
8. Comfort
9. Safety

The methods used to generate specific preferences can be divided into three categories: "value measurement models, goal-, aspirations-, and reference-level (or ideal-solution-based) models, and outranking models" (Belton & Stewart, 2002; Awasthi et al., 2018). To answer the research question, a value measurement model will be used to analyse the recommendations proposed by this report against the transport criteria. This category was chosen due to the inherent nature of value measurement models, which are: (1) simplistic, making the results easily understandable for both the researcher and stakeholders on Texel; (2) flexible, allowing them to accommodate various types of criteria and alternatives, both quantitatively and qualitatively; and (3) capable of taking into account the preferences of multiple decision-makers, a crucial aspect of this report, given that the recommendations need to be weighed against the criteria based on the preferences of nine different stakeholders and experts on Texel.

The value measurement model used is the Analytical Hierarchy Process (AHP), a model that breaks down decisions (i.e., recommendations) into a top-down structure, helping to develop a group consensus on certain options and alternatives (Vaidya & Kumar, 2006; Vafaei et al., 2016). Ishizaka and Labib (2011) mention at least 45 different sources in which the AHP model is used and roughly 30 different applications of the AHP, demonstrating the applicability of the model. The AHP method is explained in a paper written by Zahedi (1986) and has been adapted accordingly for this report with the help of SpiceLogic and their software called "Analytical Hierarchy Process" (Analytic Hierarchy Process - (Ahp Software), n.d.; SpiceLogic | Intuitive Windows Software Since 2007, n.d.; AHP Calculation Methods, 2022).

Step 1 - *Setting up the decision hierarchy*

This step requires the researcher to unpack the decision problem into smaller components, which are then organised into levels. At the first level, the objective of the decision problem is identified (i.e., reducing car usage among tourists). Then, the decision attributes are defined, with each level becoming more specific than the previous one (i.e., the four categories and nine criteria of main factors that people may find important when deciding on a type of transport). The last levels consist of decision alternatives (i.e., recommendations for reducing car usage among tourists, divided by policy and infrastructure).

The decision alternatives are developed in the data collection and SWOT Analysis phase, which identifies policy and infrastructure solutions that are then compiled to distinguish synergies between each solution. These newly developed solutions are then combined into recommendations with a specific focus, e.g., parking reform or traffic management. The hierarchy is schematically presented in *Figure 5* and has been applied to this report.

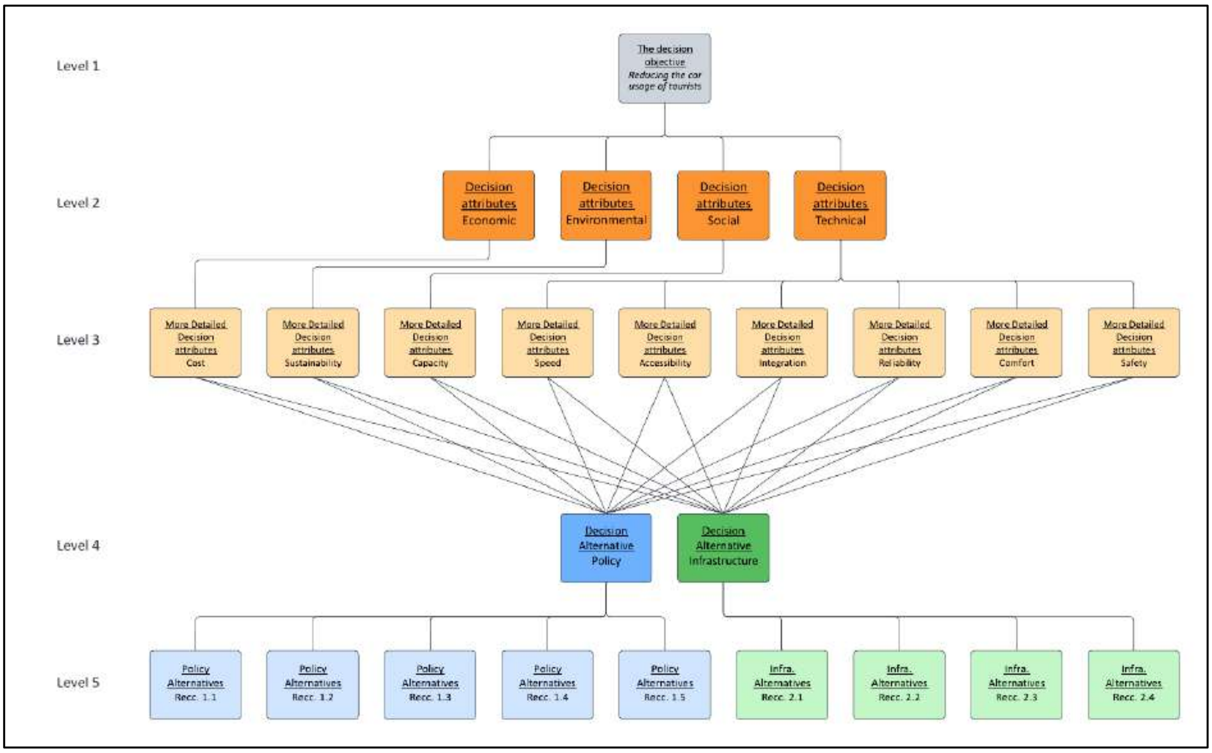


Figure 5 - The applied decision schema of the Analytical Hierarchy Process Based on the General Schema from Zahedi (1986).

Step 2 - *Conducting a pairwise comparisons of the criteria*

The second step involves conducting pairwise comparisons of the decision criteria. In this step, each decision criterion is compared with every other criterion, and a score is assigned to indicate its relative importance over the other criteria. This is done by asking the stakeholders to rate the decision elements (i.e., criteria) on a scale from 1 to 9, which was developed by Saaty and Kearns (1985). A score of 1 indicates that a criterion is least important, while a score of 9 indicates that it is most important. The average rating for each criterion is then calculated, and a pairwise comparison matrix is used to determine the relative importance of each criterion in relation to the others.

Step 3 - *Conducting a pairwise comparisons of the recommendations*

The third step involves conducting pairwise comparisons of the recommendations. Each alternative (i.e., recommendation) is rated by a panel of 9 analysts based on its ability to satisfy each criterion. This is also done using the same 1-9 rating scale proposed by Saaty (1985). The resulting ratings are then used to construct a pairwise comparison matrix for all the recommendations, organised by the criterion on which the recommendations are being rated, including an average rating for each recommendation. This is demonstrated in *Appendix 6.2.*

Step 4 - *Aggregating the relative weights of the criteria*

The fourth step involves aggregating the relative weights of the decision criteria. During this step, the pairwise comparison matrix for the criteria is normalised to eliminate any inconsistencies in the rating of their importance. The normalised matrix is then processed through a normalised geometric mean (NGM) to calculate the overall ranking of the criteria. The NGM is a method of combining the individual performance ratings of different alternatives into an overall performance score.

Step 5 – *Aggregating the relative weights of the recommendations*

Step 5 involves aggregating the relative weights of the recommendations. The averages of all the pairwise comparison matrices made for the recommendations are compiled into one table of overall priorities, *Appendix 6.2.3.* and *Figure 5*. This table of averages is then normalised, and the NGM is calculated to determine the overall ranking of the recommendations. These results will indicate how well each recommendation achieved the goals of the criteria.

Step 6 – *Calculating the consistency ratio*

The last step involves calculating the Consistency Ratio (CR) of the pairwise comparison matrices. The consistency ratio is a measure that indicates the consistency of judgments made in the pairwise comparisons. To calculate the CR, the Consistency Index (CI) needs to be divided by the Random Index (RI). The consistency index is a measure of the degree of inconsistency, and the RI is a reference value that represents the level of inconsistency that would be expected by chance based on the matrix size. In the case of this report, the matrix size is 9, resulting in the RI being 1.45. The CR has to be less than 0.1 for the judgments to be considered consistent. If the CR is larger than 0.1 or negative, then the judgments need to be revisited and revised.

To summarise, a decision hierarchy involves a decision objective, decision attributes, and alternatives. The decision attributes are assigned a rating of importance from 1 to 9, and the attributes are rated from 1 to 9 on how well they fulfil the criteria. These ratings are compiled into individual pairwise comparison matrices, which compare the ratings of the criteria against each other and compare the ratings of the alternatives against other alternatives within a specific criterion. The matrices are then aggregated by normalising the ratings to eliminate any discrepancies. The relative weightings of the criteria and recommendations are established by averaging the normalised ratings and calculating their NGM. Lastly, the consistency ratio needs to be calculated to see whether the judgments made are consistent with each other. The results of the MCDA and AHP analysis are visible in *Appendix 6.2.3.*

Reducing Car Use on Texel Through Policy Interventions

13-04-2023

Course:
Consultancy Project Global Sustainable Science (GEO3-2423)

Client:
Texlabs

Contact Persons:
Pepijn Lijklema
Alinda Wiering

Supervisor:
Javanshir Fouladvand

Subgroup Policy:
Agnese Salazzari – 7045344
Esmee de Haan - 7052596
Philip Wehry – 7059582
Ruth Soede - 3160139

Word Count: 4,136

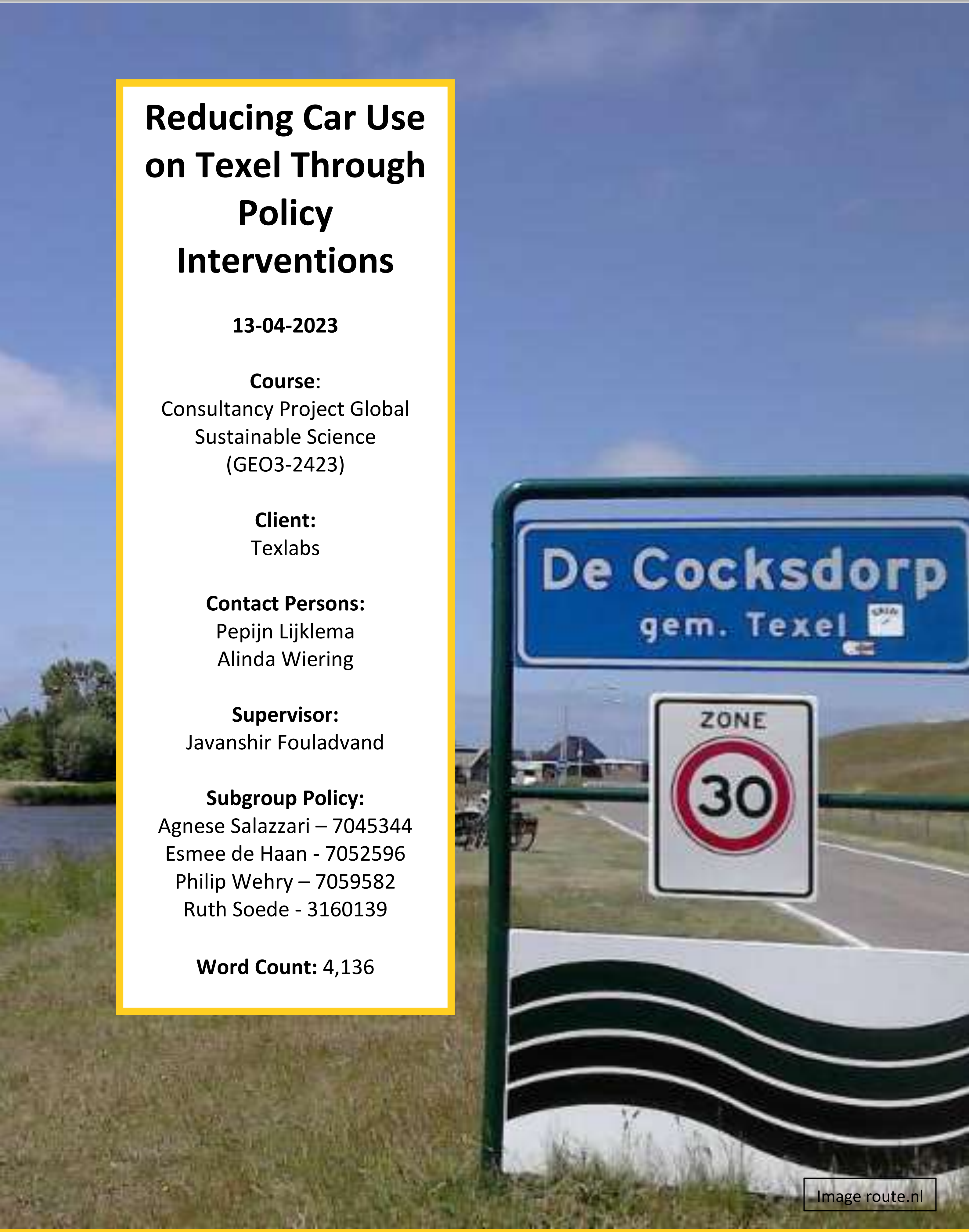


Image route.nl

3. Policy

3.1. Introduction

In this chapter, research on possible policy interventions will be presented. Multiple recommendations will be discussed, and data analysis has been carried out in four categories. These categories represent different policy instruments classified by the IPCC: regulatory instruments, economic instruments, information policies, and public goods and services (Somanathan et al., 2014; Kuss & Nicholas, 2022).

In the section that follows the recommendations, multiple possible policy interventions are considered and analyzed based on the components of the SWOT analysis. The following interventions have been proposed, based on the conclusions drawn from *Section 3.3 - Policy Instruments*, and will align with the recommendations.

3.2. Policy Recommendations

There are five policy recommendations, see *Figure 6*, that will be presented in the following text. These have been decided by analysing the synergies between the four categories.

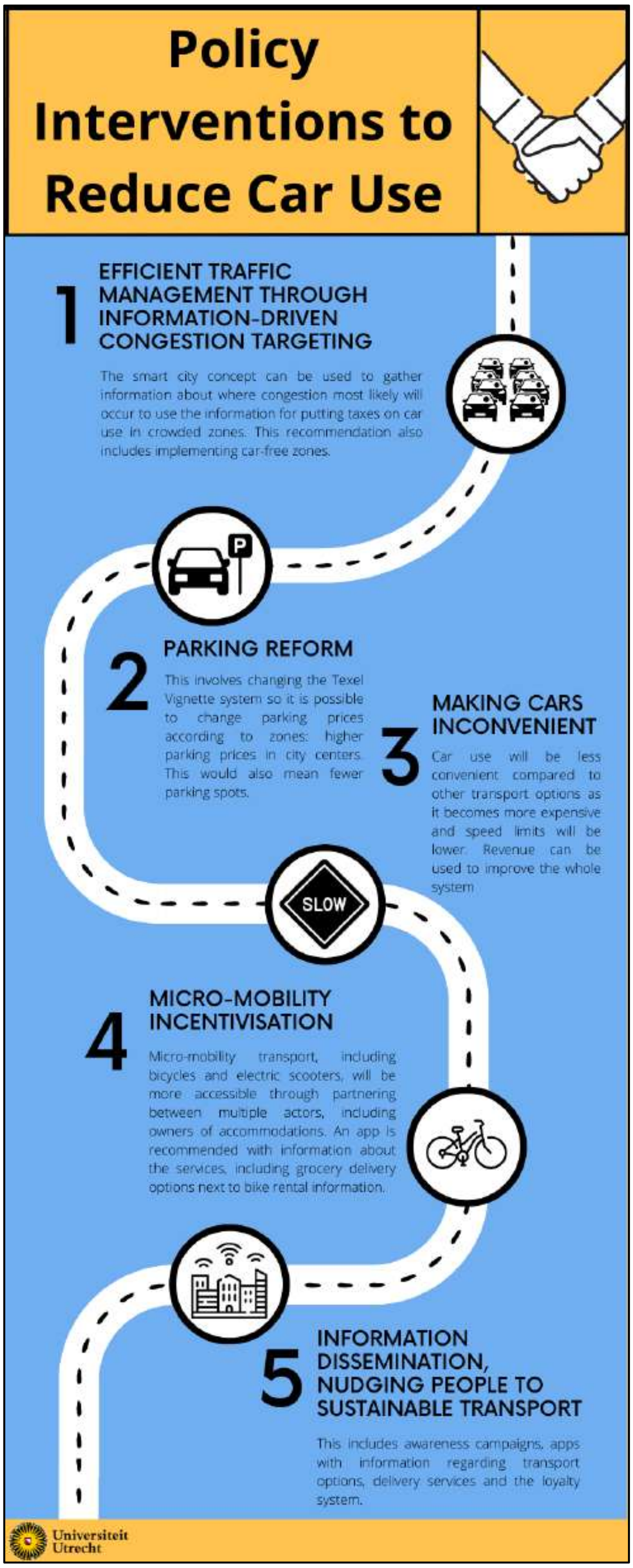


Figure 6 - Policy Infographic: Five Recommendations for Efficient Traffic Management and Sustainable Transport.

<u>1.Efficient Traffic Management through Information-Driven Congestion Targeting</u>

The first recommendation focuses on the principles of a smart city, specifically smart mobility, to reduce problems of congestion, as explained in section *3.3.3. – Information & Education*. The smart city concept can be used to track where cars are, how many there are on the island, where congestion is, and where it is likely to occur. This information can be gathered through automatic number plate recognition systems, further explained in section *3.3.2.3. – Charges*. This information can then be used to tax/charge certain cars for using certain zones at certain times. Using highly accessible information and communication infrastructure will help develop more efficient and tourist-specific congestion management strategies.

Revamping the Parking System

A second recommendation is parking reform. Currently, the vignette system is much appreciated by residents and tourists. However, this system does not allow for the flexibility to increase parking prices closer to congested zones and reduce parking prices further away from congested zones. Therefore, using information systems taken from the concept of smart cities, to determine the different zones and appropriate pricing strategies would be beneficial. With such an information system, it can also be used to direct people to parking locations outside of the city centre. This will be effective in reducing congestion and the time spent searching for a parking spot in city centres.

Making Cars Inconvenient

The third recommendation is to reduce cars through lower speed limits and make it more expensive to park, and more difficult to use the car. This will help incentivize the use of other modes of transport and reduce car usage on Texel. The money gained from car use should then be used to cross-subsidize, meaning to invest this money in public transport and other modes of transport.

Micro-mobility Incentivization

The fourth recommendation focuses on incentivizing micro-mobility, which includes bicycles, electric scooters, and other sustainable modes of transport. To incentivize their use, partnerships between accommodations, businesses, and the municipality can be established to facilitate easier access to bikes and other modes of transport. For instance, bike rental services can be set up to deliver bikes to accommodations or OV-bikes can be rented. A loyalty system can also be introduced, whereby users can earn rewards for frequent use of these services. An information-based app can also be developed to provide information on these services and their locations. Another service that could have a significant impact is a grocery delivery service, which would reduce the number of people using their cars. However, this would require collaboration between different parties.

Information Dissemination, Nudging People to Sustainable Transport

The fifth recommendation is to disseminate information to encourage people to use sustainable transport. This includes awareness campaigns, user-friendly applications that provide information about the various modes of transport, promotion of sustainable services, such as the loyalty system and grocery delivery service, and accurate tracking of the number of tourists on the island.

3.3. Policy Instruments

In order to reduce car use on Texel, several policy interventions are possible. Intervention approaches can either be restrictive or incentivizing. The first approach aims to reduce car use by discouraging it, while the latter centres around stimulating alternative transport modes other than the car. These approaches can be connected to policy instruments categorized into four types: 1) Regulatory approach; 2) Economic instruments; 3) Information and education policies; 4) Public goods and services. Packages of instruments are also possible (Kuss & Nicholas, 2022). Below, there will be a section focused on each of these types of instruments separately for interventions to reduce car use. In the last section, these interventions will be presented according to strengths, weaknesses, opportunities, and threats in a SWOT analysis, and this forms the basis of our recommendations.

3.3.1. Regulatory Approach

The first type of policy instrument that will be discussed is regulation. This includes rules, standards, and prohibitions (Kuss & Nicholas, 2022). Current regulations on Texel related to reducing car use will be presented, as well as possible interventions used in other locations.

3.3.1.1. Current Regulations on Texel

Based on the vision for mobility in Texel for the period 2015-2025 and interviews conducted in March 2023 with Interviewee C from the Municipality of Texel and Interviewee F from Stichting Kernwaarden Texel, the preferred approach to reducing car use is by stimulating and encouraging other modes of transport (Gemeente Texel, 2015). However, there are several regulations that need to be considered.

Firstly, the issue of parking needs to be addressed. According to the vision for mobility, parking should be as easy as possible (Gemeente Texel, 2015). To reduce the frustration of finding a parking spot and provide clarity surrounding the parking situation for tourists and residents alike, parking with a permit is implemented within the centers of all towns between 08:00 and 20:00. People are required to either pay at parking machines or, preferably, have the Texel vignette before traveling to Texel to be able to park almost everywhere in towns, a system that is appreciated by both tourists and residents. However, there are some locations where only residents are allowed to park, and limitations on the duration of permitted parking also occur (Gemeente Texel, 2022). Interviewee C indicated that this approach of enabling easy parking is outdated, as the vision was set up around 2015, referring to the coalition program. The same parking interventions are mentioned in this program, but with a stricter approach and the vision of reducing car use by tourists (Texels Belang, PvdA pro Texel & Groen Links Texel, 2022). This may have implications for public acceptance, which could be limited when combined with improvements in the transport system. Additionally, the reuse of parking spaces for other purposes could increase liveability (Selzer, 2021).

Furthermore, there are regulations on Texel for the maximum speed on the road. Interviewee C indicated that soon there will be only two speeds allowed on Texel, 30 km/h within the city limits and 60 km/h outside of the city. These rules will make the car less convenient (Buehler et al., 2017). However, people may ignore the limits. Interviewee C mentioned that the development of the new vision for mobility will start in the summer, and this vision will include these plans, and the aim is to speed up the implementation of these regulations. A downside of parking and speed limits is landscape pollution due to road signs (Gemeente Texel, 2015) and the need for more BOAs (Gemeente Texel, 2022).

Moreover, there are rules regarding the number of tourists to stay within capacity. Interviewee F indicated that there is a maximum of 45,000 beds for tourists, excluding people who visit Texel for one day. In practice, this is counted by a method of standard counting, confirmed based on the analysis of Toeristisch Toekomstplan Texel (Demmers, 2021). The number is not based on precise counting, which would be desirable according to Interviewee F. Also, from the interview and Toeristisch Toekomstplan Texel, it became clear that tourists staying at a B&B or on boats in the marina of Oudeschil are not included in the counting. The aim is to include B&Bs in the planning as tourists staying at these accommodations put pressure on the liveability in the villages, for instance, by using the parking facilities (Demmers, 2021).

3.3.1.2. Regulatory Interventions Outside of Texel

Regulations regarding parking and speed limits to reduce car use also occur in other cases, such as in European cities (Buehler et al., 2017). Another regulatory intervention that might be useful for Texel is the low-emission zone. This is a regulatory intervention aimed at limiting access to specific locations, often city centres (Kuss & Nicholas, 2022). In the Netherlands, these zones are implemented to comply with European Union air quality standards, thus traffic-related pollutants may be reduced, but likely in a limited way. The focus is on trucks, but the zones can also reduce overall traffic, as was the case when considering traffic intensity in Dutch case studies. Comparable to this is the congestion charging zone in the inner city of London in the United Kingdom, where all traffic entering this zone is charged, causing a reduction in traffic volumes. Retrofitting cars may be a negative consequence (Boogaard et al., 2012). On the other hand, these zones could provide the municipality with money for additional plans.

This can be extended to car-free streets, which is a form of traffic control regulation (Kuss & Nicholas, 2022). This would reduce car use, result in changes in mobility patterns, and be beneficial for the environment, health, and social inclusiveness. Often, these interventions are temporary, for example, during the summer. Car-free street experiments have taken place in Scandinavia, where cases in Sweden also demonstrated the importance of the quality of the street as a meeting place and the perceived disruption in place attachment for acceptance of the car-free streets by residents (Marcheschi et al., 2022). There are already car-free zones on Texel, but these can be made specific to the location and time of need, as exemplified by temporary car-free streets.

3.3.2. Economic Instruments

Each economic instrument is defined by one of three categories: taxes (negative incentives), subsidies (positive incentives), and charges (negative incentives) (Kuss & Nicholas, 2022). However, this report will only focus on subsidies and charges. Using these two categories, this section will evaluate a large range of economic instruments and determine which monetary incentive is the most plausible in reducing car usage by tourists on Texel. The analytical framework for Economic Instruments is presented in *Figure 7*.

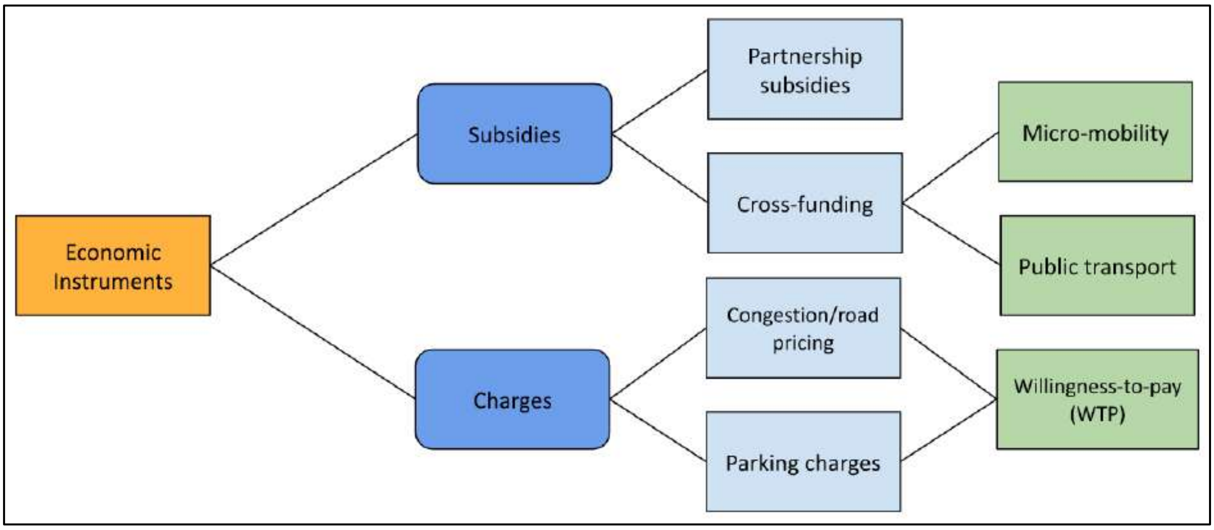


Figure 7 - Analytical Framework that Presents the Different Types of Economic Instruments Organised by Tax, Subsidies, and Charges.

3.3.2.1. Subsidies

Charges and subsidies can be combined to create a circular economy approach by applying tax revenue into subsidies (Soomauroo et al., 2020). The funds collected through tax revenues can go into cross-subsidizing alternative forms of transport such as micro-mobility, which includes private and shared (electric) bikes and scooters. Cross-subsidies for micro-mobility transport could go into sidewalk management strategies such as sidewalk management which help maintain the safety and convenience of users and non-users (Abduljabbar et al., 2021; Pimentel et al., 2020; Liu & Miller, 2022). Funds can also be used to reduce prices for accommodations, products, and services (e.g., groceries, cafes, movies, etc.), and transport (e.g., reduced bus fare). In interview G, the CEO of VVV suggests establishing a loyalty program for tourists who get around without using automobiles, which would be a good way to promote sustainable behaviour. This would help galvanize locals and tourists to use alternate forms of transport (Abduljabbar et al., 2021).

Cross-subsidizing the intensive use of public transport by tourists in peak periods for public transport in off-peak periods could also be a solution to sustaining a larger public transport network on Texel all-year-round. An example of this is Barcelona, which has only two financially profitable bus services: the airport bus and the city tour bus. Through tourism, the two services can offset the operational loss of all the other transport systems in the metropolitan area (Albalate & Bel, 2010). On Texel, the same can apply by intensifying tourist use of public transport on Texel to counterbalance the economic deficit they experience in off-peak periods. However, this does mean that the availability of the public transport needs to be increased on Texel (Thao et al., 2020). Therefore, cross subsidizing should be done carefully in conjunction with developing more available routes in peak periods to prevent net financial loss in off-peak periods (Cuccia & Rizzo, 2011).

The government of Texel, partnering with transport and accommodation providers and providing subsidized rates for tourists who use their services, can also promote the use of alternative forms of transport, such as cycling (Gronau & Kagermeier, 2007). Interviewee G suggests providing guests with bikes at their accommodation. This would be achieved by partnering with bike rental companies and accommodations, subsidizing the companies in exchange for providing free rental bikes for tourists at their accommodation, or simply offering them discounts for the bikes to further promote cycling on Texel. However, recent studies by Gronau (2017) and Thao et al. (2020) highlight the absence of collaboration between tourism stakeholders and transport planners in rural areas, echoing Texel's concerns. (Reeves, 2006; Gronau, 2017). Therefore, a separate study should be conducted to accurately assess the possibility of subsidized partnerships as an economic instrument.

3.3.2.2. Charges

Charging policies, i.e., pricing policies, are the most prominent economic instruments in reducing traffic congestion and car use, with a wide range of pricing strategies that can be implemented. There are three main pricing strategies that can be employed to influence tourist behaviour: congestion charges, parking charges, and road pricing.

Congestion charges work similarly to congestion taxes, with some slight differences. Charges are a fixed fee for entering congested areas, paid daily (Button, 1986), and Taxes are fees that can be fixed or variable, based on factors like time, congestion level, or vehicle type (Button, 1986; Small & Verhoef, 2007). This is enforced through automatic number plate recognition systems that use cameras installed on the roads to capture images of license plates as vehicles pass through a designated zone (Leape, 2006). This would require drivers entering Texel to register their vehicle and account details into a database so that the cameras can link the driver's license plate with the one registered in the database and automatically charge the drivers. However, road pricing and congestion pricing may face opposition from the public as they may be seen as an invasion of privacy and a tax increase (Borins, 1988). Studies on congestion taxes in cities like Stockholm, Gothenburg, and Singapore have shown their success and limitations in implementing this policy (Parry & Bento, 2002; Richardson et al., 2010; Hysing et al., 2015). Consequently, the following factors should be taken into consideration when applying congestion tax on Texel:

1. Top-down political bargaining and consensus with limited public involvement.
2. Meeting the goals and objectives for political acceptance.
3. Suitable tax rates to properly incentivise reducing car use.
4. Equitable congestion tax.
5. Proper planning & implementation.

Parking charges are another effective instrument in convincing car users to use an alternative form of transport. This includes increasing the hourly charge for parking cars the closer the parking spot is to the city centre (Buehler et al., 2017). Time limitations for parking can also be implemented or increased, in combination with larger fines for when cars exceed the time limit. To maintain unrestricted access to parking areas for residents, this restriction can be implemented specifically for non-local drivers by giving residents special parking permits (Buehler et al., 2017). In combination with parking prices, Texel accommodations can provide free or discounted parking spaces to convince tourists to use alternative forms of transport. However, research should be conducted on whether parking costs will mainly evoke drivers to find other places to park instead of switching modes of transport (Yan et al., 2019). Yan et al. has found that there may be synergistic effects between parking pricing and policy measures that reduce search and egress time (2019). These measures, when implemented together, could shape parking demand to a greater extent than if they were implemented individually.

To determine an appropriate price to charge car users for parking or congestion pricing, policymakers should examine willingness-to-pay (WTP). This will offer a way of examining their willingness to accept policies related to parking and congestion pricing (Abulibdeh, 2020). This can help develop an appropriate pricing system that is centralized around goals such as decreasing the environmental impacts of vehicles entering Texel, an important aspect of political acceptance as explained in section *3.3.2.1 - Taxes* (González et al., 2019).

3.3.3. Information and Education

Most stakeholders which have been interviewed prefer incentivizing alternative modes of transport rather than restricting cars. They express the opinion that the car is still necessary at certain times and should remain an easy-to-use option. Despite this, most stakeholders seem to want to be more sustainable but have a conservative attitude towards the changes required for more sustainable mobility on Texel. Many potential solutions proposed by stakeholders have been considered in this research, mostly focusing on infrastructure or regulations. Little thought has been given by most stakeholders to the role of information and education, even though they can still have an impact.

As stated in the research of Acheampong et al. (2021), transport policies are closely related to education policies, and education can increase people's environmental awareness, leading to sustainable mobility. This is also a concept used by nudging. Policymakers should consider various ways in which information can be presented to encourage behaviour change. This includes changing the information, structure, and assistance when looking at the choice architecture, as seen in *Figure 8*. These principles of nudging could be helpful in promoting sustainable travel more extensively, such as presenting sustainable deals first, highlighting the lower cost and reduction in emissions when presenting these options, and making the sustainable option the default when promoting Texel. A loyalty system as has been previously mentioned also nudges people into using more sustainable transport options. These are all examples of how to implement nudging in policies, but policymakers must be knowledgeable on how to implement them effectively.

Providing information through education, awareness campaigns, and other types of communication is key to the public acceptability of certain changes and policies (Banister, 2008). The current plan in place by the municipality incentivizes car use. This has also been reflected in previous information dissemination by the government of Texel. There is a focus on showing how easy it is to visit Texel by car. Interviewee C of the municipality noted that a new plan is currently being made, which contrasts this. It is one where cars are not as much encouraged and will take at least 2 years to get published. While this is an improvement, communication, and information about this also need to be considered.

Category	Technique
A. Decision information	A 1 Translate information *Includes: reframe, simplify*
	A 2 Make information visible *Includes: make own behavior visible (feedback), make external information visible*
	A 3 Provide social reference point *Includes: refer to descriptive norm, refer to opinion leader*
B. Decision structure	B 1 Change choice defaults *Includes: set no-action default, use prompted choice*
	B 2 Change option-related effort *Includes: increase/decrease physical/financial effort*
	B 3 Change range or composition of options *Includes: change categories, change grouping of options*
	Includes: connect decision to benefit/cost, change social consequences of the decision
C. Decision assistance	C 1 Provide reminders
	C 2 Facilitate commitment *Includes: support self-commitment/public commitment*

Figure 8, Categorisation of Choice Architecture (Münsher et al., 2015).

The concepts of the smart city could also be useful for Texel. The goal of a smart city is "a better use of public resources, the improvement of the quality of services offered to citizens, while reducing the operational costs of public administration" (Zanella et al., 2014). A smart city has different elements, one of which is the concept of smart mobility. This aspect of a smart city centres around accessible information and communication infrastructure in which sustainable, innovative, and safe transport is developed (Winkowska et al., 2019). Connectivity is key in smart mobility as it means that users can communicate traffic information accurately and instantly. This can then be used for more effective management. Information about tracking applications, car parks, car-sharing, and other modes of transport becomes available. This can then translate into efficient traffic control (limiting access to different zones, etc.) (Tomaszewska & Florea, 2018). As has been previously mentioned in the section *3.3.2.3. - Charges*, license plate recognition and the knowledge on how many tourists and cars are on Texel combine very well with the concept of smart mobility.

Multiple interviewees have expressed the possible usefulness of an information system to detect where and when certain places are busy or not. Congestion is an issue, and making this more visible through a website or an app could help people avoid this and reduce their impact on this issue. It has also been noted that people look up information mostly through apps and websites (Pourhashem et al., 2021). The concept of a smart city could also prove useful for this. There are limitations for this as the target groups also include the elderly. This means that these information systems need to be comprehensible and reliable. Besides this, working towards a smart city means a long-term investment. It would be an investment in the future as different modes of transport, autonomous vehicles, and more flexible ways of traveling work side by side in a smart city.

3.3.4. Public Goods and Services

According to literature research and interviews conducted with various stakeholders on Texel, the public infrastructure is still very car focused. The public transport is used by a very low percentage of tourists, according to Interviewee G, and it is not as capillary and organized as in cities on the mainland. Tourists are not encouraged to use public transport as it is mostly inconvenient and unclear. Bike traffic is on the rise due to the increase in e-bikes, although the bike routes are mostly shared with cars. OV-bikes, public bikes offered by the Dutch public transport system, are not available on the island for daily rent, and tourists either bring their own bikes or rent one at private facilities, as indicated by Interviewee G. Overall, there are few significant public services aimed specifically at reducing car traffic by tourists on the island.

As other islands around the world experience similar situations to the one in Texel due to tourists and car traffic, popular tourist destinations have come up with different policy solutions that might be relevant and inspiring for Texel. First, a study conducted over six different European islands shows that a large percentage of tourists prefer to move by foot once arrived on the island. Improving walking routes and paths both in the cities and in more natural areas might enhance this even more (Mantero, 2022). This also aligns with the concept of 'transport as an experience,' where tourists are encouraged to make use of unique, traditional, or educational modes of transport around the island instead of using their private car.

Another interesting finding is that some effective measures to reduce car traffic include plans to encourage people to choose an alternative from individual cars (Cairns et al., 2008). These could be in the form of work/school travel plans. In the case of Texel, as a tourist destination, this could translate into more efficient special buses during peak hours between the most popular beaches/tourist destinations and the most popular accommodation locations. Public bikes availability, rentals, and regulation might also bring tourists to a more sustainable mode of transport.

On a bigger, long-term planning overview, the implementation of the '15-minute-city' model or parts of it might be a solution. According to the 15-minute-city model, all necessities should be reachable in 15 minutes from the accommodation by foot or bike (Abdelfattah et al., 2022). This would mean tourists and residents could have access to groceries and services in the vicinity of their accommodation on the island and be more likely to reach those on foot or bike, relying much less on the car.

As mentioned before, on the island, tourists prefer to bring their car mainly for luggage and grocery transport, and a study suggests that grocery traffic contributes to about 5% of the total traffic congestion (Cairns et al., 2008). In recent years, the introduction of food and grocery delivery systems has offered a promising solution to this problem. This service not only helps reduce car traffic, as customers can wait for their groceries at home, while one van can bring around the groceries for several households, but it also shifts the control over the types of vehicles that circulate in the streets (e.g., electric, efficient, etc.), thus reducing pollution as well. It is to be noted that single and instant deliveries can represent a threat to this possibility as repeated and less-organized trips can be even more polluting than single car rides. Collaboration and good logistic overview are thus crucial for the success of this service in reducing car traffic (Aktas et al., 2021). Nevertheless, by incentivizing and advertising these types of services to tourists, it is possible that a significant amount of traffic could be reduced on the island, mostly given that the supermarkets are in city centres and busy areas.

3.3.5. SWOT Analysis

In this section, the results of the SWOT analysis of current and possible policy interventions will be presented according to the type of instrument. This is presented in *Table 3* below.

Table 3 - SWOT Analysis for Policies Aimed at Reducing Car Use.

Strengths	Weaknesses
<u>Regulations</u> • Texelvingette is appreciated by tourists and residents for reducing the disturbance caused by cars driving around, and for being clear. • Speed limits can slow down traffic and make driving less convenient. • Imposing a maximum number of beds for tourists helps to keep numbers within the capacity. • Car-free streets can cause changes in mobility patterns and have social benefits. <u>Economic Instruments</u> • Economic instruments can provide effective incentives to reduce car usage. • Cross-subsidies create a circular economy approach where tax and charges can fund alternative forms of transport. • Subsidies provide positive incentives. • Congestion and parking charges and road pricing effectively reduce congestion and car use. • Cross-subsidizing peak periods of public transport for off-peak periods can sustain a larger public transportation network year-round. <u>Information and Education</u> • Residents are open to inducing change through influencing people with information. • There are clear borders of the island which makes it easier to target people on it. <u>Public Goods and Services</u> • Bike traffic has been increasing, partially due to e-bikes.	<u>Regulations</u> • Road signs contribute to visual pollution in the landscape. • There is a need for more boats for better control. • The standard counting of tourist beds does not include all types of accommodations. • Low emission zones primarily focus on reducing emissions from trucks. <u>Economic Instruments</u> • Subsidized partnerships can be difficult to develop due to lack of collaboration between stakeholders and transportation planners in rural areas such as Texel. <u>Information and Education</u> • Previously, cars were desired and accepted, and government communication reflected this. <u>Public Goods and Services</u> • Public transport is not as developed and organized as in urban areas on the mainland. • Information and waiting times for the Texelhopper and public transport are scattered and inconvenient. • There are no OV bikes available on the island.

• The TexelHopper enables people to access a wide range of destinations. • Many tourists prefer walking or alternative transportation instead of the car.	
Opportunities	**Threats**
<u>Regulations</u> • There is a shift towards more restrictive car use by tourists. • Restrictive parking policies can lead to the reuse of parking spaces, increasing liveability. • A combination of restrictive parking policies and an improved transport system is likely to be successful and acceptable to the public. • Setting a maximum number of beds and including B&Bs in the count would limit the pressure of tourists on Texel. • Low emission zones and congestion charging zones may reduce traffic-related pollutants, but their effectiveness may be limited. • Congestion charging zones can provide the municipality with funds to implement other plans aimed at reducing car use. • Car-free streets can be a temporary measure during the high season. • Low emission zones and congestion charging zones can reduce traffic intensity. <u>Economic Instruments</u> • Establishing a loyalty program can establish sustainable behaviour. • Using automatic number plate recognition systems can be an effective way of monitoring and reducing congestion on Texel. • Learning from examples in Stockholm, Gothenburg, and Singapore can provide valuable lessons for successful congestion pricing implementation. <u>Information and Education</u> • Information system for congestion and busy areas in combination with smart city concepts • Promote sustainable and affordable deals, such as combining bike rentals with free transportation options, or offering discounts on bus/taxi rides for those who park their cars in Den Helder. • Implement nudging strategies to encourage sustainable transportation choices. <u>Public Goods and Services</u> • A clearer and more accessible platform where tourists can access travel information could encourage the use of public transport. • Transport as a tourist experience. • Public services, such as work or school transport plans, have been shown to reduce traffic mostly during peak hours. • Grocery delivery service, one vehicles transport groceries for multiple households	<u>Regulations</u> • A preference for policies that incentivize other modes of transport rather than restrict car use. • Restrictive parking policies and car-free streets might affect public acceptability. • Low emission zones may require retrofitting vehicles to comply with regulations. • Car-free streets might be experienced as disruptive by some. • With parking restrictions, and likely also with stricter speed limits, there is a need for more control by BOAs. • The counting of beds to comply with the maximum allowed on Texel follows standard counting and does not include all types of accommodations. <u>Economic Instruments</u> • Charging policies may be seen as an invasion of privacy and a tax increase. • Not properly incentivising car-use reduction through congestion tax/pricing can lead to the policy becoming ineffective. • The government should carefully apply cross-subsidizing to prevent net financial loss in off-peak periods. <u>Information and Education</u> • Privacy might be an issue with information systems. • Setting up smart city concepts and other systems might take a lot of time and money. <u>Public Goods and Services</u> • Residents or tourists may not be happy to use new platforms or services and give up the comfort of the personal car. • Unplanned grocery delivery can worsen traffic congestion.

Reducing Car Use on Texel through Infrastructural Interventions

13-04-2023

Course:
Consultancy Project Global Sustainable Science (GEO3-2423)

Client:
Texlabs

Contact Persons:
Pepijn Lijklema
Alinda Wiering

Supervisor:
Javanshir Fouladvand

Subgroup Infrastructure:
Guus Kloos - 4642703
Renske de Boer – 3059864
Timo Schortinghuis – 6775799
Wessel van Elzakker – 6878865

Word Count: 4025

Image VVV Texel (n.d. b)

Universiteit Utrecht

4. Infrastructure

4.1. Introduction

This chapter focuses on the infrastructure of Texel and its relation to car usage by tourists. In the transition to sustainable mobility, infrastructure is an important factor to consider, as it can form a barrier but also facilitate the transition (Farla et al., 2010). Infrastructure refers to the infrastructure that facilitates transport. Furthermore, the focus is to persuade tourists not to use their cars after arriving at their destination. The mode of transport to get to this destination is outside the scope of this paper. It is worth noting that tourists often use the same mode of transport at their destination as the one they used to get there (Gutiérrez & Miravet, 2016; Miravet et al., 2021; Bursa et al., 2022). As many tourists arrive by car, the tendency to use this mode of transport while on the island needs to be overcome.

The goal is to reduce issues of congestion on the island by providing recommendations on how tourist mobility can become more sustainable. This chapter contributes to this goal by answering the question: *What is the current infrastructure situation on Texel, and how can it be improved to encourage walking, cycling, and the use of public transport by tourists instead of the car?* To do this, the research in this chapter is divided into four parts. First, infrastructural measures to reduce car usage will be discussed. Then, infrastructural improvements for walking, cycling, and public transport are discussed in separate sections. These modes of transport are preferred over the car and chosen as transport methods as they are already present on the island and are more sustainable than the car. In addition, they score high on the mobility pyramid in terms of energy efficiency and health (SHARE-north, 2021), *Figure 9*.

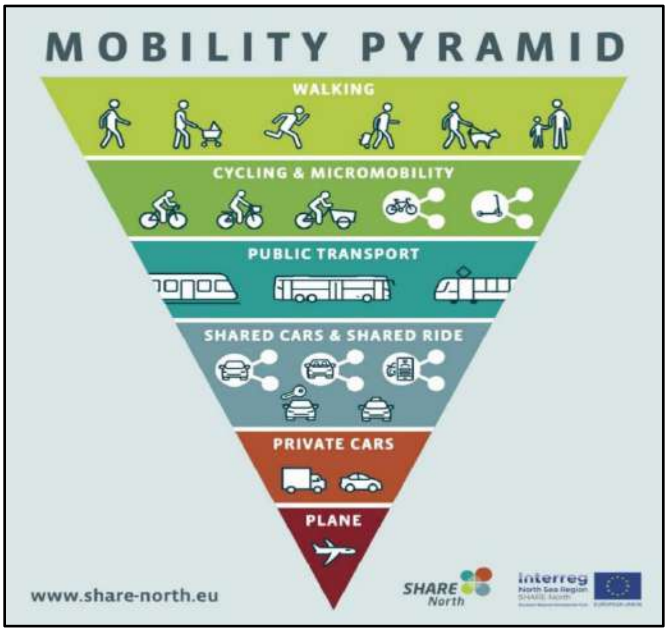


Figure 9 - The Mobility Pyramid (SHARE-North, 2021).

Information on either reducing car usage or improving other transport methods is found in literature, and then specified to the situation on Texel with the help of stakeholder interviews and other sources. The findings are combined in a SWOT analysis. Following this, four recommendations are given to improve the sustainability of tourist mobility on Texel from the infrastructural point of view. These recommendations are presented in section *4.2 – Infrastructural Measures*. In Chapter *2 – Integrative Advice*, the infrastructure recommendations are integrated with policy recommendations to form cohesive advice.

4.2. Infrastructure Recommendations

From the perspective of infrastructure, this section presents advice on how to reduce car usage by tourists on Texel. This is done by providing four specific recommendations, which form a conclusion to the research conducted in section *4.3 – Infrastructural Measures*. Background information and argumentation for the recommendations can be found in this section. See the infographic in *Figure 10* for an overview of the recommendations.

<u>Improve Public Transport by Optimising Connectivity and Frequency</u>

Time-efficient scheduling and optimal service frequency are crucial factors in improving public transport in areas like Texel. It is recommended that Texel's public transport system should focus on improving connectivity with the ferry and train from the mainland to optimize the overall effectiveness. Increasing the frequency of bus services during peak weeks to match the ferry and train schedules helps ensure efficient movement of tourists. The frequency can be improved by adding an extra bus line during high season on the east side of the island, to improve connectivity and the range of public transport. Furthermore, to complete the connectivity, the buses should have the ability to take bicycles with them, for example by placing bicycle racks at the back or on top of the buses. Optimizing the time schedules and connectivity of public transport can reduce waiting times and make travel more convenient and reliable. Lastly, integrating public transport with bicycle use can attract more visitors to the area by public transport, enhancing sustainability by reducing car use.

<u>Separate Bus and Bike Lanes and Improved Walking Experience</u>

To increase the use of alternative modes of transport, it is important to improve

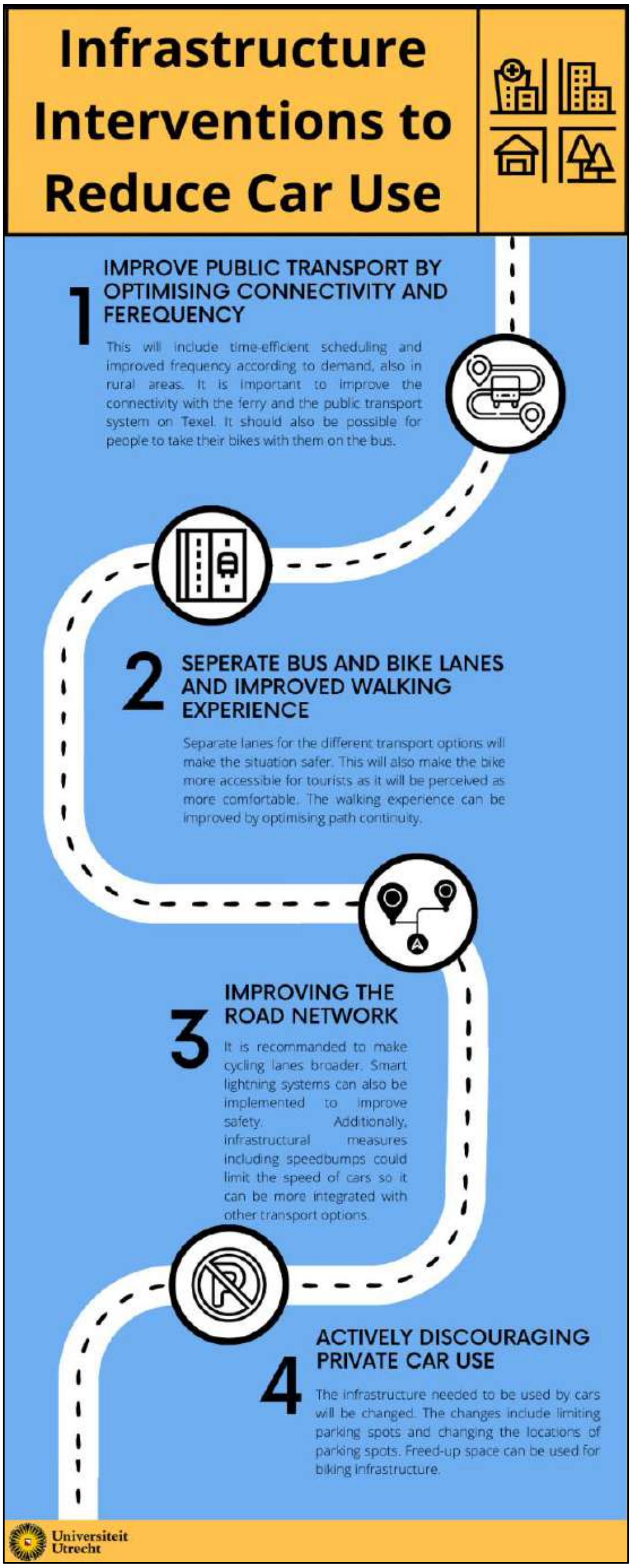


Figure 10 - Infrastructure Infographic: Improving Public Transport and Road Network for Sustainable Transport in Texel.

the safety and accessibility of the road network. Research shows that tourists prefer separate bicycle lanes, rather than bike lanes on the sides of the road. Bike lanes should be separated from roads wherever possible. This will increase the use of bikes by tourists, especially those from abroad who may not be as comfortable on bikes as Dutch tourists.

Furthermore, Texel should focus on improving the walking experience in urban areas. Walking is an effective mode of transport in these areas, as distances are small and there are more walking paths available. The walking experience can be improved by focusing on path continuity, which allows smooth travel with few delays. Measures like implementing crossroads, placing traffic lights, and implementing separate walking paths can all contribute to this improvement.

Improving Road Network

The third recommendation is improving the road network on Texel to accommodate other modes of transport. This includes not only roads for cars, but also cycling lanes and walking paths. In busy cycling areas, the lanes are often too narrow to accommodate the increased usage of e-bikes and cargo bikes, creating a chaotic and unsafe feeling for cyclists. To address this, broader cycling lanes should be created in these areas to generate a sense of calm and safety, thereby encouraging people to travel by bike. Additionally, to improve safety at night, Texel could implement smart lighting systems that do not cause light pollution, but are effective in increasing safety, see section *4.3.2.1. – Cycling Lanes*.

Another improvement to the road network could be bicycle streets. Separating cycling lanes from roads is not always feasible, especially near towns, so bicycle streets can be a solution where cyclists are prioritized, but cars are also welcome. It is important however, to clearly mark these bicycle streets to ensure that car drivers drive slowly, see section *4.3.2.1. – Cycling Lanes*.

Limiting the speed of cars through infrastructural measures can also improve safety on Texel for both cyclists and car drivers. This could be achieved by adding more speed bumps, raised crossroads, or chicanes, section *4.3.4. – Discouraging Car Usage*.

Actively Discouraging Private Car Use

To reduce car usage, alternative modes of transport should be promoted, but the use of private cars should also be actively discouraged. The municipality is planning to change the car-friendly environment section *4.3.4. – Discouraging Car Usage.* One way to restrict cars is by limiting the amount of infrastructure available for parking and driving. The first step is to limit parking spots at popular destinations and towns. By reducing parking availability, it takes longer to find a spot, and it may be further away from the destination. This will encourage tourists to choose a different mode of transport. The freed-up space can be used to build proper bike parking infrastructure, including larger parking spots for cargo bicycles. At tourist destinations, bike parking should be built closer to the destination, while car parking is further away. In interview D, the interviewee talked about Mobian Global, which turns car parks into mobility hubs including bicycle parking and charging. This is applicable on Texel at the beaches and towns.

4.3. Infrastructural Measures

This section is divided into the four transport types previously defined: driving, cycling, walking, and public transport. The driving section focuses on reducing car usage, while the other sections focus on increasing the use of other modes of transport by tourists. In these subsections, findings from literature relevant to the research aim and information from stakeholder interviews are provided. This will provide a basis and further explanations for the recommendations given in the previous section. Information from the four transport modes is integrated with the help of a SWOT analysis, which was performed in section *4.3.5 – SWOT Analysis*.

4.3.1. Improving Walking Infrastructure

Walking is, in many ways, the optimal mode of transport, as portrayed in the Mobility Pyramid. It requires little infrastructure and resources compared to other means of transport discussed in this paper. Furthermore, it is sustainable, and there are additional health benefits. An increase in the usage of this mode of transport can result in a decrease in car usage. Therefore, we should investigate the possibilities for promoting walking among tourists on Texel.

4.3.1.1. Improving Urban Walking Infrastructure

Improving walking infrastructure includes creating new walking paths, as well as improving the safety and accessibility of existing infrastructure. A case study carried out in two small cities in New Zealand provides useful information about the effectiveness of this method. Both cities were allocated a budget of 7.6 million Euros to promote walking and cycling (Keall et al., 2018). 85% of the money was spent on infrastructural improvements, such as creating and improving walkways and bike lanes. The remaining 15% was used for information and education. Both cities created walkways that connected to existing walkways. These interventions resulted in a 30% increase in active travel (walking and cycling), accounting for a 5.3% decrease in motorized trips. The costs of these interventions could be seen as a barrier for implementing the changes; however, the reduction in CO2 emissions and improved health should also be considered.

In another case study, tourists were given a survey with six categories based on literature review (Pira et al., 2021). The tourists were asked to rate the importance of each category and rank the three elements within each category, see *Figure 11*.

Table 1
Pre-survey results.

Categories	Importance (%sample)	Ranking (Average)	Elements	Ranking
1. Path's characteristics	71%	**1.55**	1. Path continuity	**1.45**
			2. Slope/Number of Steps	2.1
			3. Road signals	2.45
4. Path's conditions	86%	**1.54**	1. Cleanliness	**1.67**
			2. Maintenance	2.21
			3. Perceived safety	2.12
7. Road traffic	68%	2.79	1. Road congestion	1.89
			2. Traffic conflict	2.84
			3. Pedestrian crossing	**1.26**
10. Freight delivery	14%	4.25	1. Presence of heavy vehicles	2.75
			2. Parking of heavy vehicles	2
			3. Interference with freight distribution operations	**1.25**
13. Thermal comfort	25%	3.43	1. Shadow	2.43
			2. Green spaces	**1.71**
			3. Protection from rain	1.86
16. Public services	68%	3.16	1. Restrooms	**1.74**
			2. Drinking fountains	2.63
			3. Public toilets	1.63
19. Path's environment	29%	3.37	1. Transit stops or stations	**1**
			2. Commercial activities	2.63
			3. Attractions	2.63

Figure 11 - Survey Results (Pira et al., 2021).

As can be seen from the results, tourists rated the path's characteristics and conditions as highly important, with path continuity and pedestrian crossing being ranked the highest. These elements are related to each other, as pedestrian crossing contributes to path continuity. Clearly, tourists prefer a walking route that allows for smooth travel with minimal delays.

4.3.2. Improve Cycling Infrastructure

Cycling is an integral part of Dutch culture, with people in the Netherlands using their bikes for 25% of their trips, second only to cars as a transport method. Residents rely on bikes for various purposes, including recreation and practical needs (CBS, 2021). Therefore, cycling is an interesting mode of transport to consider as a replacement for cars. Additionally, cycling ranks high in the mobility pyramid as designed by SHARE-north (2021), *Figure 9* above, as it is a healthy, space-efficient, and energy-efficient mode of transport.

Despite the positive impacts of cycling on the environment and health (de Kruijf et al., 2018), many Dutch residents still prefer cars due to their perceived advantages in terms of pleasantness, flexibility, speed, comfort, and safety (KiM, 2017). Recognizing the perceived advantages of both cars and bicycles can help nudge tourists towards choosing the latter as their preferred mode of transport. The same KiM research also shows that bikes are perceived as the mode of transport that brings the most joy. Highlighting the fun aspect of cycling could be used in promoting bikes as a mode of transport for tourists who want to have a good time on the island. Additionally, improving cycling infrastructure could enhance comfort, efficiency, safety, and other factors in which cars currently score higher.

4.3.2.1. Cycling Lanes

In terms of infrastructure, there are many elements that can make people more inclined to use cycling as a mode of transport. Separating bicycle lanes from the main road is the best strategy to improve the appeal of a street for bicycles, but this is not always possible or feasible (Mertens et al., 2018). If the existing infrastructure does not allow for large changes like this, there are also several micro-environmental factors that could be implemented to improve the appeal of bicycle lanes. Factors related to safety are most effective, followed by comfort and aesthetics.

A study conducted in Denmark by Vedel et al. (2017) on the attractiveness of cycling lanes showed similar results; separate cycling lanes are most attractive. Crowding and stops on the route have a negative impact on attractiveness, while greenery along the route increases attractiveness. Dutch research also emphasizes the importance of route attractiveness. The decision of whether to take the bike or not largely depends on the perception of the time it takes to cycle the route. Cyclists' subjective perception of the time it takes to cycle their route is influenced by the attractiveness of the cycling path. This attractiveness is mainly influenced by comfort and variety in the route. Additionally, characteristics that give a feeling of calm have a positive influence on attractiveness. Green surroundings and signs of recognition also have a positive influence (Kalter & Groenendijk, 2018).

On Texel, the separation of cycling lanes from the main road is not always present. This is one of the main points that the cycling association of Texel (Fietsersbond) is advocating for, as this used to be more common (Interviewee B). This is especially important for the roads between the ferry and concentration areas Den Burg and De Koog. Where separation of cycling lanes is not possible, a solution could be a bicycle street. In this type of street, cars are guests, and the speed is limited to 30 km/h. This has to be indicated well, to avoid issues like those on Emmalaan (Sitalsing, 2022). To improve safety, the cycling association proposes smart lighting along the main cycling routes and proper placement of signs. Smart lighting can consist of lights that turn on when a cyclist is approaching and shut off a minute later. This is because Texel aims for a dark sky, which is part of the effort to decrease light pollution in the nature area of the Waddeneilanden (NP Duinen van Texel, n.d.). Smart lighting systems can increase the perception of safety in cycling lanes without a large increase in light pollution.

Another selling point of cycling lanes that should be promoted, according to Interviewee B, Texel is the unique locations that can be visited by bike but not by car. Several cycling routes on the island provide a unique experience of the nature areas and atmosphere of the island, such as the route along the mudflats.

4.3.2.2. E-Bikes

Another way to promote the use of bikes instead of cars is by using e-bikes. In an e-bike promotion program in the Netherlands, 50% of trips that would have been taken by car were instead taken using e-bikes (De Kruijf et al., 2018). E-bikes have a longer range than conventional bikes, making them more appealing to tourists.

Electric cargo bikes can also be used to reduce car usage. Cargo bike users in the US reduced their car usage by 40% (Riggs, 2016). As tourists often have many items to carry during their stay, cargo bikes can be a convenient option for transporting belongings without needing a car. Tourists on

Texel often rent bikes for a day, so electric bikes can be charged at the rental facility at night, according to Interviewee D. However, when tourists rent them for longer periods or bring their own, charging stations are needed at accommodations or destinations to charge the bikes. Infrastructure on the island needs to support these charging stations.

The rental services available on the island offer bikes for rent for a specific period, from an afternoon to multiple days. However, more flexible bike rental services, like those seen in cities where bikes can be rented and returned at different locations and riders pay for the distance travelled, do not exist on the island. According to the largest rental service on the island, this fits the needs of the tourists as they do not want to find no bikes available when they want to return from a visit to the beach. There could be a market for a more flexible bike rental system, but this would require more specific and detailed organization (interviewee D).

A third way to encourage the use of bikes is by allowing people to take their bikes with them on public transport. This way, they have more freedom in how they want to travel and are not limited to cycling back if they do not want to.

4.3.3. Improving Public Transport

This section will investigate the possibilities of stimulating the shift away from car usage to public transport. Currently, the public transport consists of one bus line and the Texelhopper, a bus on call, which can transport a limited number of people and does not connect well with the ferry's time schedule. Additionally, the Texelhopper is inconvenient in terms of waiting times, Interviewee A.

Thus, an important condition for the general public can be identified as time efficiency (Cools et al., 2009). Furthermore, policymakers need to investigate the removal of social barriers (Rathnayake, 2012). Several options exist to increase the time efficiency of the public transport system; many of these include radical changes, which could potentially lead to high financial costs and environmental hazards if it regards large infrastructural changes. Therefore, it is necessary to look at the opportunities provided by the existing infrastructure.

Policymakers could evaluate the possibilities of separate bus lanes and efficient time scheduling that is connected to the ferry's schedule. Moreover, public transport can be made more attractive when it is more cost-efficient compared to the use of cars, which can be achieved through various pricing methods (Cools et al., 2009).

4.3.3.1 Time Efficiency

An approach to improving public transport in Texel is through the implementation of time-efficient scheduling. By optimizing the frequency and connectivity of trains, buses, and ferries, residents and tourists can enjoy more reliable and frequent services. For instance, increasing the frequency of bus services during peak seasons can help accommodate the higher demand and increase ridership (Taylor & Fink, 2013). On the other hand, Paudel (2021) found that public transport service is more reliable when fewer people make use of it, meaning that increased frequency would help to increase ridership by relieving buses of overcrowding. Moreover, the bus often does not connect directly to the ferry, causing tourists to wait. Optimizing this time schedule could be a huge motivation for tourists to use the bus (Ibarra-Rojas et al., 2015).

4.3.3.2. Self-Driving Buses

Another (pilot) solution is the usage of self-driving buses, which could help reduce costs for public transit, especially the hiring cost, while improving service reliability. Self-driving buses have significant potential, as they are an improvement for efficiency, reliability, and even safety (Zhang et al., 2021). Autonomous vehicles would maximize routes and connectivity with other modes of public transport via software, adjust their speeds and acceleration based on patterns, and reduce stopping times. Meaning that public transport would become a more viable option for those with tight schedules (Liu et al., 2019). Self-driving buses also improve safety on the road, since they are equipped with sensors and cameras allowing them to respond to dangers on the road. Therefore, self-driving buses can reduce accidents and make public transport a safer option (Yeong et al., 2021). In addition, the software for self-driving buses can be programmed so that the convenience of the commuters will be improved as stopping times could be set to specific locations and times via applications (like Texelhopper). However, it is a relatively new technology that is still in a pilot/testing phase (such as in Oslo), therefore, this will not be a short-term solution for all the public transport on Texel (Haugland & Skjølsvold, 2020) also, according to Interviewee E. Though, it could be an interesting pilot project for the public transport of Texel, especially as it is a small, confined island.

4.3.3.3. Road Infrastructure

Creating separate bus lanes can be an effective way to stimulate the use of public transport on a small island. By separating buses from other traffic, the bus lanes can help to reduce congestion and create faster, more reliable, and more convenient travel for passengers (Surprenant-Legault & Levinson, 2011). One of the primary benefits of creating separate bus lanes is that they can significantly reduce travel time (Russo et al., 2021). On a small island, traffic congestion can be a major problem, especially during peak hours (Nunkoo & Ramkissoon, 2010). Dedicated lanes for buses lead to efficiency for public transit as the buses can bypass traffic and reach their destinations more quickly. This incentivizes people to choose public transport over driving their own vehicles, as they can save time and avoid the stress of getting stuck in traffic (Hu et al., 2015). Another key advantage of separate bus lanes is that they improve the overall reliability and convenience of public transport since buses are less likely to be delayed by traffic, meaning that passengers can more easily rely on public transit (Guler & Menendez, 2014).

4.3.3.4. Social Barriers

Shifting to public transport can be a challenge for people, with various social barriers hindering the transition (Al-Rashid et al., 2020). These barriers can range from personal preferences to financial constraints, and they can vary depending on location, culture, and individual beliefs. Personal preferences are one of the most significant barriers to shifting to public transport (Masoumi, 2019). Many people are accustomed to using their own vehicle and may not find public transport convenient or comfortable. They could also feel a sense of independence and freedom when using their own vehicle (Siren & Hakamies-Blomqvist, 2005). Providing more comfortable and convenient public transport options encourages people to shift towards public transport (Foth & Schroeter, 2010).

Another social barrier is the perception of safety. Some people claim that public transport is unsafe, based on incidents such as public harassment, theft, or accidents, which discourage people from using public transport (Ceccato et al., 2022; Ouali et al., 2020; Stradling et al., 2007). Implementing measures such as cameras, security personnel, or anti-harassment campaigns/policies can improve safety (Smith & Clarke, 2000; Welsh & Farrington, 2009).

A lack of information or promotion about public transport services can also be a significant barrier. Some people are not aware of the availability or accessibility of public transport in their area, preventing them from considering it as a possibility (Yaliniz & Bilgiç, 2015). Providing easily accessible information about public transport services increases general awareness. Awareness can be created through online or offline channels, such as mobile applications, online social media, or physical signage (Foth & Schroeter, 2010).

4.3.4. Discouraging Car Usage

To persuade tourists to change their mode of transport, improving the infrastructure of alternative transport modes is not sufficient. The use of a car should be actively discouraged, and changing the design of car infrastructure is an effective measure to accomplish this. Many studies have focused on reducing car usage, but the literature often directs towards reducing car usage through policy measures. Academic literature on reducing car usage by actively changing road infrastructure is limited.

Factors that tourists consider when choosing their transport options include travel time, cost, frequency, convenience, flexibility, comfort, and safety (Kelly et al., 2007). Increasing friction for drivers in these categories using road design and parking management will reduce the appeal of driving and persuade tourists to use different modes of transport.

Limiting the amount of car parking available at a destination will lower the capacity of people able to arrive by car. The time to find a parking spot will increase, and it may be further away from the destination. This increases travel time while reducing convenience and flexibility.

Trip time is a significant factor when deciding the mode of transport (Hamadneh & Jaber, 2023; Mahdi et al., 2022). By lowering driving speeds and increasing driving distances, trip time can be increased. Lowering the speed limit is a measure often applied, but studies show that in the absence of active enforcement, drivers are inclined to drive as fast as they feel comfortable, regardless of the speed limit (Brewer et al., 2006). Street design can influence the speed drivers feel comfortable with, and thus be more effective in lowering driving speeds. This process is called 'traffic calming.' Traffic calming involves physical changes to streets to reduce vehicle speed and cut-through volumes (Ewing, 1999). To slow down vehicles, several traffic calming measures can be applied to the street. These include speed humps, speed tables, raised crosswalks, tight corner radii, and chicanes (Doomah & Paupoo, 2022).

4.3.5. SWOT Analysis

Findings from the previous sections are presented in this SWOT analysis to provide an overview of the most important aspects of the four types of infrastructure measures, see *Table 4* on the next page.

Table 42 - SWOT Analysis of Infrastructure to Reduce Car Use.

Strengths	**Weaknesses**

• Cycling network.
  ○ There is already an extensive cycling network on the island.
  ○ Work on separating cycling lanes or creating bicycle streets.
  ○ Bicycles provide access to places that cars cannot reach.
• Bike rental.
  ○ Bike rental services are widely available on the island.
  ○ All types of bikes can be rented for flexible periods of time.
• Flexibility & range of the Texelhopper.
  ○ The bus-on-call service can pick up passengers from their desired location.
• Walking requires minimal infrastructure and is sustainable.
	• Towns are widely accessible by cars.
	• Abundant parking in towns on streets and other parking lots in the area.
	• Roads between towns are straight without traffic calming.
	• No physical barriers between cycling paths and high-speed roads on some roads.
	• Walking and cycling are inferior to other modes of travel in terms of speed and comfort.
	• Public transport infrastructure and financial opportunities
	  ○ There are no resources available for the instalment of new modes of public transport.
	• Self-driving buses are not a short-term solution.
	  ○ The self-driving buses are still in the testing phase and the people from Texel might be conservative in implementing them.

Opportunities	**Threats**

• Limit car parking availability.
  ○ Reduce parking in towns.
  ○ Reduce parking at beaches.
• Reduce road capacity.
  ○ Remove roads.
  ○ Car free roads.
• Traffic calming.
  ○ Using speed bumps, chicanes, and raised crosswalks.
• Smart traffic systems.
  ○ Implementing smart lighting.
  ○ Using smart signs.
• Frequency of bus services.
  ○ Increasing bus frequency during peak hours and periods to encourage higher ridership.
• Time schedules and connectivity.
  ○ Connect the bus line to ferry arrival to motivate tourists.
• Improve walking paths
  ○ Designating walking paths in urban areas with continuous connectivity.
• Self-driving buses
  ○ Reducing costs, improving reliability, and enhancing safety.
	• Negative perception by tourists.
	  ○ Tourists may perceive a reduction in car usage negatively.
	• Electric (cargo) bikes.
	  ○ The increasing popularity of e-bikes and e-cargo bikes may strain the current cycling infrastructure due to their higher speeds and wider dimensions.
	• The removal of social barriers could be challenging.
	  ○ Overcoming stigmas and initiating motivational promotions in a conservative area may be challenging.
	• The lack of opportunity for new modes of public transport infrastructure.
	  ○ Promoting public transport significantly may be difficult when only the bus is available, as it may result in system overload.

5. Reference List

Abdelfattah, L., Deponte, D., & Fossa, G. (2022). The 15-minute city: Interpreting the model to bring out urban resiliencies. Transport research procedia, 60, 330-337.

Abduljabbar, R. L., Liyanage, S., & Dia, H. (2021). The role of micro-mobility in shaping sustainable cities: A systematic literature review. *Transportation Research Part D-transport and Environment*, *92*, 102734. https://doi.org/10.1016/j.trd.2021.102734

Abulibdeh, A. (2020). Planning for Congestion Pricing Policies in the Middle East: Public Acceptability and Revenue Distribution. Transport Letters: The International Journal of Transport Research, 14(3), 282–297. https://doi.org/10.1080/19427867.2020.1857908

Acheampong, R. A., Cugurullo, F., Gueriau, M., & Dusparic, I. (2021a). Can autonomous vehicles enable sustainable mobility in future cities? Insights and policy challenges from user preferences over different urban transport options. Cities, 112, 103134. https://doi.org/10.1016/j.cities.2021.103134

AHP Calculation Methods. (2022). Copyright © 2007-2023. SpiceLogic Inc. All Rights Reserved. https://www.spicelogic.com/docs/ahpsoftware/intro/ahp-calculation-methods-396

Aktas, E., Bourlakis, M., & Zissis, D. (2021). Collaboration in the last mile: evidence from grocery deliveries. International Journal of Logistics Research and Applications, 24(3), 227-241.

Al-Rashid, M. A., Goh, H. H., Harumain, Y. A. S., Ali, Z., Campisi, T., & Mahmood, T. (2020). Psychosocial Barriers of Public Transport Use and Social Exclusion among Older Adults: Empirical Evidence from Lahore, Pakistan. International Journal of Environmental Research and Public Health, 18(1), 185. https://doi.org/10.3390/ijerph18010185

Albalate, D., & Bel, G. (2010). Tourism and urban public transport: Holding demand pressure under supply constraints. Tourism Management, 31(3), 425–433. https://doi.org/10.1016/j.tourman.2009.04.011

Analytic Hierarchy Process - (ahp software). (n.d.). Copyright © 2007-2023. SpiceLogic Inc. All Rights Reserved. https://www.spicelogic.com/Products/ahp-software-30

Awasthi, A., Omrani, H., & Gerber, P. (2018). Investigating ideal-solution based multicriteria decision making techniques for sustainability evaluation of urban mobility projects. Transportation Research Part A-policy and Practice, 116, 247–259. https://doi.org/10.1016/j.tra.2018.06.007

Banister, D. (2008). The sustainable mobility paradigm. *Transport Policy*, *15*(2), 73–80. https://doi.org/10.1016/j.tranpol.2007.10.005

Belton, V., & Stewart, T. (2002). Multiple Criteria Decision Analysis: An Integrated Approach. Springer Science & Business Media.

Benzahta, M.A., Elwalda, A., Mousa, M.M., Erkan, I. & Rahman, M. (2021). SWOT Analysis Applications: An Integrative Literature Review. Journal of Global Business Insights, 6(1), 55-73. https://www.doi.org/ 10.5038/2640-6489.6.1.1148

Boogaard, H., Janssen, N. A., Fischer, P., Kos, G., Weijers, E., Cassee, F. R., Van Der Zee, S. C., De Hartog, J. J., Meliefste, K., Wang, M., Brunekreef, B., & Hoek, G. (2012). Impact of low emission zones and local traffic policies on ambient air pollution concentrations. *Science of the Total Environment*, *435–436*, 132–140. https://doi.org/10.1016/j.scitotenv.2012.06.089

Borins, S. (1988). Electronic road pricing: An idea whose time may never come. *Transportation Research Part A: General*, *22*(1), 37–44. https://doi.org/10.1016/0191-2607(88)90061-1

Brewer, M. A., Pesti, G., & Schneider, W. F. (2006). Improving Compliance with Work Zone Speed Limits. Transport Research Record, 1948(1), 67–76. https://doi.org/10.1177/0361198106194800108

Buehler, R., Pucher, J., Gerike, R. & Cötschi, T. (2017). Reducing car dependence in the heart of Europe: lessons from Germany, Austria, and Switzerland. Transport Reviews, 37(1), 4-18. https://doi.org/10.1080/01441647.2016.1177799

Buehler, R., Pucher, J., Gerike, R., & Götschi, T. (2017). Reducing car dependence in the heart of Europe: lessons from Germany, Austria, and Switzerland. Transport Reviews, 37(1), 4–28. https://doi.org/10.1080/01441647.2016.1177799

Bursa, B., Mailer, M., & Axhausen, K. W. (2022). Intra-destination travel behavior of alpine tourists: a literature review on choice determinants and the survey work. Transport, 49(5), 1465–1516. https://doi.org/10.1007/s11116-022-10267-y

Button, K. J. (1986). Transport Economics. Gower Publishing Company.

Cairns, S., Sloman, L., Newson, C., Anable, J., Kirkbride, A., & Goodwin, P. (2008). Smarter choices: assessing the potential to achieve traffic reduction using 'soft measures'. Transport reviews, 28(5), 593-618

Ceccato, V., Gaudelet, N., & Graf, G. (2022). Crime and safety in transit environments: a systematic review of the English and the French literature, 1970–2020. Public Transport, 14(1), 105–153. https://doi.org/10.1007/s12469-021-00265-1

Centraal Bureau voor de Statistiek. (2021). Hoeveel fietsen inwoners van Nederland? https://www.cbs.nl/nl-nl/visualisaties/verkeer-en-vervoer/personen/fietsen

Cools, M., Moons, E., Janssens, B., & Wets, G. (2009). Shifting towards environment-friendly modes: profiling travelers using Q-methodology. Transport, 36(4), 437–453. https://doi.org/10.1007/s11116-009-9206-z

Cuccia, T., & Rizzo, I. (2011). Tourism seasonality in cultural destinations: Empirical evidence from Sicily. Tourism Management, 32(3), 589–595. https://doi.org/10.1016/j.tourman.2010.05.008

de Kruijf, J., Ettema, D., Kamphuis, C. B. M., & Dijst, M. (2018). Evaluation of an incentive program to stimulate the shift from car commuting to e-cycling in the Netherlands. Journal of transport and health, 10, 74–83. https://doi.org/10.1016/j.jth.2018.06.003

Demmers, L. (2021). Toeristisch Toekomstplan Texel. Texel in balans. Naar een authentiek, duurzaam en gastvrij eiland. Retrieved on 03-03-2023 via https://loket.texel.nl/mozard/document/docnr/5882087

Doomah, M., & Paupoo, D. (2022). Evaluation of the effectiveness of speed tables combined with other traffic calming measures and their community acceptance in Mauritius. Case studies on transport policy, 10(3), 1550–1565. https://doi.org/10.1016/j.cstp.2022.04.022

Ewing, R. (1999). Traffic Calming: State of the Practice [Presentatieslides; Seminar]. National Association of City Transport Officials. https://nacto.org/wp-content/uploads/2012/06/Ewing-Reid-1999.pdf

Farla, J., Alkemade, F., & Suurs, R. A. (2010). Analysis of barriers in the transition toward sustainable mobility in the Netherlands. Technological Forecasting and Social Change, 77(8), 1260–1269. https://doi.org/10.1016/j.techfore.2010.03.014

Foth, M., & Schroeter, R. (2010). Enhancing the experience of public transport users with urban screens and mobile applications. Proceedings of the 14th International Academic MindTrek Conference: Envisioning Future Media Environments. https://doi.org/10.1145/1930488.1930496

Gemeente Texel. (2015). Mobiliteitsvisie Texel 2015-2025 Durzame mobiliteit op Texel. Retrieved on 03-03-2023 via https://www.texel.nl/wp-content/uploads/2021/04/Mobiliteitsvisie-Texel-2015-2025.pdf

Gemeente Texel. (2022). Evaluatie betaald parkeren Texel 2021. Retrieved on 03-03-2023 via https://texel.bestuurlijkeinformatie.nl/Document/View/0159c114-ff90-48dc-b39f-47c472ef064b

González, R. M., Román, C., & De Dios Ortúzar, J. (2019). Preferences for sustainable mobility in natural areas: The case of Teide National Park. Journal of Transport Geography, 76, 42–51. https://doi.org/10.1016/j.jtrangeo.2019.03.002

Gronau, W. (2017). Encouraging behavioural change towards sustainable tourism: a German approach to free public transport for tourists. Journal of Sustainable Tourism, 25(2), 265–275. https://doi.org/10.1080/09669582.2016.1198357

Gronau, W., & Kagermeier, A. (2007). Key factors for successful leisure and tourism public transport provision. Journal of Transport Geography, 15(2), 127–135. https://doi.org/10.1016/j.jtrangeo.2006.12.008

Guler, S. I., & Menendez, M. (2014). Analytical formulation and empirical evaluation of pre-signals for bus priority. Transport Research Part B-methodological, 64, 41–53. https://doi.org/10.1016/j.trb.2014.03.004

Gutiérrez, A., & Miravet, D. (2016). The Determinants of Tourist Use of Public Transport at the Destination. Sustainability, 8(9), 908. https://doi.org/10.3390/su8090908

Hamadneh, J., & Jaber, A. (2023). Modeling of intra-city transport choice behaviour in Budapest, Hungary. Journal of urban mobility, 3, 100049. https://doi.org/10.1016/j.urbmob.2023.100049

Haugland, B. T., & Skjølsvold, T. M. (2020). Promise of the obsolete: expectations for and experiments with self-driving vehicles in Norway. Sustainability : Science, Practice and Policy, 16(1), 37–47. https://doi.org/10.1080/15487733.2020.1765677

History Extra. (2021). Texel: Europe's last battle of the Second World War. Retrieved on 25-02-2023 via https://www.historyextra.com/period/second-world-war/texel-dutch-island-georgia-germany-europe-last-battle-ww2/

Hu, X., Chiu, Y., & Zhu, L. (2015). Behavior Insights for an Incentive-Based Active Demand Management Platform. International journal of transport science and technology, 4(2), 119–133. https://doi.org/10.1260/2046-0430.4.2.119

Hysing, E., Frändberg, L., & Vilhelmson, B. (2015). Compromising sustainable mobility? The case of the Gothenburg congestion tax. Journal of Environmental Planning and Management, 58(6), 1058–1075. https://doi.org/10.1080/09640568.2014.912615

Ibarra-Rojas, O. J., Delgado, F., Giesen, R., & Muñoz, J. C. (2015). Planning, operation, and control of bus transport systems: A literature review. Transport Research Part B-methodological, 77, 38–75. https://doi.org/10.1016/j.trb.2015.03.002

Ishizaka, A., & Labib, A. (2011). Review of the main developments in the analytic hierarchy process. Expert Systems With Applications. https://doi.org/10.1016/j.eswa.2011.04.143

Kalter, M. J. O., Coffeng, G., & Groenendijk, L. (2018). Aantrekkelijkheid en afwisseling routes meer sturend in keuzegedrag fietsers dan snelheid. https://www.cvs-congres.nl/e2/site/cvs/custom/site/upload/file/cvs_2018/id_209_laura_groenendijk_aantrekkelijkheid_en_afwisseling_routes_meer_sturend_in_keuzegedrag_.pdf

Keall, M., Shaw, C., Chapman, R., & Howden-Chapman, P. (2018, 1 december). Reductions in carbon dioxide emissions from an intervention to promote cycling and walking: A case study from New Zealand. Transport Research Part D-transport and Environment; Elsevier BV. https://doi.org/10.1016/j.trd.2018.10.004

Kelly, J., Haider, W., & Williams, P. (2007). A Behavioral Assessment of Tourism Transport Options for Reducing Energy Consumption and Greenhouse Gases. Journal of Travel Research, 45(3), 297–309. https://doi.org/10.1177/0047287506292700

Kennisinstituut voor Mobiliteitsbeleid (KiM), Harms, L., Berveling, J., & Hoogendoorn, R. (2017). Stabiele beelden verdiept: trends in beleving en beeldvorming van mobiliteit. Kimnet.nl.https://www.kimnet.nl/publicaties/rapporten/2017/04/24/stabiele-beelden-verdiept-trends-in-beleving-en-beeldvorming-van-mobiliteit

Kuss, P. & Nicholas, K.A. (2022). A dozen effective interventions to reduce car use in European cities: Lessons learned from a meta-analysis and transition management. Case Studies on Transport Policy, 10, 1494-1513. https://doi.org/10.1016/j.cstp.2022.02.001

Kuss, P., & Nicholas, K. A. (2022). A dozen effective interventions to reduce car use in European cities: Lessons learned from a meta-analysis and transition management. Case studies on transport policy, 10(3), 1494–1513. https://doi.org/10.1016/j.cstp.2022.02.001

Leape, J. (2006). The London Congestion Charge. Journal of Economic Perspectives, 20(4), 157–176. https://doi.org/10.1257/jep.20.4.157

Liu, C., Wang, J., Cai, W., & Zhang, Y. (2019). An Energy-Efficient Dynamic Route Optimization Algorithm for Connected and Automated Vehicles Using Velocity-Space-Time Networks. IEEE Access, 7, 108866–108877. https://doi.org/10.1109/access.2019.2933531

Liu, L., & Miller, H. J. (2022). Measuring the impacts of dockless micro-mobility services on public transit accessibility. Computers, Environment and Urban Systems, 98, 101885. https://doi.org/10.1016/j.compenvurbsys.2022.101885

Lyonel, A. (2015). Electrifying transport with e-bikes - A Travel Awareness campaign plan. http://lup.lub.lu.se/student-papers/record/5471723

Mahdi, A. J., Hamadneh, J., & Esztergár-Kiss, D. (2022). Modeling of Travel Behavior in Budapest: Leisure Travelers. Transport research procedia, 62, 310–317. https://doi.org/10.1016/j.trpro.2022.02.039

Mantero, C. (2022). Sustainable, Smart and Safe Mobility at the Core of Sustainable Tourism in Six European Islands. Sustainable Mobility for Island Destinations, 1-18.

Marcheschi, E., Vogel, N., Larsson, A., Perander, S. & Koglin, T. (2022). Residents' acceptance towards car-free street experiments: Focus on perceived quality of life and neighborhood attachment. Transport Research Interdisciplinary Perspective, 14, 1-10. https://doi.org/10.1016/j.trip.2022.100585

Masoumi, H. E. (2019). A discrete choice analysis of transport mode choice causality and perceived barriers of sustainable mobility in the MENA region. Transport Policy, 79, 37–53. https://doi.org/10.1016/j.tranpol.2019.04.005

Mertens, L., Van Dyck, D., Ghekiere, A., De Bourdeaudhuij, I., Deforche, B., Van De Weghe, N., & Van Cauwenberg, J. (2016). Which environmental factors most strongly influence a street's appeal for bicycle transport among adults? A conjoint study using manipulated photographs. International Journal of Health Geographics, 15(1). https://doi.org/10.1186/s12942-016-0058-4

Miravet, D., Domènech, A., & Gutiérrez, A. (2021). What prompts tourists to become public transport users at their destination? The case of a Mediterranean city. Travel behaviour and society, 24, 10–21. https://doi.org/10.1016/j.tbs.2021.01.007

Münscher, R., Vetter, M., & Scheuerle, T. (2015). A Review and Taxonomy of Choice Architecture Techniques. Journal of Behavioral Decision Making, 29(5), 511–524. https://doi.org/10.1002/bdm.1897

Nationaal Park Duinen van Texel (n.d.). Dark Sky Waddengebied. Retrieved 20-3-2023 from: https://www.npduinenvantexel.nl/16049/over-het-park/dark-sky-in-waddengebied

Noori, N., Hoppe, T. & de Jong, M. (2020). Classifying Pathways for Smart City Development: Comparing Design, Governance and Implementation in Amsterdam, Barcelona, Dubai, and Abu Dhabi. Sustainability, 12(10), 1-26. doi:10.3390/su12104030

Nunkoo, R., & Ramkissoon, H. (2010). Small island urban tourism: a residents' perspective. Current Issues in Tourism, 13(1), 37–60. https://doi.org/10.1080/13683500802499414

Ouali, L. A. B., Graham, D. Y., Trompet, M., & Barron, A. R. (2020). Gender differences in the perception of safety in public transport. Journal of the Royal Statistical Society, 183(3), 737–769. https://doi.org/10.1111/rssa.12558

Parry, I. W., & Bento, A. M. (2002). Estimating the Welfare Effect of Congestion Taxes: The Critical Importance of Other Distortions within the Transport System. Journal of Urban Economics, 51(2), 339–365. https://doi.org/10.1006/juec.2001.2248

Paudel, J. (2021). Bus ridership and service reliability: The case of public transport in Western Massachusetts. Transport Policy, 100, 98–107. https://doi.org/10.1016/j.tranpol.2020.10.010

Pimentel, D., Lowry, M. B., Koglin, T. W., & Pimentel, R. W. (2020). Innovation in a Legal Vacuum: The Uncertain Legal Landscape for Shared Micro-Mobility. Journal of Law and Mobility, 2020, 17. https://doi.org/10.36635/jlm.2020.innovation

Pira, M. L., Marcucci, E., & Gatta, V. (2021, juli 9). Roman holiday: Tourist heterogeneous preferences for walking path elements. Research in Transport Economics; Elsevier BV. https://doi.org/10.1016/j.retrec.2021.101106

Pourhashem, G., Malichova, E., & Kovacikova, T. (2021). The role of participation behavior and information in nudging citizens sustainable mobility behavior: a case study of Bratislava region. 2021 19th International Conference on Emerging ELearning Technologies and Applications (ICETA). https://doi.org/10.1109/iceta54173.2021.9726681

Rathnayake, U. (2012). Paradox between Public Transport and Private Car as a Modal Choice in Policy Formulation. Journal of Bangladesh Institute of Planners, 2, 71–77. https://doi.org/10.3329/jbip.v2i0.9568

Reeves, R. (2006). Tackling traffic. Council for National Parks.

Richardson, T., Hjerpe, M., & Gullberg, A. (2010). Changing Frames of Mobility through Radical Policy Interventions? The Stockholm Congestion Tax. International Planning Studies, 15(1), 53–67. https://doi.org/10.1080/13563471003765703

Riggs, W. (2016). Cargo bikes as a growth area for bicycle vs. auto trips: Exploring the potential for mode substitution behavior. Transport Research Part F-traffic Psychology and Behaviour, 43, 48–55. https://doi.org/10.1016/j.trf.2016.09.017

Route.nl. (n.d.). Een rondje over Texel. Retrieved on 03-04-2023 via https://www.route.nl/route?route-id=114655/een-rondje-over-texel

Russo, A., Adler, M. W., & Van Ommeren, J. (2022). Dedicated bus lanes, bus speed and traffic congestion in Rome. Transport Research Part A-policy and Practice, 160, 298–310. https://doi.org/10.1016/j.tra.2022.04.001

Saaty, T. L., & Kearns, K. P. (1985). The Analytic Hierarchy Process. Elsevier eBooks, 19–62. https://doi.org/10.1016/b978-0-08-032599-6.50008-8

Selzer, S. (2021). Car-reduced neighborhoods as blueprints for the transition toward an environmentally friendly urban transport system? A comparison of narratives and mobility-related practices in two case studies. Journal of Transport Geography, 96, 1-12. https://doi.org/10.1016/j.jtrangeo.2021.103126

SHARE-North. (2021) Shared Mobility Should be part of every SUMP. Retrieved on 13-03-2023 from: https://share-north.eu/the-guide/

Siren, A. K., & Hakamies-Blomqvist, L. (2005). Sense and sensibility. A narrative study of older women's car driving. Transport Research Part F-traffic Psychology and Behaviour, 8(3), 213–228. https://doi.org/10.1016/j.trf.2005.04.008

Sitalsing, S. (2022). De Volkskrant. Achter elke crisis schuilt een bestuurlijke clusterfuck. Retrieved on 12-03-2023 from: https://www.volkskrant.nl/nieuws-achtergrond/achter-elke-crisis-schuilt-een-bestuurlijke-clusterfuck~bc21fda4/

Small, K. A., & Verhoef, E. T. (2007). The Economics of Urban Transport. Psychology Press.

Smith, M. N., & Clarke, R. V. (2000). Crime and Public Transport. *Crime and Justice*, *27*, 169–233. https://doi.org/10.1086/652200

Somanathan, E., Sterner, T., Sugiyama, T., Chimanikire, D. P., Dubash, N. K., Essandoh-Yeddu, J. K., Fifita, S., Goulder, L. H., Jaffe, A. B., Labandeira, X., Managi, S., Mitchell, C., Montero, J., Teng, F., & Zylicz, T. (2014). National and Sub-national Policies and Institutions. Cambridge University Press EBooks, 1141–1206. https://doi.org/10.1017/cbo9781107415416.021

Soomauroo, Z., Blechinger, P., & Creutzig, F. (2020). Unique Opportunities of Island States to Transition to a Low-Carbon Mobility System. Sustainability, 12(4), 1435. https://doi.org/10.3390/su12041435

SpiceLogic | Intuitive Windows Software since 2007. (n.d.). Copyright © 2007-2023. SpiceLogic Inc. All Rights Reserved. https://www.spicelogic.com/

Stradling, S. G., Carreno, M., Rye, T., & Noble, A. F. (2007). Passenger perceptions and the ideal urban bus journey experience. Transport Policy, 14(4), 283–292. https://doi.org/10.1016/j.tranpol.2007.02.003

Surprenant-Legault, J., & Levinson, D. (2011). Introduction of Reserved Bus Lane. Transport Research Record, 2218(1), 10–18. https://doi.org/10.3141/2218-02

Taylor, B. D., & Fink, C. (2013). Explaining transit ridership: What has the evidence shown? Transport Letters: The International Journal of Transport Research, 5(1), 15–26. https://doi.org/10.1179/1942786712z.0000000003

TESO. (2022). TESO Vervoerscijfers. https://www.kadotexel.nl/cijfers/teso-vervoerscijfers

Texel Monitor. (2022). VVV Texel. https://www.kadotexel.nl/cijfers/monitor-texelbezoek

Texels Belang, PvdA pro Texel & Groen Links Texel. (2022). Bouwen aan vertrouwen, voor een sociaal en duurzaam Texel Coalitieakkoord van Texels Belang - PvdA pro Texel - Groenlinks Texel. Retrieved on 18=-3-2023 via https://www.texel.nl/wp-content/uploads/2022/06/Coalitieakkoord-2022-2026-Bouwen-aan-vertrouwen-voor-een-sociaal-en-duurzaam-Texel.pdf

Texlabs. (n.d). Retrieved on 15-02-2023 via https://www.texlabs.nl

Thao, V. T., Von Arx, W., & Frölicher, J. (2020). Swiss Cooperation in the Travel and Tourism Sector: Long-term Relationships and Superior Performance. Journal of Travel Research, 59(6), 1044–1060. https://doi.org/10.1177/0047287519871105

Tomaszewska, E. J., & Florea, A. (2018). Urban smart mobility in the scientific literature — bibliometric analysis. Engineering Management in Production and Services, 10(2), 41–56. https://doi.org/10.2478/emj-2018-0010

Tormo-Lancero, M.T. et al. (2022). Development of a Roadmap for the Implementation of a Sustainable Mobility Action Plan in University Campus of Emerging Countries. Frontiers in Sustainable Cities, 3, 1-13. https://doi.org/10.3389/frsc.2021.668185

Vafaei, N., Ribeiro, R. A., & Camarinha-Matos, L. M. (2016). Normalization Techniques for Multi-Criteria Decision Making: Analytical Hierarchy Process Case Study. Springer eBooks, 261–269. https://doi.org/10.1007/978-3-319-31165-4_26

Vaidya, O. S., & Kumar, S. (2006). Analytic hierarchy process: An overview of applications. European Journal of Operational Research, 169(1), 1–29. https://doi.org/10.1016/j.ejor.2004.04.028

Vedel, S. E., Jacobsen, J. B., & Skov-Petersen, H. (2017). Bicyclists' preferences for route characteristics and crowding in Copenhagen – A choice experiment study of commuters. Transport Research Part A-policy and Practice, 100, 53–64. https://doi.org/10.1016/j.tra.2017.04.006

VVV Texel. (n.d.a). Wist je dat over Texel? https://www.texel.net/nl/over-texel/wist-je-dat-over-texel/

VVV Texel. (n.d.b). De favoriete fietsroutes van VVV Texel. Retrieved on 03-04-2023 via https://www.texel.net/nl/zien-en-doen/sportief/fietsen/de-favoriete-fietsroutes-van-vvv-texel/

Welsh, B. C., & Farrington, D. P. (2009). Public Area CCTV and Crime Prevention: An Updated Systematic Review and Meta-Analysis. Justice Quarterly, 26(4), 716–745. https://doi.org/10.1080/07418820802506206

Winkowska, J., Szpilko, D., & Pejić, S. (2019). Smart city concept in the light of the literature review. Engineering Management in Production and Services, 11(2), 70–86. https://doi.org/10.2478/emj-2019-0012

Yaliniz, P., & Bilgiç, Ş. (2015). As a Sustainable Transport Issue Evaluation Of Dolmush Taxi Transition in Bursa Turkey. National Research Council of Italy. https://doi.org/10.15224/978-1-63248-079-8-51

Yan, X., Levine, J. M., & Marans, R. W. (2019). The effectiveness of parking policies to reduce parking demand pressure and car use. Transport Policy, 73, 41–50. https://doi.org/10.1016/j.tranpol.2018.10.009

Yeong, D. J., Velasco-Hernandez, G., Barry, J. M., & Walsh, J. T. (2021). Sensor and Sensor Fusion Technology in Autonomous Vehicles: A Review. Sensors, 21(6), 2140. https://doi.org/10.3390/s21062140

Zahedi, F. (1986). The Analytic Hierarchy Process—A Survey of the Method and its Applications. Interfaces, 16(4), 96–108.

Zanella, A., Bui, N., Castellani, A., Vangelista, L., & Zorzi, M. (2014). Internet of Things for Smart Cities. IEEE Internet of Things Journal, 1(1), 22–32. https://doi.org/10.1109/jiot.2014.2306328

Zhang, Y., Wang, L., Jiang, X., Zeng, Y., & Dai, Y. (2021). An efficient LiDAR-based localization method for self-driving cars in dynamic environments. Robotica, 40(1), 38–55. https://doi.org/10.1017/s0263574721000369

6. Appendices

6.1 Interviews

Appendix 1 contains the questions from the interviews conducted with the stakeholders. Additionally, the interviewees are introduced, and a summary of the interview is provided.

6.1.1. Interview Questions

This is the list of general interview questions that we asked each interviewee. Potential follow-up questions are noted below each question. During the interview questions related to specific details of the interview might have been asked. However, those question are not included in this list.

Question 1
Can you introduce yourself? Can you tell us about the organisation and your role within the organisation?

(Kunt u uzelf kort introduceren, wat doet uw organisatie en wat is uw rol daarin?)

Question 2
What do you think about the current situation around mobility on Texel, and specifically around tourist mobility? Could you reflect on this in terms of safety, accessibility, user-friendliness and sustainability?

(Wat denkt u over de huidige situatie met betrekking tot mobiliteit op Texel, en specifiek de mobiliteit rondom toerisme? Kunt u veiligheid, toegankelijkheid, gebruikersvriendelijkheid en duurzaamheid hierbij betrekken?)

Follow up:

- What can be improved?

(Wat kan er worden verbeterd?)

- What policy/ infrastructure changes are needed to facilitate this improvement?

(Welke veranderingen in beleid en infrastructuur zijn nodig om verbetering te faciliteren?)

- Do you think this situation is sustainable (as in, does it work in the long run?)

(Denkt u dat de huidige situatie duurzaam is en stand kan houden op de lange termijn?)

Question 3
How is/can your organisation (be) related to sustainable mobility for tourists on Texel?

(Hoe is (kan) uw organisatie verwant zijn aan duurzame mobiliteit voor toeristen op Texel?)

Follow up:

- Are there any future plans/projects within the organisation to create more sustainable mobility?

(Zijn er projecten voor in de toekomst of plannen binnen de organisatie met de intentie om meer duurzame mobiliteit te creëren?)

- What collaborations are needed between your organisation and other ones to realise a change?

(Welke samenwerkingen tussen uw organisatie en andere partijen zijn nodig om verandering te realiseren?)

- In what way is your organisation in contact with tourists on Texel?

(Op wat voor een manier is uw organisatie in contact met toeristen op Texel?)

- What can your organisation's role be in the transition to sustainable mobility?

(Wat kan de rol zijn van uw organisatie in de transitie tot duurzame mobiliteit?)

- Do you know of any innovations to promote sustainable mobility on the island? Do you think these could be successful?

(Zijn er op het eiland innovaties waar u kennis van heeft die duurzame mobiliteit promoten? Denkt u dat deze succesvol zijn?)

Question 4

What are the current challenges in sustainable tourism that Texel faces in the transition to sustainable mobility?

(Wat zijn de huidige uitdagingen voor duurzaam toerisme waar Texel tegen aan loopt in de transitie naar duurzame mobiliteit)

Follow up:

What is needed to overcome these challenges?

(Wat is er voor nodig om deze uitdagingen aan te kunnen pakken?)

Question 5

Could you please rate the following criteria around mobility on importance from 1-5?

(Kunt u alstublieft de volgende criteria rondom mobiliteit een cijfer geven van 1-5 op basis van belang voor mobiliteit?)

1. **Accessibility**

(Toegankelijkheid)

2. **Cost/fare of ticket or cost of service**

(Kosten)

3. **Fuel efficiency/ carbon emission**

(Brandstofefficiëntie en uitstoot)

4. **Speed**

(Snelheid)

5. **Capacity/Carrying Capacity**

(Capaciteit)

6. **Integration with other modes**

(Integratie met andere transport opties)

7. **Reliability of the vehicle/mode & frequency**

(Betrouwbaarheid & regelmaat)

8. **Comfort**

(Comfort)

9. **Safety**

(Veiligheid)

6.1.2. Interview Summaries and Stakeholder Group Justification

Interviewee A

Interviewee A is, as a director of TESO and an active member of the sustainability board, can be seen as a private actor, this is stakeholder group 1. Following is a summary of the interview:

In this interview, the director of TESO talks about the mobility situation on the Dutch island of Texel. Interviewee A explains that Texel, mobility-wise, is comparable to a mid-sized city, with up to 60,000 visitors per day during the summer. Most of these visitors are tourists who usually stay an average of around 5 nights on the island. Tourists want to experience as much as possible of Texel's culture and nature, so they often travel around 50 kilometres per day, which consists of multiple trips. As Texel lacks a public transport network that can support this kind of mobility, visitors often rely on cars to get around. The director explains that cycling is the most sustainable way to get around Texel after walking. However, the bike paths can become overcrowded, leading to safety issues. The director also mentions that TESO, a ferry company, has reduced its fares for pedestrians to encourage sustainable travel. The director concludes by saying that TESO lacks a bus connection for its passengers on over 4,000 crossings per year. TESO is interested in developing a sustainable solution that would encourage more visitors to travel by public transport or bicycle, rather than cars.

Interviewee B

Interviewee B is part of stakeholder group 2, the users, as he is the chairman of the Cycling Association of Texel, the Fietsersbond. In addition, he is a professor of sustainable development in Delft and Aalborg. Following is a summary of the interview:

Interviewee B has been involved in sustainable tourism on Texel for years, and also lives on Texel half of the year. He would rate the mobility situation on Texel around a 7, mainly from a cyclists perspective. Texel used to be in the top 10 in the annual Fietsersbond survey, but now it dropped outside of the top hundred. That has to do with the experience of cycling lanes, safety and facilities. The public bus service can be extended again, like on the other islands.

Texel has lost its top position as cycling area. There used to be more separate cycling lanes, but then there was more focus on shared space and this changed. On many roads cyclists share the road with cars. They call them bicycle roads, but this is not communicated well. Additionally, in the plans for the Texel dark sky cycling lanes would get smart lighting systems, but this was not realised. This creates feelings of unsafety.

The Fietsersbond has become more active in recent years, as they saw the situation had become worse, especially compared to other areas that score high in the Fietsersbond survey. These are not only other islands, but also areas like around Utrecht where they use smart lighting and sign systems. It is expected that this will also come to Texel, but there are some issues as people on Texel like to drive hard.

Texel could improve by learning from other places, islands or the mainland, and admit that they are doing a better job.

The Fietsersbond is also looking at how a luggage delivery system could be implemented, as this also facilitates cycling. The same goes for transporting bikes on the Texelhopper. Many studies have been done on these subjects, but for some reason they have not been implemented.

Texel attracts people from all kinds of groups in society, as it is easy to reach for a day. Other islands have a more academic character. Many people also come to Texel for the nature, they behave more sustainably. But Texel also remains a farmers island. Compared to the other islands, Texel has a bit of a rough image, so this is double about Texels character. This is also seen in public discussions about the future of tourism, whether it should increase or decrease. Should we aim for quality of quantity?

The quality of the cycling lanes on Texel is not according to standards anymore, especially when it is busy. This has to do with the amount of tourists and the different types of bikes they use. The province pays for the upkeep of roads, and in turn this has to be done following some regulations. They take the money, but do their own thing with it, without much control. This leads to bicycle streets that do not function as such, leading to unsafety.

Interviewee B has the impression that tourists use their cars mostly for groceries or transport of other stuff like luggage. They also use them when the weather is bad and want to get somewhere. There is also still an official VVV Texel route designed for cars.

Interviewee C

This interview was conducted with Interviewee C , who is an employee at the municipality of Texel. This interviewee is categorized as a 'public actor' and is thus part of stakeholder group 3 because of his role at the local government. Following is a summary of the interview:

Interviewee C, who resides on Texel and works at the municipality of Texel, is tasked with examining green and blue spaces as well as transport on the island. He plans to develop a new mobility vision during the summer. According to Interviewee C, there has been an increase in the use of cars for activities like visiting museums and beaches. To promote alternative modes of transport, Interviewee C recommends improving bike paths and utilizing bike rental services. For instance, it would be beneficial to have a bike available at all tourist accommodations. Additionally, Interviewee C suggests allowing renters to return their bikes at different locations to account for wind conditions. Other small initiatives include car-sharing services, a coupon book linked to using bikes, and collaboration with various organizations and stakeholders. The primary focus will be on the bike, and the current car-friendly environment will be transformed into a situation where car usage is restricted. Furthermore, Interviewee C highlights that Texel differs from other Waddeneilanden due to its larger size, which explains why cars are permitted on Texel but not on Vlieland or Terschelling. The municipality of Texel aims to reduce car usage by promoting sustainable transport through incentives rather than laws and regulations. When considering various policy instruments such as regulations, economic incentives, education, and services, Interviewee C does not have a dominant preference. Finally, the interviewee suggests examining the coalition program.

Interviewee D

This interview was conducted with interviewee D, who is the owner of bicycle a rental company on Texel. This interviewee is categorized as a 'private actor', group 1, because he is a local entrepreneur on the island. Following is a summary of the interview:

The company has thousands of bicycles available for rental. Renters pay for a specific period of time, not for the amount they use the bike. The company also has a stake in Mobian Global, which buys overcapacity from parking garages and converts it into mobility hubs. According to the interviewee, the problem feels bigger than it actually is, especially in the summer months. It is preferable to reward people for not using their car, instead of punishing those who do want to drive. The interviewee is worried about parts of the cycling network because electrification of bikes makes them quicker. Additionally, there are increasingly many cargo bicycles on the island, and the infrastructure was not designed for these. When asked what should be improved, he suggests upgrading the quality of the cycling paths. It is necessary to critically examine how tourists and inhabitants can be persuaded to use different modes of transport. He is developing an app that will reward travellers points for every kilometre travelled sustainably. The interviewee also notes that Texel has no underground parking garages, which is something he thinks people should be open to.

When asked about the flexibility of bike rental, he explains that renters must bring the bike back to where it was rented and always pay for a full day of rental. He thinks that a shared-bike system is difficult on Texel, but there could be a very specific market for it. Regarding public transport on Texel, he stated that the Texelhopper service is a good solution. He also does not believe in making public transport free, as it would do little to reduce congestion. However, he thinks that cars can be partly replaced by (electric) cargo bikes. The bike is a solution, but not the only one, as with bad weather, people would take the car. He reiterated that people should not be punished for this. He is working on an idea that rewards cyclists with points that can be exchanged for museum tickets or at restaurants. He also believes that infrastructure should be improved, and charging stations should be built. He thinks the ferry service TESO plays a crucial role in promoting sustainable transport, but notes that they traditionally are a closed organization that is hesitant to change.

Regarding the safety of cycling on Texel, he believes it is generally safe, but there are critical areas that need attention. Interviewee D is willing to play an active role in finding a solution to the transport problem on Texel.

Interviewee E

This interview was conducted with interviewee E, who is the director-owner of TBO Texel, who also have control over the company of Texelhopper, public transport companies on Texel. This interviewee is categorized as a 'private actor', group 1, because he is a local entrepreneur on the island. Following is a summary of the interview:

The interview is with the director-owner of TBO Texel, which has a sister company called Texelhopper, responsible for transport on the island. Texelhopper is a demand-driven public transport service for both locals and tourists, which is part of the public transport system in North Holland. The company is working with Connexxion to improve mobility in the future, especially in terms of sustainability. Texel faces the challenge of reducing car use by tourists, but the company is realistic and aims to find a balance between accommodating tourists and not disturbing locals. Currently, Texelhopper uses diesel vehicles, but the company is looking into electric and hydrogen options to reduce emissions. One of the biggest challenges is the logistics and range of electric vehicles, which is why Texelhopper currently still uses diesel vehicles. The company has investigated using hydrogen as an alternative fuel source, but currently, it is not economically viable. Therefore, the director-owner emphasizes that both technological advancement and collective action are necessary to achieve sustainable transport on the island.

Interviewee F

Interviewee E is a representative of Stichting Texelse Kernwaarden and is categorised in stakeholder group 2: Public Actors as this organisation has an influence on the local government. Following is a summary of the interview:

Interviewee F, a representative of Texelse Kernwaarden, a public organization consisting of residents of Texel Island in the Netherlands, discusses the importance of accurately tracking tourists. According to Interviewee F, Texel has a maximum limit of 45,000 tourist beds, determined by a norm that assigns different values to various types of accommodations. Interviewee F notes that there are additional considerations, such as the local government's tourism plan that includes a "paraplu plan" outlining these values. He feels there are issues related to the values associated with bed and breakfasts, which were previously unregulated, and overnight stays in marinas, that should be considered when determining the actual number of tourists on the island.

Many visitors arrive by car, which is helpful for transporting luggage, but Interviewee F suggests that visitors use alternative modes of transport once on the island. He mentions the possibility of a transferium, where visitors would be picked up by a bus and their luggage transported separately to their accommodation. However, he believes most visitors will continue to use their cars even if this system is implemented. Cycling is a good alternative, with numerous rental options available, and the island is investing in improving its bike paths. Interviewee F cautions against widening all bike paths, as it may detract from the island's character, but suggests focusing on areas with the most traffic. The main bus line connects the ferry port to De Koog with stops along the way, and the rest of the island is served by Texel Hopper, a flexible service that can be ordered by phone half an hour in advance. Although Interviewee F believes that the Texel Hopper service has improved, he prefers to use a bike or car. He explains that Texel's road network is more complex than that of other Dutch islands due to its unique shape and thinks that the current transport system is the best feasible option.

To help regulate traffic on narrow roads, the island needs to introduce grass paving on the sides of the roads to visually narrow them and reduce speeds. Interviewee F believes that this is a good solution, especially given the increase in traffic over the years. Texelse KernWaarden advises the local government and takes legal action when they believe decisions are not in the island's best interest. However, they prefer to be involved in decision-making from the beginning rather than merely acting as enforcers. Interviewee F highlights the importance of encouraging people to use alternative modes of transport rather than forcing them to do so. He also mentions the challenge of dealing with companies that rent out vehicles like tuk-tuks and quads, which can be noisy and disruptive. While these vehicles are legally allowed on the island, some people use them in ways that are not permitted, and there is limited capacity for enforcement. Interviewee F also mentions the popularity of nostalgic modes of transport like solexes, which are rented out to groups for leisurely rides on the island's bike paths.

Interviewee G

Stakeholder group: as the director of VVVTexel, a turistic information and booking platform for Texel, the interviewee is a representative of the Private Actor stakeholder group (group 1). Following is a summary of the interview:

VVV is a platform that tourists can use on Texel, with four main tasks: promotional, booking platform, information, and statistical data researching and managing. It represents a great revenue stream for the island economy, given the large density of tourists (nearly 1,200,000 yearly).

The interviewee stated that the board on the island has been discussing excessive tourism for years and that mobility is the biggest issue in terms of safety, accessibility, user-friendliness, and sustainability. According to the Central Bureau for Statistics, although the number of tourists has not grown much in the last decades, the number of cars did, bringing traffic congestions and unsafe situations during peak season. Bike and e-bike traffic has also increased. The interviewee argued that the problem is not the number of tourists but the number of cars, bikes, and general movement patterns.

As most tourists are either elderly couples or families with children, it is hard to convince them to come to the island by public transport for reasons of accessibility and luggage transport. The focus should be on convincing them to leave the car at the accommodation while on the island and make use of alternative transport instead. Attracting more environmentally aware people as tourists could be a possible solution, as well as providing guests with rental bikes directly at the accommodations.

The interviewee suggests prioritizing walking and cycling to encourage sustainable options among tourists. He also suggests implementing a loyalty system where tourists would get rewarded with discounts when using public transport or bikes. The municipality is investing more in cycling infrastructure, although much long-term, wholesome plans are needed as about 50% of residents are reaching retirement age soon, with little to no replacement options.

VVV uses mostly social media and email newsletter to reach out to people. There is a new 'Sustainable Mobility' group within VVV, which is thinking of ways to encourage tourists to choose more sustainable transport options.

The interviewee concludes that the main issue on the island is the number of cars. Since a reduction in cars would result in an increase in bicycle movement, cycling infrastructure needs to be improved. The scores of mobility criteria are listed in *Appendix 6.3.1.*

Interviewee H

Interviewee H is part of stakeholder group 4: Knowledge Institutes. The interviewee is part of KADO Texel, an research organisation. Following is a summary of the interview:

Interviewee H is the chairman of KADO Texel, which conducts research, provides advice, and data to businesses such as VVV for tourism. Interviewee H explains that tourism accounts for 70% of Texel's economy and generates around 800 million euros each year. Texel has a population of just under 15,000 and can take up to a maximum of 60,000 people when all beds are occupied. Regarding transport on Texel, interviewee H discusses the existing Texelhopper, pointing out that only 1% of the people on Texel use public transport. He refers to the rest of the Netherlands, stating that only 2.5% of people use public transport. He states that half of the population on Texel bike, but it's unclear how many people bring their bikes and how many rent them.

The interviewer discusses plans for building a parking garage in Den Helder, but interviewee H shares his doubts about whether these plans will ever be realized because it depends on a discussion taking place in Den Helder, and there are many complications with the limited space on Texel and the concentration of people in certain areas. Interviewee H then mentions a new boat dock that could be built on Texel, although it would be built on the Navy's premises, which could become a complex matter.

The interviewer asks about the relationship between the company and sustainable mobility for tourists on Texel. Interviewee H explains that sustainability and mobility are both important values for the company and that all five Wadden Islands need to collaborate to address sustainability issues. Energy production is an issue for Texel, and sustainable energy production has a lot of potential on Texel, but there is a lack of political will between governments and organizations to make it happen.

The interviewer asks interviewee H about the challenges for Texel in transitioning towards sustainable mobility. Interviewee H expresses his satisfaction with the fact that new organizations are taking unconventional and alternative approaches towards sustainable mobility and acknowledges that it is difficult to predict which solutions will be successful in the long term. The interviewer then asks interviewee H whether Uber can be considered a form of public transport, which interviewee H confirms is a potential, although he points out that it is not widely used on Texel.

Lastly, the interviewer asks interviewee H to rate nine different mobility criteria from one to five, which he does, giving reasons such as that if accessibility is not prioritized, then the particular transport option will become too expensive. Interviewee H explains that cost is also important because if it becomes too costly, it may dissuade people from using that form of transport. He also states that speed is not as important as other criteria, such as reducing emissions.

6.2. MCDA

6.2.1. Rating of MCDA criteria

	Criteria								
Interviewees	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
A	-	-	-	-	-	-	-	-	-
B	7	5	7	-	-	-	-	7	9
C	9	5	7	1	5	9	9	7	9
D	7	3	7	7	9	9	9	7	9
E	7	3	3	5	7	5	9	3	7
F	9	5	7	1	3	7	5	3	7
G	5	7	5	3	5	3	7	5	9
H	9	9	9	5	9	9	9	7	9
Average	**7.57**	**5.29**	**6.43**	**3.67**	**6.33**	**7.00**	**8.00**	**5.57**	**8.43**
Note: 1. Accessibility, 2. Cost, 3. Sustainability, 4. Speed, 5. Capacity, 6. Integration, 7. Reliability, 8. Comfort, 9. Safety									

Criteria	**Stakeholder Average**	**Normalized Weight**
Accessibility	7.57	0.13
Cost/fare of ticket or cost of service	5.29	0.09
Sustainability	6.43	0.11
Speed	3.67	0.06
Capacity/ Carrying Capacity (with space)	6.33	0.11
Integration with other modes	7.00	0.12
Reliability of the vehicle/mode & frequency	8.00	0.14
Comfort	5.57	0.10
Safety	8.43	0.14

6.2.2. Ranking of Recommendations with MCDA Criteria

We have developed a criterion that shows the main factors that people may consider when choosing a certain type of transport. The advice is rated on how well it would perform on each criterion after being implemented, using the rating scale of **1 to 5** (1 indicating that the solution/advice would not meet the standards or requirements set by that criterion, and 5 meaning that the solution/advice performs very well on that criterion). By evaluating these factors using the Multi-Decision Criteria Analysis tool, we can gain a clear understanding of the crucial aspects of the problem and make informed decisions when selecting the best solutions.

Recommendation 1.1: Traffic Management Through Information Driven Congestion Targeting

Advice 1.1: Traffic management through information driven congestion targeting	**Criteria** *Note: 1. Accessibility, 2. Cost, 3. Sustainability, 4. Speed, 5. Capacity, 6. Integration, 7. Reliability, 8. Comfort, 9. Safety*								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Philip	5	4	4	3	2	2	4	2	3
Esmee	4	2	4	4	4	4	4	4	5
Ruth	4	4	4	3	3	2	4	4	3
Agnese	3	2	2	4	2	2	5	5	3
Renske	3	2	4	3	3	3	4	4	5
Wessel	5	2	2	3	2	2	5	4	3
Guus	3	2	3	4	3	2	4	5	4
Timo	4	3	4	3	2	2	5	4	4
Pepijn	4	1	4	2	2	4	4	3	3
Average	3.89	2.44	3.44	3.22	2.56	2.56	4.33	3.89	3.67

Recommendation 1.2: Parking Reform

Advice 1.2: Parking Reform	**Criteria** *Note: 1. Accessibility, 2. Cost, 3. Sustainability, 4. Speed, 5. Capacity, 6. Integration, 7. Reliability, 8. Comfort, 9. Safety*								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Philip	3	4	3	2	1	2	3	1	1
Esmee	3	4	4	3	3	3	3	3	4
Ruth	2	3	5	2	2	3	3	2	3

Agnese	2	2	2	3	2	2	4	5	3
Renske	3	2	4	3	4	3	3	2	4
Wessel	4	3	3	4	2	2	4	4	3
Guus	3	2	3	2	3	2	2	3	4
Timo	3	2	4	3	2	2	3	2	4
Pepijn	3	2	4	3	2	4	3	2	4
Average	2.89	2.67	3.56	2.78	2.33	2.56	3.11	2.67	3.33

Recommendation 1.3: Making Cars Inconvenient

Advice 1.3: Making Cars Inconvenient	**Criteria** *Note: 1. Accessibility, 2. Cost, 3. Sustainability, 4. Speed, 5. Capacity, 6. Integration, 7. Reliability, 8. Comfort, 9. Safety*								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Philip	2	3	3	2	1	2	2	1	4
Esmee	3	2	4	3	3	4	4	1	4
Ruth	2	3	5	2	3	3	4	2	4
Agnese	2	3	4	3	5	5	4	3	4
Renske	3	2	5	3	4	3	4	1	4
Wessel	3	3	3	3	1	3	4	3	4
Guus	2	2	3	3	2	4	4	2	4
Timo	3	2	4	3	2	4	4	3	5
Pepijn	2	4	5	2	3	2	4	3	5
Average	2.44	2.67	4.00	2.67	2.67	3.33	3.78	2.11	4.22

Recommendation 1.4: Micro-Mobility Incentivization

Advice 1.4: Micro-mobility incentivization	**Criteria** *Note: 1. Accessibility, 2. Cost, 3. Sustainability, 4. Speed, 5. Capacity, 6. Integration, 7. Reliability, 8. Comfort, 9. Safety*

	1	2	3	4	5	6	7	8	9
Philip	5	3	5	3	3	5	5	3	3
Esmee	5	3	4	4	4	5	5	5	4
Ruth	5	3	5	3	4	5	4	3	4
Agnese	4	3	5	3	5	5	4	4	4
Renske	5	3	4	4	3	3	3	4	4
Wessel	4	3	4	3	3	3	4	4	3
Guus	4	2	4	3	3	4	4	2	4
Timo	4	4	4	2	3	5	4	3	3
Pepijn	3	3	4	2	3	2	3	3	4
Average	4.33	3.00	4.33	3.00	3.44	4.11	4.00	3.44	3.67

Recommendation 1.5: Information Dissemination and Nudging

Advice 1.5: Information dissemination and nudging	**Criteria** *Note: 1. Accessibility, 2. Cost, 3. Sustainability, 4. Speed, 5. Capacity, 6. Integration, 7. Reliability, 8. Comfort, 9. Safety*								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Philip	4	3	4	1	1	3	1	1	2
Esmee	4	3	4	2	4	4	3	4	4
Ruth	4	3	5	2	4	5	3	4	3
Agnese	5	4	4	3	4	5	4	3	4
Renske	3	3	4	2	3	4	3	3	3
Wessel	5	2	3	3	4	3	4	4	3
Guus	3	4	4	2	2	4	2	3	4
Timo	3	3	5	1	3	4	2	3	3
Pepijn	2	3	3	3	2	2	3	2	4
Average	3.67	3.11	4.00	2.11	3.00	3.78	2.78	3.00	3.33

Recommendation 2.1: Improve Public Transport by Optimizing Connectivity and Frequency

Advice 2.1: Improve Public Transport by Optimizing Connectivity and Frequency	**Criteria** *Note: 1. Accessibility, 2. Cost, 3. Sustainability, 4. Speed, 5. Capacity, 6. Integration, 7. Reliability, 8. Comfort, 9. Safety*							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Philip	5	3	4	3	5	5	3	4	5
Esmee	5	2	4	4	4	5	3	4	4
Ruth	4	2	5	3	5	5	4	3	4
Agnese	4	3	5	2	5	5	4	3	4
Renske	4	2	3	3	4	5	2	3	4
Wessel	4	2	4	3	4	5	3	4	4
Guus	4	3	3	3	5	4	3	4	4
Timo	4	2	3	3	4	5	5	5	4
Pepijn	4	2	5	3	4	3	4	4	5
Average	4.22	2.33	4.00	3.00	4.44	4.67	3.44	3.78	4.22

Recommendation 2.2: Separate Bus and Bike Lanes and Improved Walking Experience

Advice 2.2: Separate Bus and Bike Lanes and Improved Walking Experience	**Criteria** *Note: 1. Accessibility, 2. Cost, 3. Sustainability, 4. Speed, 5. Capacity, 6. Integration, 7. Reliability, 8. Comfort, 9. Safety*							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Philip	4	5	5	2	3	3	5	3	5
Esmee	4	4	3	4	4	3	3	4	5
Ruth	4	4	4	4	3	4	3	3	4
Agnese	3	4	5	3	5	4	4	3	5
Renske	4	4	3	3	2	2	4	3	5
Wessel	5	5	5	3	5	5	5	3	4
Guus	4	5	4	3	4	5	5	4	4

Timo	3	4	4	4	3	5	4	3	5
Pepijn	3	1	2	4	4	4	4	5	5
Average	3.78	4.00	3.89	3.33	3.67	3.89	4.11	3.44	4.67

Recommendation 2.3: Improving the Road Network

Advice 2.3: Improving the Road Network	**Criteria** *Note: 1. Accessibility, 2. Cost, 3. Sustainability, 4. Speed, 5. Capacity, 6. Integration, 7. Reliability, 8. Comfort, 9. Safety*								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Philip	5	4	3	3	3	4	3	3	4
Esmee	4	3	3	4	4	4	4	4	4
Ruth	3	4	2	3	2	4	4	3	4
Agnese	4	3	3	2	4	4	4	3	5
Renske	4	3	3	3	3	3	4	4	5
Wessel	3	2	3	4	2	3	4	4	3
Guus	4	3	4	4	3	4	4	4	4
Timo	4	3	3	3	3	4	3	4	5
Pepijn	3	1	2	5	5	3	4	4	3
Average	3.78	2.89	2.89	3.44	3.22	3.67	3.78	3.67	4.11

Recommendation 2.4: Actively Discouraging Private Car Use

Advice 2.4: Actively Discouraging Private Car Use	**Criteria** *Note: 1. Accessibility, 2. Cost, 3. Sustainability, 4. Speed, 5. Capacity, 6. Integration, 7. Reliability, 8. Comfort, 9. Safety*								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Philip	2	3	3	2	2	3	3	3	4
Esmee	2	3	4	3	3	3	3	3	4
Ruth	2	3	5	2	3	4	3	3	4

Agnese	2	3	4	3	3	4	3	3	4
Renske	2	3	4	3	3	2	3	3	4
Wessel	2	3	4	2	2	4	4	3	4
Guus	2	4	4	3	2	4	3	2	5
Timo	1	3	5	2	2	4	3	3	4
Pepijn	2	4	5	3	3	3	3	3	5
Average	1.89	3.22	4.22	2.56	2.56	3.44	3.11	2.89	4.22

6.2.3. AHP Analysis

Interview Results

Scale 1 - 5									
Interviewee	1 (Accessibility)	2 (Cost)	3 (Sustainability)	4 (Speed)	5 (Capacity)	6 (Integration)	7 (Reliability)	8 (Comfort)	9 (Safety)
A									
B	4.00	3.00	4.00					4.00	5.00
C	5.00	3.00	4.00	1.00	3.00	5.00	5.00	4.00	5.00
D	4.00	2.00	4.00	4.00	5.00	5.00	5.00	4.00	5.00
E	4.00	2.00	2.00	3.00	4.00	3.00	5.00	2.00	4.00
F	5.00	3.00	4.00	1.00	2.00	4.00	3.00	2.00	4.00
G	3.00	4.00	3.00	2.00	3.00	2.00	4.00	3.00	5.00
H	5.00	5.00	5.00	3.00	5.00	5.00	5.00	4.00	5.00
Average	4.29	3.14	3.71	2.33	3.67	4.00	4.50	3.29	4.71

Key:	
Red:	X = 1
Yellow:	X = 2
Blue:	X = 3
Green:	X = 4
Dark Green	X = 5

Scale 1 - 9									
Interviewee	1 (Accessibility)	2 (Cost)	3 (Sustainability)	4 (Speed)	5 (Capacity)	6 (Integration)	7 (Reliability)	8 (Comfort)	9 (Safety)
A									
B	7	5	7					7	9
C	9	5	7	1	5	9	9	7	9
D	7	3	7	7	9	9	9	7	9
E	7	3	3	5	7	5	9	3	7
F	9	5	7	1	3	7	5	3	7
G	5	7	5	3	5	3	7	5	9
H	9	9	9	5	9	9	9	7	9
Average	7.57	5.29	6.43	3.67	6.33	7.00	8.00	5.57	8.43

Scale conversion (New value =	
1.00	1
2.00	3
3.00	5
4.00	7
5.00	9

Appendix 6.2.3. Figure 1- Interview Results.

Pairwise Comparison Matrix: Interview

Scale Results									
Interviewee	1 (Accessibility)	2 (Cost)	3 (Sustainability)	4 (Speed)	5 (Capacity)	6 (Integration)	7 (Reliability)	8 (Comfort)	9 (Safety)
A									
B	7.00	5.00	7.00					7.00	9.00
C	9.00	5.00	7.00	1.00	5.00	9.00	9.00	7.00	9.00
D	7.00	3.00	7.00	7.00	9.00	9.00	9.00	7.00	9.00
E	7.00	3.00	3.00	5.00	7.00	5.00	9.00	3.00	7.00
F	9.00	5.00	7.00	1.00	3.00	7.00	5.00	3.00	7.00
G	5.00	7.00	5.00	3.00	5.00	3.00	7.00	5.00	9.00
H	9.00	9.00	9.00	5.00	9.00	9.00	9.00	7.00	9.00
AVERAGE	7.57	5.29	6.43	3.67	6.33	7.00	8.00	5.57	8.43

Key:	
Red:	X = 1
Yellow:	X = 3
Blue:	X = 5
Green:	X = 7
Dark Green	X = 9

Scale Results Transposed									
Interviewee	A	B	C	D	E	F	G	H	AVERAGE
Accessibility		7.00	9.00	7.00	7.00	9.00	5.00	9.00	7.57
Cost		5.00	5.00	3.00	3.00	5.00	7.00	9.00	5.29
Sustainability		7.00	7.00	7.00	3.00	7.00	5.00	9.00	6.43
Speed			1.00	7.00	5.00	1.00	3.00	5.00	3.67
Capacity			5.00	9.00	7.00	3.00	5.00	9.00	6.33
Integration			9.00	9.00	5.00	7.00	3.00	9.00	7.00
Reliability			9.00	9.00	9.00	5.00	7.00	9.00	8.00
Comfort		7.00	7.00	7.00	3.00	3.00	5.00	7.00	5.57
Safety		9.00	9.00	9.00	7.00	7.00	9.00	9.00	8.43

Key:	
Red:	X = 1
Yellow:	X = 3
Blue:	X = 5
Green:	X = 7
Dark Green	X = 9

	Pairwise Comparison Matrix of Average									
Criteria	Accessibility	Cost	Sustainability	Speed	Capacity	Integration	Reliability	Comfort	Safety	AVERAGE
Accessibility	1.00	1.43	1.18	2.06	1.20	1.08	0.95	1.36	0.90	1.240
Cost	0.70	1.00	0.82	1.44	0.83	0.76	0.66	0.95	0.63	0.865
Sustainability	0.85	1.22	1.00	1.75	1.02	0.92	0.80	1.15	0.76	1.052
Speed	0.48	0.69	0.57	1.00	0.58	0.52	0.46	0.66	0.44	0.600
Capacity	0.84	1.20	0.99	1.73	1.00	0.90	0.79	1.14	0.75	1.037
Integration	0.92	1.32	1.09	1.91	1.11	1.00	0.88	1.26	0.83	1.146
Reliability	1.06	1.51	1.24	2.18	1.26	1.14	1.00	1.44	0.95	1.310
Comfort	0.74	1.05	0.87	1.52	0.88	0.80	0.70	1.00	0.66	0.912
Safety	1.11	1.59	1.31	2.30	1.33	1.20	1.05	1.51	1.00	1.380
SUM	7.70	11.03	9.07	15.90	9.20	8.33	7.29	10.46	6.92	9.54

Key:	
Red:	X < 0.49
Green:	1.49 > X > 0.5
Yellow:	X > 1.5

	Normalized Pairwise Comparison Matrix of Average												
Criteria	Accessibility	Cost	Sustainability	Speed	Capacity	Integration	Reliability	Comfort	Safety	**SUM**	**Product**	**Geometric Mean**	**Normalized Geomentric Mean (i.e. Priority)**
Accessibility	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.1299	1.05327E-08	0.1299	0.1299
Cost	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.0907	4.14834E-10	0.0907	0.0907
Sustainability	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.1103	2.4153E-09	0.1103	0.1103
Speed	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.0629	1.54306E-11	0.0629	0.0629
Capacity	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.1087	2.1117E-09	0.1087	0.1087
Integration	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.1201	5.19784E-09	0.1201	0.1201
Reliability	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.1373	1.72882E-08	0.1373	0.1373
Comfort	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.0956	6.66254E-10	0.0956	0.0956
Safety	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.1446	2.7652E-08	0.1446	0.1446
SUM	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.000		1.0000	1.0000

Appendix 6.2.3. Figure 2 – Pairwise Comparison Matrix Interview.

Advice	Average (Scale 1 - 5)								
	Note: 1. Accessibility, 2. Cost, 3. Sustainability, 4. Speed, 5. Capacity, 6. Integration, 7. Reliability, 8. Comfort, 9. Safety								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1.1	3.89	2.44	3.44	3.22	2.56	2.56	4.33	3.89	3.67
1.2	2.89	2.67	3.56	2.78	2.33	2.56	3.11	2.67	3.33
1.3	2.44	2.67	4.00	2.67	2.67	3.33	3.78	2.11	4.22
1.4	4.33	3.00	4.33	3.00	3.44	4.11	4.00	3.44	3.67
1.5	3.67	3.11	4.00	2.11	3.00	3.78	2.78	3.00	3.33
2.1	4.22	2.33	4.00	3.00	4.44	4.67	3.44	3.78	4.22
2.2	3.78	4.00	3.89	3.33	3.67	3.89	4.11	3.44	4.67
2.3	3.78	2.89	2.89	3.44	3.22	3.67	3.78	3.67	4.11
2.4	1.89	3.22	4.22	2.56	2.56	3.44	3.11	2.89	4.22

Advice	Average (Scale 1 - 9)								
	Note: 1. Accessibility, 2. Cost, 3. Sustainability, 4. Speed, 5. Capacity, 6. Integration, 7. Reliability, 8. Comfort, 9. Safety								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1.1	6.78	3.89	5.89	5.44	4.11	4.11	7.67	6.78	6.33
1.2	4.78	4.33	6.11	4.56	3.67	4.11	5.22	4.33	5.67
1.3	3.89	4.33	7.00	4.33	4.33	5.67	6.56	3.22	7.44
1.4	7.67	5.00	7.67	5.00	5.89	7.22	7.00	5.89	6.33
1.5	6.33	5.22	7.00	3.22	5.00	6.56	4.56	5.00	5.67
2.1	7.44	3.67	7.00	5.00	7.89	8.33	5.89	6.56	7.44
2.2	6.56	7.00	6.78	5.67	6.33	6.78	7.22	5.89	8.33
2.3	6.56	4.78	4.78	5.89	5.44	6.33	6.56	6.33	7.22
2.4	2.78	5.44	7.44	4.11	4.11	5.89	5.22	4.78	7.44

Advice	Average (Scale 1 - 9) Transposed								
	1.1	**1.2**	**1.3**	**1.4**	**1.5**	**2.1**	**2.2**	**2.3**	**2.4**
1	7	5	4	8	6	7	7	7	3
2	4	4	4	5	5	4	7	5	5
3	6	6	7	8	7	7	7	5	7
4	5	5	4	5	3	5	6	6	4
5	4	4	4	6	5	8	6	5	4
6	4	4	6	7	7	8	7	6	6
7	8	5	7	7	5	6	7	7	5
8	7	4	3	6	5	7	6	6	5
9	6	6	7	6	6	7	8	7	7

Appendix 6.2.3. Figure 3 – Scale Transformation.

Pairwise Comparison Matrix: Recommendations

	Pairwise Comparison Matrix									
	1.1	**1.2**	**1.3**	**1.4**	**1.5**	**2.1**	**2.2**	**2.3**	**2.4**	AVERAGE
1.1	1.00	1.42	1.74	0.88	1.07	0.91	1.03	1.03	2.44	1.28
1.2	0.70	1.00	1.23	0.62	0.75	0.64	0.73	0.73	1.72	0.90
1.3	0.57	0.81	1.00	0.51	0.61	0.52	0.59	0.59	1.40	0.74
1.4	1.13	1.60	1.97	1.00	1.21	1.03	1.17	1.17	2.76	1.45
1.5	0.93	1.33	1.63	0.83	1.00	0.85	0.97	0.97	2.28	1.20
2.1	1.10	1.56	1.91	0.97	1.18	1.00	1.14	1.14	2.68	1.41
2.2	0.97	1.37	1.69	0.86	1.04	0.88	1.00	1.00	2.36	1.24
2.3	0.97	1.37	1.69	0.86	1.04	0.88	1.00	1.00	2.36	1.24
2.4	0.41	0.58	0.71	0.36	0.44	0.37	0.42	0.42	1.00	0.53

Key:	
Red:	X < 0.49
Green:	1.49 > X > 0.5
Yellow:	X > 1.5
Blue:	3.49 > X > 2.5

	Pairwise Comparison Matrix (Cost)									
	1.1	**1.2**	**1.3**	**1.4**	**1.5**	**2.1**	**2.2**	**2.3**	**2.4**	AVERAGE
1.1	1.00	0.90	0.90	0.78	0.74	1.06	0.56	0.81	0.71	0.83
1.2	1.11	1.00	1.00	0.87	0.83	1.18	0.62	0.91	0.80	0.92
1.3	1.11	1.00	1.00	0.87	0.83	1.18	0.62	0.91	0.80	0.92
1.4	1.29	1.15	1.15	1.00	0.96	1.36	0.71	1.05	0.92	1.07
1.5	1.34	1.21	1.21	1.04	1.00	1.42	0.75	1.09	0.96	1.11
2.1	0.94	0.85	0.85	0.73	0.70	1.00	0.52	0.77	0.67	0.78
2.2	1.80	1.62	1.62	1.40	1.34	1.91	1.00	1.47	1.29	1.49
2.3	1.23	1.10	1.10	0.96	0.91	1.30	0.68	1.00	0.88	1.02
2.4	1.40	1.26	1.26	1.09	1.04	1.48	0.78	1.14	1.00	1.16

Key:	
Red:	X < 0.49
Green:	1.49 > X > 0.5
Yellow:	X > 1.5
Blue:	3.49 > X > 2.5

	Pairwise Comparison Matrix (Sustainability)									
	1.1	**1.2**	**1.3**	**1.4**	**1.5**	**2.1**	**2.2**	**2.3**	**2.4**	AVERAGE
1.1	1.00	0.96	0.84	0.77	0.84	0.84	0.87	1.23	0.79	0.91
1.2	1.04	1.00	0.87	0.80	0.87	0.87	0.90	1.28	0.82	0.94
1.3	1.19	1.15	1.00	0.91	1.00	1.00	1.03	1.47	0.94	1.08
1.4	1.30	1.25	1.10	1.00	1.10	1.10	1.13	1.60	1.03	1.18
1.5	1.19	1.15	1.00	0.91	1.00	1.00	1.03	1.47	0.94	1.08
2.1	1.19	1.15	1.00	0.91	1.00	1.00	1.03	1.47	0.94	1.08
2.2	1.15	1.11	0.97	0.88	0.97	0.97	1.00	1.42	0.91	1.04
2.3	0.81	0.78	0.68	0.62	0.68	0.68	0.70	1.00	0.64	0.73
2.4	1.26	1.22	1.06	0.97	1.06	1.06	1.10	1.56	1.00	1.14

Key:	
Red:	X < 0.49
Green:	1.49 > X > 0.5
Yellow:	X > 1.5
Blue:	3.49 > X > 2.5

	Pairwise Comparison Matrix (Speed)									
	1.1	**1.2**	**1.3**	**1.4**	**1.5**	**2.1**	**2.2**	**2.3**	**2.4**	AVERAGE
1.1	1.00	1.20	1.26	1.09	1.69	1.09	0.96	0.92	1.32	1.17
1.2	0.84	1.00	1.05	0.91	1.41	0.91	0.80	0.77	1.11	0.98
1.3	0.80	0.95	1.00	0.87	1.34	0.87	0.76	0.74	1.05	0.93
1.4	0.92	1.10	1.15	1.00	1.55	1.00	0.88	0.85	1.22	1.07
1.5	0.59	0.71	0.74	0.64	1.00	0.64	0.57	0.55	0.78	0.69
2.1	0.92	1.10	1.15	1.00	1.55	1.00	0.88	0.85	1.22	1.07
2.2	1.04	1.24	1.31	1.13	1.76	1.13	1.00	0.96	1.38	1.22
2.3	1.08	1.29	1.36	1.18	1.83	1.18	1.04	1.00	1.43	1.27
2.4	0.76	0.90	0.95	0.82	1.28	0.82	0.73	0.70	1.00	0.88

Key:	
Red:	X < 0.49
Green:	1.49 > X > 0.5
Yellow:	X > 1.5
Blue:	3.49 > X > 2.5

Pairwise Comparison Matrix (Capacity)	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	AVERAGE
1.1	1.00	1.12	0.95	0.70	0.82	0.52	0.65	0.76	1.00	0.84
1.2	0.89	1.00	0.85	0.62	0.73	0.46	0.58	0.67	0.89	0.74
1.3	1.05	1.18	1.00	0.74	0.87	0.55	0.68	0.80	1.05	0.88
1.4	1.43	1.61	1.36	1.00	1.18	0.75	0.93	1.08	1.43	1.20
1.5	1.22	1.36	1.15	0.85	1.00	0.63	0.79	0.92	1.22	1.02
2.1	1.92	2.15	1.82	1.34	1.58	1.00	1.25	1.45	1.92	1.60
2.2	1.54	1.73	1.46	1.08	1.27	0.80	1.00	1.16	1.54	1.29
2.3	1.32	1.48	1.26	0.92	1.09	0.69	0.86	1.00	1.32	1.11
2.4	1.00	1.12	0.95	0.70	0.82	0.52	0.65	0.76	1.00	0.84

Key:	
Red:	X < 0.49
Green:	1.49 > X > 0.5
Yellow:	X > 1.5
Blue:	3.49 > X > 2.5

Pairwise Comparison Matrix (Integration)	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	AVERAGE
1.1	1.00	1.00	0.73	0.57	0.63	0.49	0.61	0.65	0.70	0.71
1.2	1.00	1.00	0.73	0.57	0.63	0.49	0.61	0.65	0.70	0.71
1.3	1.38	1.38	1.00	0.78	0.86	0.68	0.84	0.89	0.96	0.98
1.4	1.76	1.76	1.27	1.00	1.10	0.87	1.07	1.14	1.23	1.24
1.5	1.59	1.59	1.16	0.91	1.00	0.79	0.97	1.04	1.11	1.13
2.1	2.03	2.03	1.47	1.15	1.27	1.00	1.23	1.32	1.42	1.43
2.2	1.65	1.65	1.20	0.94	1.03	0.81	1.00	1.07	1.15	1.17
2.3	1.54	1.54	1.12	0.88	0.97	0.76	0.93	1.00	1.08	1.09
2.4	1.43	1.43	1.04	0.82	0.90	0.71	0.87	0.93	1.00	1.01

Key:	
Red:	X < 0.49
Green:	1.49 > X > 0.5
Yellow:	X > 1.5
Blue:	3.49 > X > 2.5

Pairwise Comparison Matrix (Reliability)	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	AVERAGE
1.1	1.00	1.47	1.17	1.10	1.68	1.30	1.06	1.17	1.47	1.27
1.2	0.68	1.00	0.80	0.75	1.15	0.89	0.72	0.80	1.00	0.86
1.3	0.86	1.26	1.00	0.94	1.44	1.11	0.91	1.00	1.26	1.08
1.4	0.91	1.34	1.07	1.00	1.54	1.19	0.97	1.07	1.34	1.16
1.5	0.59	0.87	0.69	0.65	1.00	0.77	0.63	0.69	0.87	0.75
2.1	0.77	1.13	0.90	0.84	1.29	1.00	0.82	0.90	1.13	0.97
2.2	0.94	1.38	1.10	1.03	1.59	1.23	1.00	1.10	1.38	1.19
2.3	0.86	1.26	1.00	0.94	1.44	1.11	0.91	1.00	1.26	1.08
2.4	0.68	1.00	0.80	0.75	1.15	0.89	0.72	0.80	1.00	0.86

Key:	
Red:	X < 0.49
Green:	1.49 > X > 0.5
Yellow:	X > 1.5
Blue:	3.49 > X > 2.5

Pairwise Comparison Matrix (Comfort)	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	AVERAGE
1.1	1.00	1.56	2.10	1.15	1.36	1.03	1.15	1.07	1.42	1.32
1.2	0.64	1.00	1.34	0.74	0.87	0.66	0.74	0.68	0.91	0.84
1.3	0.48	0.74	1.00	0.55	0.64	0.49	0.55	0.51	0.67	0.63
1.4	0.87	1.36	1.83	1.00	1.18	0.90	1.00	0.93	1.23	1.14
1.5	0.74	1.15	1.55	0.85	1.00	0.76	0.85	0.79	1.05	0.97
2.1	0.97	1.51	2.03	1.11	1.31	1.00	1.11	1.04	1.37	1.27
2.2	0.87	1.36	1.83	1.00	1.18	0.90	1.00	0.93	1.23	1.14
2.3	0.93	1.46	1.97	1.08	1.27	0.97	1.08	1.00	1.33	1.23
2.4	0.70	1.10	1.48	0.81	0.96	0.73	0.81	0.75	1.00	0.93

Key:	
Red:	X < 0.49
Green:	1.49 > X > 0.5
Yellow:	X > 1.5
Blue:	3.49 > X > 2.5

Pairwise Comparison Matrix (Safety)	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	AVERAGE
1.1	1.00	1.12	0.85	1.00	1.12	0.85	0.76	0.88	0.85	0.94
1.2	0.89	1.00	0.76	0.89	1.00	0.76	0.68	0.78	0.76	0.84
1.3	1.18	1.31	1.00	1.18	1.31	1.00	0.89	1.03	1.00	1.10
1.4	1.00	1.12	0.85	1.00	1.12	0.85	0.76	0.88	0.85	0.94
1.5	0.89	1.00	0.76	0.89	1.00	0.76	0.68	0.78	0.76	0.84
2.1	1.18	1.31	1.00	1.18	1.31	1.00	0.89	1.03	1.00	1.10
2.2	1.32	1.47	1.12	1.32	1.47	1.12	1.00	1.15	1.12	1.23
2.3	1.14	1.27	0.97	1.14	1.27	0.97	0.87	1.00	0.97	1.07
2.4	1.18	1.31	1.00	1.18	1.31	1.00	0.89	1.03	1.00	1.10

Key:	
Red:	X < 0.49
Green:	1.49 > X > 0.5
Yellow:	X > 1.5
Blue:	3.49 > X > 2.5

Appendix 6.2.3. Figure 4 – Pairwise Comparison Matrix Recommendations.

Overall Priorities

	Average pairwise comparison of recommendations									
Rec.	1 (Accessibility)	2 (Cost)	3 (Sustainability)	4 (Speed)	5 (Capacity)	6 (Integration)	7 (Reliability)	8 (Comfort)	9 (Safety)	**AVERAGE**
1.1	1.28	0.83	0.91	1.17	0.84	0.71	1.27	1.32	0.94	1.028
1.2	0.90	0.92	0.94	0.98	0.74	0.71	0.86	0.84	0.84	0.860
1.3	0.74	0.92	1.08	0.93	0.88	0.98	1.08	0.63	1.10	0.926
1.4	1.45	1.07	1.18	1.07	1.20	1.24	1.16	1.14	0.94	1.161
1.5	1.20	1.11	1.08	0.69	1.02	1.13	0.75	0.97	0.84	0.976
2.1	1.41	0.78	1.08	1.07	1.60	1.43	0.97	1.27	1.10	1.192
2.2	1.24	1.49	1.04	1.22	1.29	1.17	1.19	1.14	1.23	1.224
2.3	1.24	1.02	0.73	1.27	1.11	1.09	1.08	1.23	1.07	1.093
2.4	0.53	1.16	1.14	0.88	0.84	1.01	0.86	0.93	1.10	0.939
SUM	9.9793	9.3094	9.1729	9.2871	9.5017	9.4674	9.2474	9.4738	9.1470	9.398

	Normalized Average Pairwise Comparison												
	1 (Accessibility)	2 (Cost)	3 (Sustainability)	4 (Speed)	5 (Capacity)	6 (Integration)	7 (Reliability)	8 (Comfort)	9 (Safety)	**SUM**	**Product**	**Geometric Mean**	**Normalized Geomentric Mean (i.e. Priority)**
1.1	0.13	0.09	0.10	0.13	0.09	0.07	0.14	0.14	0.10	0.109	1.82197E-09	0.1069	0.1083
1.2	0.09	0.10	0.10	0.11	0.08	0.07	0.09	0.09	0.09	0.092	4.3186E-10	0.0911	0.0923
1.3	0.07	0.10	0.12	0.10	0.09	0.10	0.12	0.07	0.12	0.099	7.6509E-10	0.0971	0.0984
1.4	0.15	0.11	0.13	0.12	0.13	0.13	0.13	0.12	0.10	0.123	6.32439E-09	0.1227	0.1244
1.5	0.12	0.12	0.12	0.07	0.11	0.12	0.08	0.10	0.09	0.104	1.22337E-09	0.1023	0.1037
2.1	0.14	0.08	0.12	0.12	0.17	0.15	0.11	0.13	0.12	0.126	6.99647E-09	0.1241	0.1258
2.2	0.12	0.16	0.11	0.13	0.14	0.12	0.13	0.12	0.13	0.130	1.03935E-08	0.1297	0.1315
2.3	0.12	0.11	0.08	0.14	0.12	0.12	0.12	0.13	0.12	0.116	3.53176E-09	0.1151	0.1166
2.4	0.05	0.12	0.12	0.10	0.09	0.11	0.09	0.10	0.12	0.100	8.06764E-10	0.0976	0.0990
SUM	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		0.9866	1.0000

Appendix 6.2.3. Figure 5 – Overall Priorities.

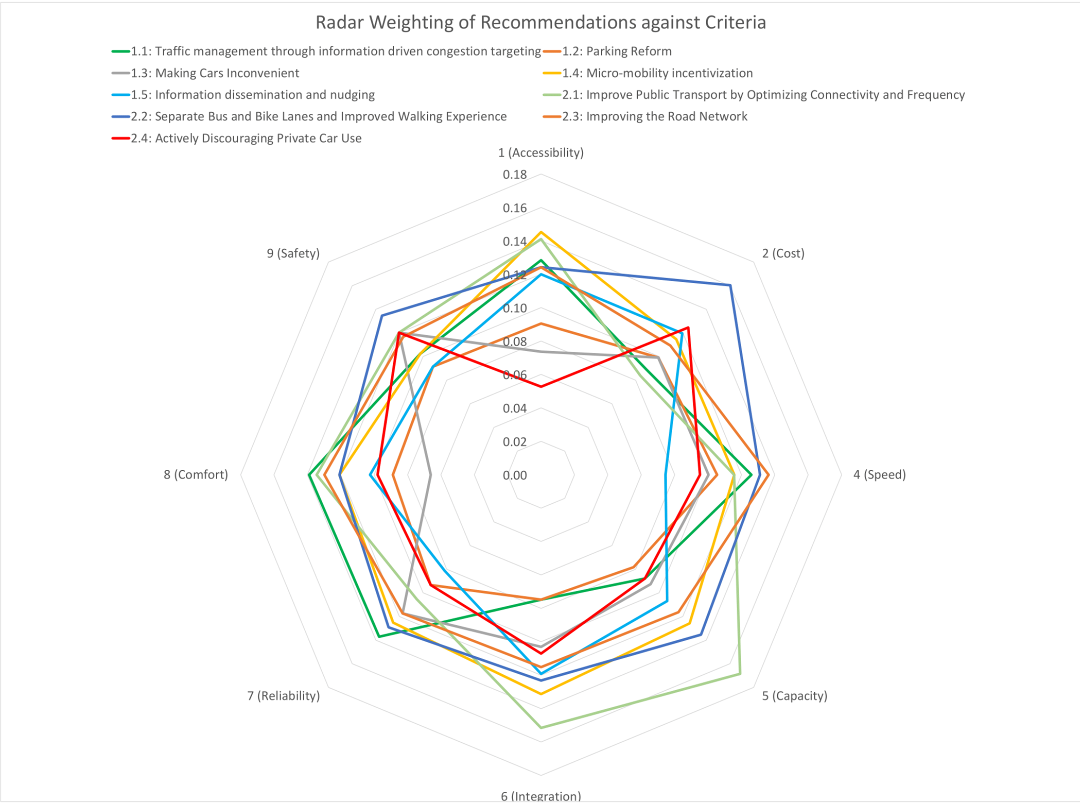
Consistency Ratio (CR)

	Principle Eigenvalue											
	1 (Accessibility)	2 (Cost)	3 (Sustainability)	4 (Speed)	5 (Capacity)	6 (Integration)	7 (Reliability)	8 (Comfort)	9 (Safety)	**SUM**	**Eigen Vector**	
1.1	0.1388	0.0765	0.0891	0.1455	0.0866	0.0890	0.1668	0.1535	0.0926	1.0385	9.5854	
1.2	0.0979	0.0853	0.0924	0.1218	0.0772	0.0890	0.1136	0.0981	0.0829	0.8583	9.2956	
1.3	0.0797	0.0853	0.1059	0.1158	0.0912	0.1227	0.1426	0.0730	0.1089	0.9251	9.4029	
1.4	0.1571	0.0984	0.1160	0.1337	0.1240	0.1564	0.1523	0.1334	0.0926	1.1638	9.3544	
1.5	0.1297	0.1028	0.1059	0.0861	0.1053	0.1420	0.0991	0.1132	0.0829	0.9670	9.3294	
2.1	0.1525	0.0722	0.1059	0.1337	0.1661	0.1805	0.1281	0.1485	0.1089	1.1963	9.5081	
2.2	0.1343	0.1378	0.1025	0.1515	0.1333	0.1468	0.1571	0.1334	0.1219	1.2186	9.2689	
2.3	0.1343	0.0940	0.0723	0.1574	0.1146	0.1372	0.1426	0.1434	0.1056	1.1015	9.4459	
2.4	0.0569	0.1072	0.1126	0.1099	0.0866	0.1275	0.1136	0.1082	0.1089	0.9314	9.4108	
	Equations	**Random Consistency Index (RI)**									9.4002	**Principal Eigenvalue**
	CR = CI/RI	Matrix size = 9									0.0500	**Consistency Index**
	CI = (λmax - n)/(n-1)	RI = 1.45									0.0345	**Consistency Ratio**

Appendix 6.2.3. Figure 6 – Consistency Ration

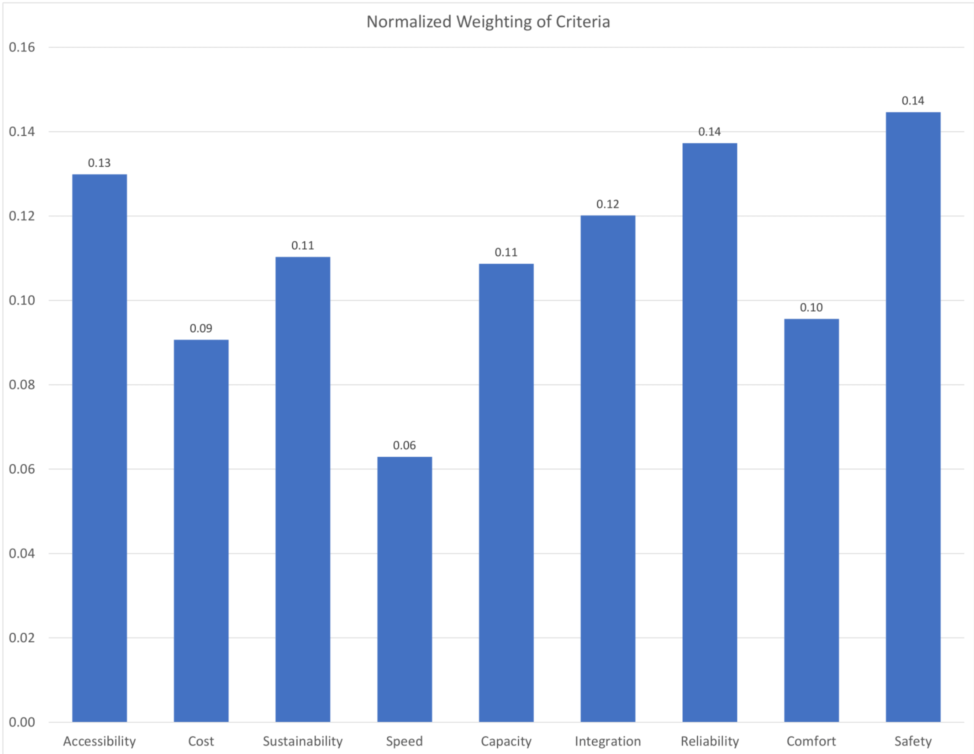
Matrix size	Random consistency index (RI)
1	0.00
2	0.00
3	0.58
4	0.90
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49

Appendix 6.2.3. Figure 7- Random Consistency Index (Saaty & Kearns, 1985).

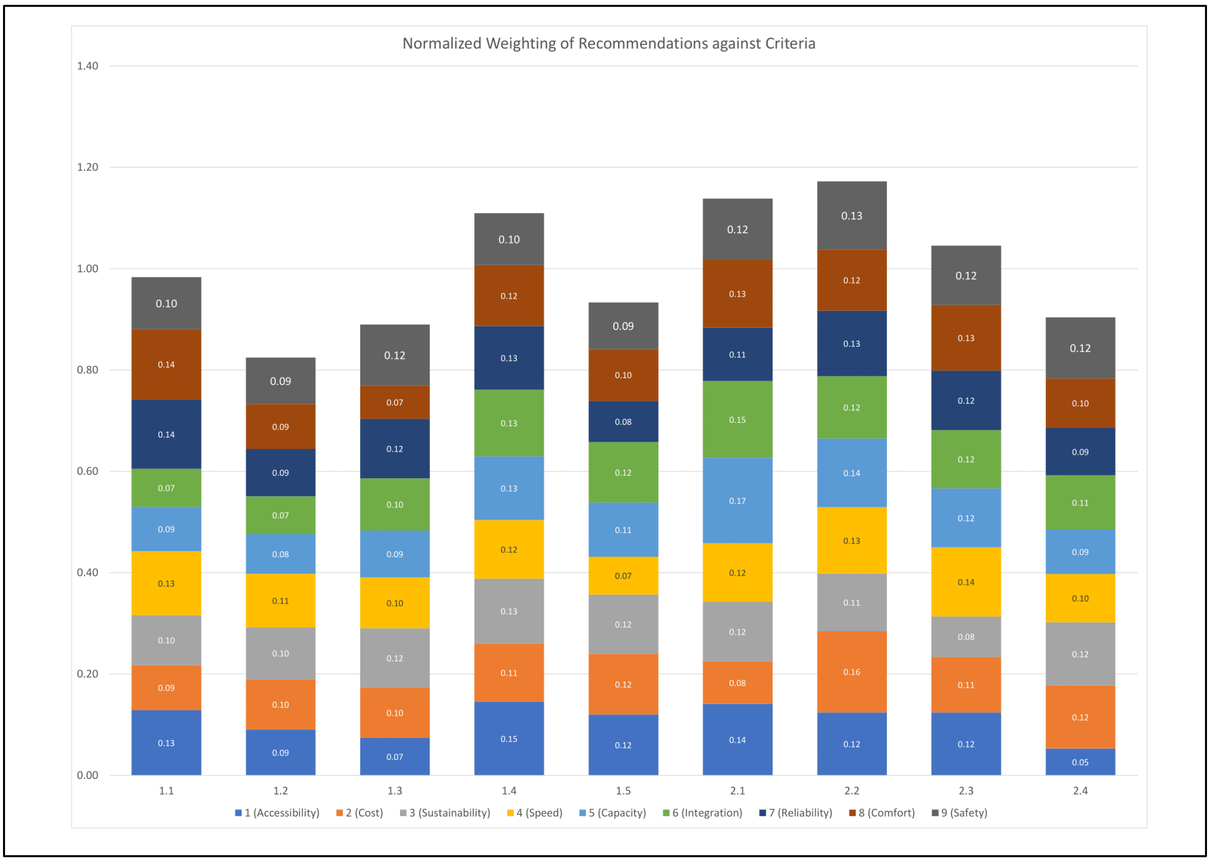


Appendix 6.2.3. Figure 8 – Radar Weighting of Recommendations against Criteria.

Criteria	Weight
Accessibility	0.13
Cost	0.09
Sustainability	0.11
Speed	0.06
Capacity	0.11
Integration	0.12
Reliability	0.14
Comfort	0.10
Safety	0.14
SUM	1.000



Appendix 6.2.3. Figure 9 – Normalised Weighting of Criteria.



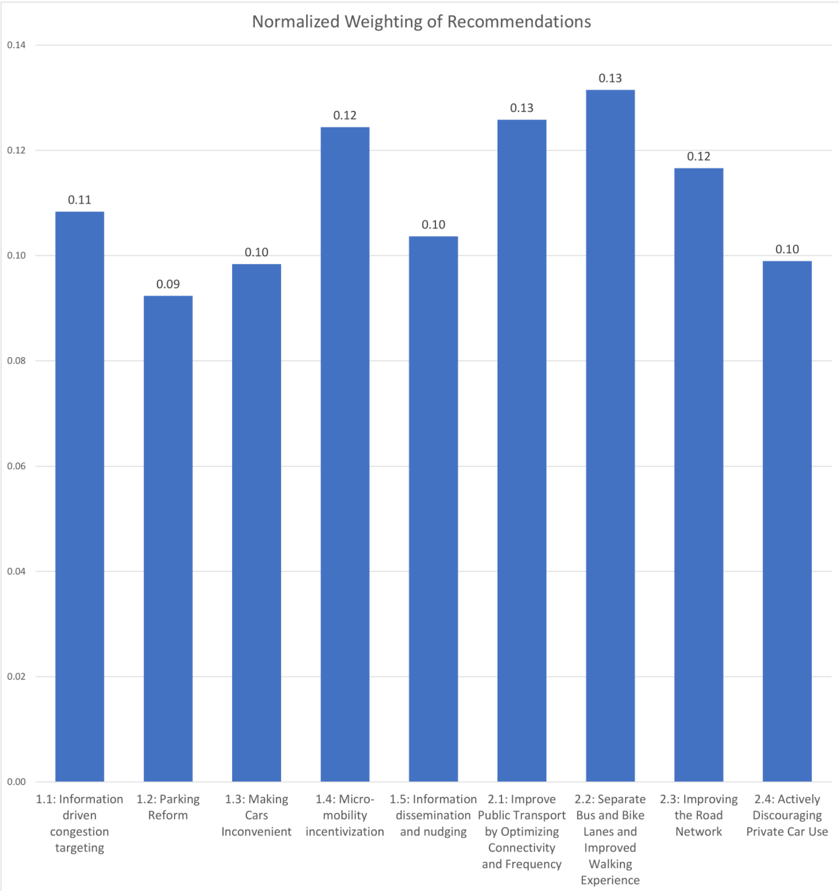
Appendix 6.2.3. Figure 10 – Normalised Weighting of Recommendations Against Criteria.

Weighted Attributes

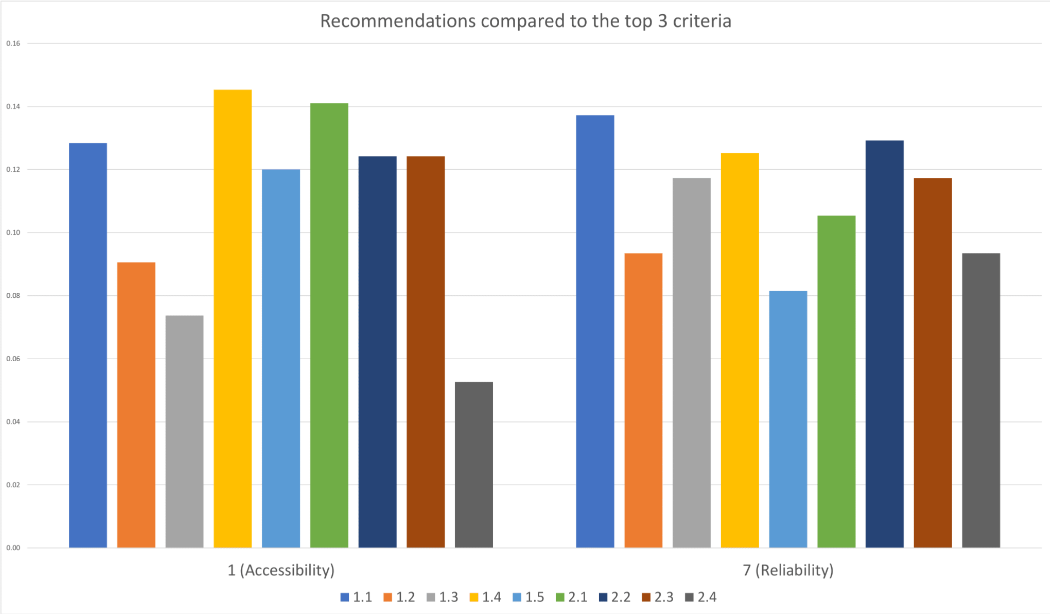
	Normalized Average Pairwise Comparison							
	1 (Accessibility)	2 (Cost)	4 (Speed)	5 (Capacity)	6 (Integration)	7 (Reliability)	8 (Comfort)	9 (Safety)
1.1: Traffic management through information driven congestion targeting	0.13	0.09	0.13	0.09	0.07	0.14	0.14	0.10
1.2: Parking Reform	0.09	0.10	0.11	0.08	0.07	0.09	0.09	0.09
1.3: Making Cars Inconvenient	0.07	0.10	0.10	0.09	0.10	0.12	0.07	0.12
1.4: Micro-mobility incentivization	0.15	0.11	0.12	0.13	0.13	0.13	0.12	0.10
1.5: Information dissemination and nudging	0.12	0.12	0.07	0.11	0.12	0.08	0.10	0.09
2.1: Improve Public Transport by Optimizing Connectivity and Frequency	0.14	0.08	0.12	0.17	0.15	0.11	0.13	0.12
2.2: Separate Bus and Bike Lanes and Improved Walking Experience	0.12	0.16	0.13	0.14	0.12	0.13	0.12	0.13
2.3: Improving the Road Network	0.12	0.11	0.14	0.12	0.12	0.12	0.13	0.12
2.4: Actively Discouraging Private Car Use	0.05	0.12	0.10	0.09	0.11	0.09	0.10	0.12
SUM	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Appendix 6.2.3. Figure 11- Weighted Attributes.

Recommendations	Weight
1.1: Information driven congestion targeting	0.11
1.2: Parking Reform	0.09
1.3: Making Cars Inconvenient	0.10
1.4: Micro-mobility incentivization	0.12
1.5: Information dissemination and nudging	0.10
Connectivity and Frequency	0.13
Improved Walking Experience	0.13
2.3: Improving the Road Network	0.12
2.4: Actively Discouraging Private Car Use	0.10
SUM	1.000



Appendix 6.2.3. Figure 12 – Normalised Weighting of Recommendations



	3 Normalized Average Pairwise Compari		
	1 (Accessibility)	7 (Reliability)	**AVERAGE**
1.1	0.13	0.14	0.123
1.2	0.09	0.09	0.092
1.3	0.07	0.12	0.104
1.4	0.15	0.13	0.124
1.5	0.12	0.08	0.098
2.1	0.14	0.11	0.122
2.2	0.12	0.13	0.129
2.3	0.12	0.12	0.119
2.4	0.05	0.09	0.089
SUM	1.0000	1.0000	1.000

Appendix 6.2.3. Figure 13 – Recommendations Compared to the Top 3 Criteria.