Road to Renewal: Reshaping Infrastructure for a Sustainable Mobility Renaissance

Bachelor Thesis

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Abstract

This thesis explores infrastructure reclamation dynamics that can contribute to a sustainable system change within mobility. The scope of this thesis is infrastructure currently assigned to motorized vehicles used for private mobility in The Netherlands. This study conducts qualitative in-depth expert interviews with four future thinkers in the (work)field of sustainable mobility. Additionally, best practices from cities around the world are reviewed by a policy paper systematic review. This study finds that to reach sustainability goals, infrastructure needs to be more aimed towards space-efficient movement of people, as well as a reconsideration of space we have once chosen for channelling car traffic. Furthermore, this thesis finds that infrastructure design is crucial to the economics of public transport. To achieve these systematic changes, this research discusses several administrative strategy improvements for the Netherlands specifically.

Introduction

At the time of writing, June 2023, the city of Amsterdam is experimenting with substituting car lanes for walking and cycling space and connecting neighbourhoods that once were separated as a result of the construction of wide automobile boulevards (Municipality of Amsterdam, 2021). In contrast, highways surrounding the same capital experience expansion after expansion (Rijksoverheid, 2022) trying to minimize traffic jams (KiM, 2018). This suspects that in The Netherlands, different levels of government follow different narratives.

Despite negative impacts on sustainability, car ownership grows faster than the population of The Netherlands (CBS, 2020) and infrastructure is still being expanded (Rijksoverheid, 2022), suggesting induced demand. For this research, sustainability is defined as carefully handling the scarce resources of life, space and energy.

Implications to life are one of the main critics on car usage. Traffic crashes are the leading cause of death for young people around the world (WHO, 2018). Motor vehicles are the most significant traffic accident contributors in The Netherlands. This includes burden to drivers and passengers, as well as to counterparties, mostly active modes. Strangely enough, Dutch media coverage is often blaming the victim, often the cyclist, instead of tackling the automobile itself as a source of danger (Te Brömmelstroet, 2020).

Böhm et al. (2006) concluded that the car is a major space consumer in cities, compared to public transportation and active modes both consuming space more efficiently. The subdivision of scarce road space helps pick winners and losers in mobility (Hamilton-Braillie, 2008). In comparison, a moving car takes up 70 per cent more space than a single walking pedestrian (Municipality of Groningen, 2021).

Worlds' climate concerns are rising (IPCC, 2023), while most societies are still dominated by the self-expanding automobile system (Urry, 2004). The automobile consumes at least a dozen times more energy per passenger kilometre compared to active modes and twice compared to public transportation (Banister, 2006). What adds to the energy impact of travelling is travel time, which tends to remain constant, disregarding the mode of travel (Marchetti, 1994). This would mean that if travellers were to choose a faster and a more energy consuming mode, but still travel as long as before, distance will increase with it. This makes the energy consumption increase massively.

Theoretical Framework

Although a lot of cities aim for improving alternatives to the car, such as Paris building pop-up bike lanes (Morgan, 2022), the creation of bike lanes and electric vehicles are viewed as not enough for a transition (Sheller, 2012). Neither does better public transport automatically attract car drivers (Harman, et al., 2012).

Waiting for individual mobility niches, like pop-up bike lanes (Becker, et al., 2022), to trigger system changes will have insufficient impact on reducing CO_2 emissions. These individual niches (small innovative markets for specific demands) often have a limited internal movement. Thus, niche-innovations need aggregation in order to change the mobility landscape (Geels, 2012).

Geels (2012) sees that the realisation of these transition paths would require several changes in actor attitudes and strategies, for instance the willingness of national governments to introduce car-restraining policies, often with a controversial character (Van Wee, et al., 2023).

On the other hand, Nello-Deakin (2020) advocates to rather focus on "traffic evaporation" (opposite of induced traffic) as a reduction in the amount of available road space for general traffic. Due to a saturated amount of research, it is evident that providing infrastructure for sustainable modes (like cycling) promotes the use of it. Traditionally, traffic evaporation effects were only researched for temporary closures (Cairns, et al., 2002). However, policy makers, especially in Europe's capitals (Municipality of Amsterdam, 2021) (Nello-Deakin, 2022), aim for traffic evaporation by

reallocating road space to sustainable alternatives like pedestrians, cyclists or public transport. For streets, this process is known as street reclamation (Engwicht, 1999). Little research is conducted on situations where more road space for active modes is provided **at the cost of motorized traffic** (Nello-Deakin, 2020). The goal of this research is to analyse decision making specifically for The Netherlands on this topic.

A recent possible system change suggestion for The Netherlands that makes use of infrastructure reclamation is proposed by Kloppenburg & Buiter (2023). Their so-called Gulden Snelweg (Guilder Highway), entails a future public transit system in the Netherlands consisting of multiple niches. In short, the Guilder Highway aims to redistribute road infrastructure, with the most prominent example of giving priority to high-occupancy vehicles, like Bus Rapid Transit (BRT), on a national scale. Transit hubs outside the city provide the connection with the Guilder Highway, or current transit stations, with shared mobility for traveling the last or first mile.

The model conceptualizing this thesis (Figure 1) is concerned with the relationship between relevant concepts previously described. The System of Automobility (Urry, 2004) is characterized by an extensive use of resources, which leads to intensive energy usage, space constraints and health problems (low sustainability level). Sustainable alternatives however, tend to achieve the opposite sustainability scores. The research questions aim to find how infrastructure reclamation (Engwicht, 1999) can lead to evaporating traffic (Nello-Deakin, 2020) leading to a reduction of the System of Automobility (Urry, 2004) and a promotion to sustainable alternatives that all together can trigger a sustainable system change (Geels, 2012). Notice that this not only entails street reclamation (Engwicht, 1999), but reclamation of all infrastructure space assigned for automobiles in The Netherlands. Hence the term infrastructure reclamation.

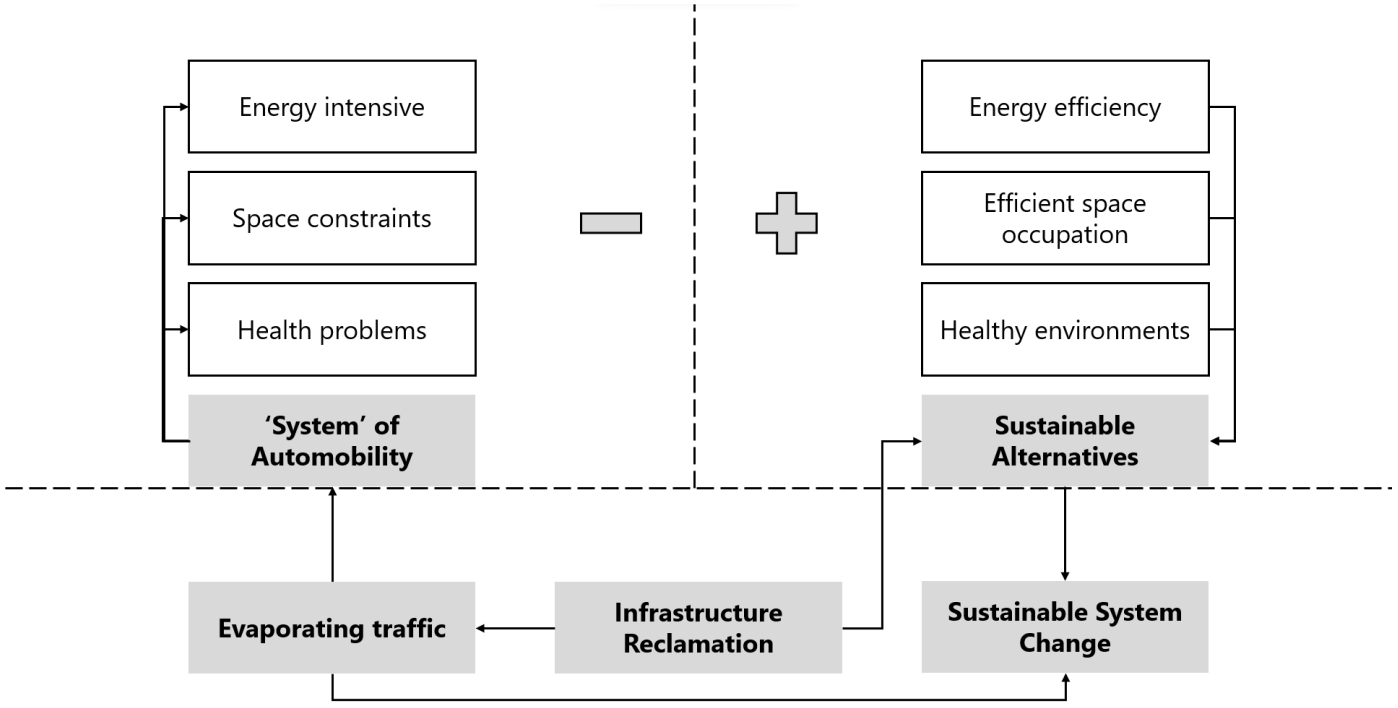

Figure 1: Conceptual model. Grey: concepts, white: sustainability impacts

Research questions

This study investigates experts' views on reclaiming infrastructure and its connection with practices around the world. Specifically, this research is guided by the main question of "**How can infrastructure reclamation contribute to a sustainable system change in the Netherlands?**" and the following sub-questions:

1. What are the dynamics of infrastructure reclamation in the Netherlands?
2. What can The Netherlands learn from other places where infrastructure is reclaimed?
3. Which methods can be used in The Netherlands to reach traffic evaporation?

Hypothesis

The hypothesis of this research is that a redistribution that takes away car infrastructure and assigns it to sustainable alternatives (reclamation) can trigger certain system changes. Literature suggests a diffusion of niche innovations could have the potential to trigger a system change. If infrastructure reclamation can accommodate these niche innovations while also restricting the usage of motorized vehicles, a more sustainable mobility system is expected to be reached.

Methodology

This qualitative study is established by using a mixed-method approach based on both primary and secondary data types. First, semi-structured in-depth expert interviews are conducted. Second, grey literature, produced by organizations outside of the traditional academic publications is used to conduct a policy analysis.

Primary data

System change is interesting to explore via experts, because they are concerned with mobility on a daily basis and are able to look into a broader future. Thus, this research made use of in-depth expert interviews. According to Bogner & Menz (2009), experts are people who either have published extensively in related fields or play a critical role in relevant organizations.

Experts are defined as people who have an "institutionalized authority to construct reality" (Meuser & Nagel, 2009). Accordingly, experts in this study were people who either had published extensively in the related fields or played a critical role in the relevant organizations (Bogner & Menz, 2009). Further details on the identity of the participants and the details per interview can be found in Appendix 2.

A non-probability sampling method was used to select the participants (Creswell, 2014). The process started from examining existing literature, policy documents and media publications on professional platforms like LinkedIn with idealistic and progressive characteristics in terms of sustainable infrastructure visions. From there, a list of key-experts was established. Special attention was paid to give voice to experts who had pioneered to work related to alteration of infrastructure and education from both academia and industry (Creswell, 2014).

Interviews lasted between 32 and 61 minutes. Due to the semi-structured character of the interviews, they were purposefully held face-to-face, to accommodate for more interaction between interviewer and expert. This allowed experts to unravel their thoughts and reflections (Meuser & Nagel, 2009). A semi-structured interview guide was used (Appendix 1). All interviews were audio recorded and later transcribed and coded.

Within ATLAS.ti, the coding process was characterized by a three-stage process (Meuser & Nagel, 2009). First, one interview was coded by the a priori coding scheme (Table 1), established prior to the interviewing process. This scheme caused a single-sided discussion, because enablers and barriers were separated for every theme, instead of opposing pros and cons forming a natural discussion. Additionally, the premises theme was too vague and the coding was too much led by the research questions, which gave biased results and an uneven distribution in the amount of quotations per code.

Research question	Coding by theme
What are ways to redesign infrastructure that accommodate for sustainable travel?	Sustainability
What kind of redistributions are needed for these changes?	Redistribution
What are important premises in making infrastructural decisions?	Premises
What are the barriers/enablers to (systematic) changes that you proposed?	Barriers
What are the barriers/enablers to (systematic) changes that you proposed?	Enablers
What is the difference/relation between rural/urban?	Topographies

Table 1: A priori coding scheme.

Thus, in the second step, a new more detailed posteriori coding scheme was created (Table 2), which made an even distribution of open-discussable codes possible. For this, a complete recoding of this first interview was required. The distribution of themes across all interviews can be found in the discussion. The third stage consisted of further sifting through the a posterior coding scheme, containing the creation of sub-codes (Appendix 3), making it possible to relate arguments within the code themes. The analysis focussed on thematic units rather than the sequence of participants' statements, as suggested by Meuser & Nagel (2009).

Secondary data

In addition to the empirical data collection, best practices from cities around the world were reviewed by a policy paper (grey literature) systematic analysis. Table 3 shows the policy papers used. These papers were selected by examples given by influential urbanists on professional media platforms, as well as policy papers mentioned during the interview process.
Afterwards, the main takeaway principles were used in this study. In the results section, the policy papers are used to clarify specific topics. For instance, the case of Barcelona is used after the code *Quality of Life*. This, because Barcelona is a frontrunner in applying quality of life as one of their main street and neighbourhood design principles.

Themes	**Sustainability**	**Car culture**	**Alternatives**	**Administrative**
Codes	Space (a priori)	Role of car	Active modes	Policy
	Health (a priori)	Parking	Public Transport	Politics
	Environment (a priori)	Traffic	Shared Mobility	Spatial Planning
	Quality of Life (a posteriori)	Economy		Design
		Logistics		Modelling
		Mobility		Orientation
				Topographies

Table 2: A posteriori coding scheme (besides codes concerned with the Sustainability problem statement).

Location	**Authority level**	**Policy Paper**
The Netherlands	Dutch Government	Mobiliteitsvisie 2050
Groningen, The Netherlands	Municipality	Nieuwe Ruimte Ontwerpleidraad Leefkwaliteit Openbare Ruimte
Oslo, Norway	Agency for Urban Environment	Street Design Manual
Vancouver, Canada	TransLink Public Transit agency	Rapid Implementation Design Guide for Bikeways in Metro Vancouver
Barcelona, Spain	Municipality	Superblock Government Measure
Ghent, Belgium	City	Mobiliteitsplan Gent

Table 3: Analysed policy documents

Results

The structure of the results section is directly derived from the main themes from step 2 in the methodology section. In the following sections, these main themes of Sustainability, Car Culture, Alternatives and Administrative are analysed by the corresponding codes. The relative amount of codes distributed over the interviews can be found in Figure 6. The sub-coding of step 3, explained in the methodology section, is applied within each section, to accommodate for a structured analysis of quotations across all experts. The sub-coding trees used can be found in Appendix 3.

Not all codes occurred equally throughout the interviews. To give an overview of the most discussed topics and their relation to each other, a Code Co-occurrence Force-directed synthesis (Figure 2) was constructed. As an example, from the synthesis one can reason that the relation between the codes *Economy* and *Public Transport* was often invoked. In contrast, *Logistics*, *Environment* and *Shared Mobility* were discussed to a lesser extent.

Sustainability

The problem statement on sustainability is extended and clarified in this Sustainability section. Furthermore, the relation between sustainability and infrastructure is examined. Partly derived from the problem statement of this research, the codes of *Space*, *Health and Energy* were applied. Later, *Energy* was framed into *Environment*, as this description fitted more interview quotations. Additionally, multiple experts underlined the importance of *Quality of Life* as a factor to Sustainability. They found *Health* to be too much focussed on the physical medical costs, whereas *Quality of Life* is more focussed on the mental well-being of the population.

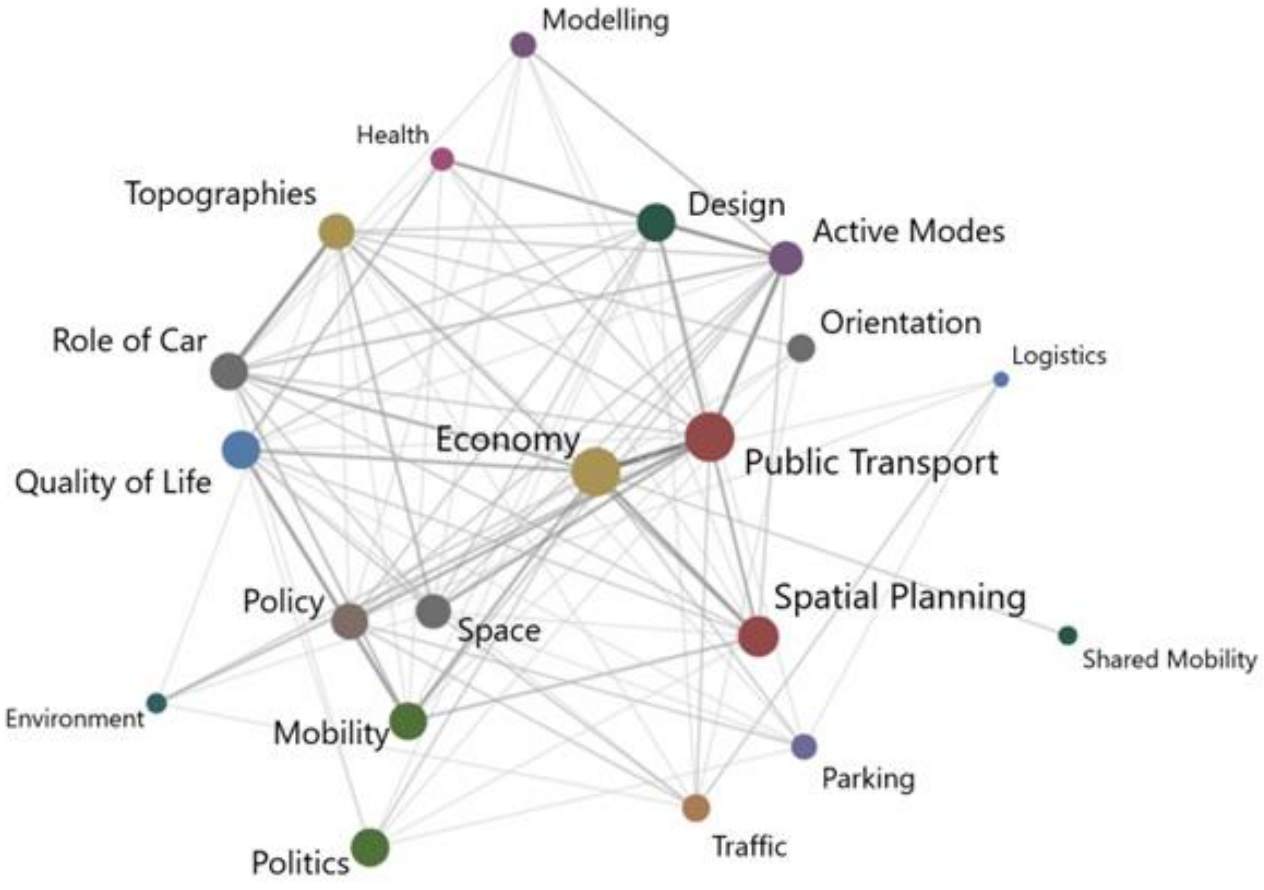

Figure 2: Code Co-occurrence Force-directed Synthesis based on the a posteriori coding scheme (Table 2)

The importance of Space was evident in every interview. Professor Bertolini characterized Space as a tangible, experienceable problem (compared to e.g. climate change) in dense urban settings. De Wilde agrees with this setting, since space is a major constraint for the dense city of Groningen as well. All experts agree that the car has a significant contribution to these space problematics, since it is such a space inefficient mode to travel. De Wilde noted that besides urban planning, the disciplines architecture and landscape agencies also demand space in cities. However, he relativise the problem of urban space constraints, as less space for infrastructure is needed when functions are close together. The separation of traffic streams is found space inefficient by all experts. According to Stoker, not only available asphalt space has to be divided, but also traffic space, for example green times at intersections. On the other hand, separating public transport can lead to a fixed space claim, which can be beneficial for the availability of fast and reliable public transport. However, the main agreement across interviews was that scarce space can best be distributed to slow modes:

> You can have trains running, but if there are no passengers, it's pointless. It's the same in the city. As long as there is no space for people to move around and be present, there is no incentive to go there or any traffic. It all starts with everyone being a pedestrian, and then you optimize how people can travel efficiently over longer distances. [De Wilde]

Environment was considered relevant as well in making infrastructural decisions. Bertolini and Stoker have seen major improvements in air quality since the introduction of zero-emission vehicles. However, Bertolini explains that with only reducing vehicle emissions, the climate crisis would not be solved. An enabler however in making sustainable infrastructural decisions is the nitrogen crisis, which was discussed with both Berr and Bertolini. In line with the nitrogen and climate concerns of the Dutch Government, Berr finds it crucial that high speed train lines should receive more or at least equal funding from the state, compared to traffic smoothening measures on the national highway network. Furthermore, Bertolini points out the importance of making streets climate adaptive, when climate change increases in severity.

The code *Health* consists of physical (economical) costs of mobility habits. Bertolini sees having functions within walking distance beneficial for physical and mental health. Berr also experienced a healthier lifestyle having moved to walkable urban cores. To decrease health cost, several road safety measures were discussed. Despite the document having the principles of car-dominance, Berr finds the Dutch national Duurzaam Veilig road guideline (SWOV, 2018) a good way to standardize safe roads for car drivers. However, he mentioned that road danger worsens when the amount of car lanes is increased. Berr explains that it supplies more points of conflicts. He justifies building new car infrastructure only when these conflict points are minimalized, for example in the form of a motorway fly-over. A balance needs to be found between road safety and mobility;

> …mobility is also a prerequisite for living. We can't easily say, "Yeah, it's very easy to have no mobility." And then it's perfectly safe in terms of traffic, but then it's no longer liveable… [De Wilde]

Thus, reducing mobility can have negative consequences for the *Quality of Life* as well, which is according to De Wilde the most important human-perspective policy principle. On the contrary, the other experts explain that reducing car mobility can also make room for other Quality of Life indicators, such as value creation, culture, communal areas and general aesthetics. Barcelona is one of the cities that specifically aims at prioritizing quality of life in one third of their street network, after reclaiming it from automobile lanes. (Municipality of Barcelona, 2021). Consequently, the first positive signs of traffic evaporation have already become visible (Nello-Deakin, 2022). Instead of transforming just a few streets, Bertolini emphasizes the use of so-called Superblocks, Barcelona's grid network primarily revolved around staying or living instead of trespassing. Furthermore, Berr and Bertolini agree on these new areas contributing to inclusivity when the street is not solely used for traffic channelling, but instead has diverse purposes. In the following chapter, the relation

between the code *Mobility* and the theme Car Culture is specifically discovered.

Car Culture

The Car Culture section generally collects and opposes arguments against infrastructure reclamation measures, often used to retain a positive image for automobiles. During the analysis process, interview quotations that had to do with these pro-car ideologies could best be analysed with the codes of *Mobility*, *Role of car*, *Traffic*, *Parking*, *Logistics* and *Economy*.

Notable is that experts have different opinions on the role of the car. Interestingly, when questions were asked about the role of the car, all four experts immediately stated that they were no car haters explicitly. Additionally, without it being an actual question in the interview guide, experts mentioned car parking almost a dozen times (Appendix 3). Possibly this showcases the (political) controversy and sensitivity on the subjects of role of car (parking).

Experts do not collectively agree on the value of *Mobility* in the current car-dominated system. De Wilde, Stoker and Bertolini see mobility in some occasions as an essentiality, in terms of economy, access to jobs, friends, shops leisure activities, individual freedom and quality of life in general. De Wilde argues that places that allow for great motorized mobility are attractive to residents. On the other hand, Berr and Bertolini also see attractive places where motorized mobility is kept low, such as the city centre of Amsterdam. In these places, mobility reduction is possible due to the proximity of destinations and the availability of alternatives to the car where longer distances need to be travelled. Bertolini explains that there is a shift away from having mobility as the solely goal in designing a street. Berr complements that not only long-distance mobility contributes to an attractive place, but also the possibility to safely cross a street in the first place:

> These movements, even at slow speeds, contribute to the overall function of access, as they facilitate travel from point A to point B. In this sense, the entire street serves as a travel surface. [Berr]

All experts find the current role of the car very intertwined with spatial planning principles, where large residential extensions often came with some sort of car-dominance. Bertolini finds the outskirts of Dutch cities comparable with car paradise Los Angeles. In these outer areas, design rules are used in favour of the car. Compared to car ownership in "sustainable" city centres, Bertolini sees the two different trends almost as schizophrenic. Especially in low-density places, Stoker sees the car as an effective means to reach the doorstep continuing for the future. However, he states that a car decoupling point can be used for a good integration with more sustainable alternatives, such as a Park & Ride Transit Hub mechanism, because he argues that mobility is too car-oriented. Berr agrees that a car is only the best mode of travel for point to point intermediate distances. Thus, for other journey types, alternatives should be used when reasoned from a sustainability standpoint.

As a clarification on the Transit Hub by Stoker, current individual parking should happen rather in these hubs, to unlock space in dense areas. As a result, there will also be more room to establish fast and reliable metro-like connections from hub to city. Stoker sees benefits in these kinds of integration of parking and fast public transit, because fast transit is affordable for the operator and the former car driver. When the proper infrastructure measures are taken, metro busses can also compete time-wise and thus form an attractive alternative. Compared to this pull-measure, Stoker is calling for politicians to increase tariffs and decrease quantity of parking spaces as a push measure. To bring this call to the next level, Berr talks about an elimination of the automatic parking space assumption. He proposes a free market approach where parking spaces need to be paid upfront if car owners desperately want one.

> This approach prevents overbuilding of car parks and encourages a more efficient use of space. For example, a housing

> development company might offer a house for 200,000 euros and ask if the buyer would like two car parking spaces for an additional cost of 30,000 euros. The company would then build the two car parking spaces on the street, only for those who have purchased them. [Berr]

The code *Logistics* was applied for impacts of possible infrastructure alterations on freight streams. With improving technologies, Stoker sees a chance in integrating autonomous delivery vehicles and passenger transport, to make better use of vehicle capacity. Contradicting, De Wilde warns for freight stream stagnations on arterial networks and explains that this makes the reliability of highways so important for national economy and government. The street in Haarlem (Kruisweg) where the interview was held with Berr was a perfect example of the impacts of evaporating infrastructure on logistic streams within a dense urban setting:

> It used to be a regular road, and what they've done is trucks can still go through. Here, the setup is actually better economically because there are fewer cars stopping the trucks from getting to where they need to go. So these deliveries are more on time. [Berr]

Concerning economic impacts, coding was applied to all quotations linked with *Economy*. According to De Wilde, mobility plays a crucial role for the economy. Bertolini adds, however, that an alternative infrastructure network triggers a different kind of economy. Business will follow slow-mobility markets and will result in small-scale diffuse business. He states that this would generate winners and losers, more jobs and higher prices due to the lack of economies of scale. The return, on the other hand, is an attractive place with high real estate capita and high quality of life. Bertolini underlines the absence of a strong relationship between happiness and economy, and thus questions economic growth per se.

Experts saw improvements in investment and subsidy streams possible. For suburban streetscapes, Berr notes that infrastructure is generally less solvent. Additionally, De Wilde finds it hard to build cost-covering public transportations in these areas, because the place is actually designed for cars. On a network level, Bertolini sees a lack of a clear shift away from cars. This is complimented by Berr, who says that a balanced transportation system can be established, when we stop subsidizing cars to such a large extent. He and Bertolini argue that there should be more incentives for experimenting with mobility budgets. Compared to rail infrastructure for example, Berr sees highways as not profitable either:

> They however provide a service. So, the economic streams from the government should prioritize public transport, especially trains, because they can move more people ... It's important to have a fair and balanced approach. [Berr]

As a future perspective, The Dutch Government sees the mobility of automobiles as essential. Automobile infrastructure expansions are prioritized and justified, because the Ministry highly values the societal and economic benefits of automobility in their mobility vision (Ministry of Infrastructure and Water Management, 2023).

Traffic was a commonly discussed subject in the expert interviews. Traffic management is a significant contributor to infrastructural decisions. Despite De Wilde seeing traffic management as dehumanizing, he sees it as an effective alternative tool to avoid building new infrastructure. Additionally, Stoker values traffic management crucially for free flowing lanes of bus traffic. Especially the national government tries to avoid traffic jams on the motorway network by large costs. On the contrary, Berr raises questions about the dominance of traffic engineering, because all façade-to-façade space is usually designed by traffic engineers, while he and Bertolini doubt traffic channelling as the main function of streetscapes. Furthermore, Berr sees the underlying problem as a network efficiency

deficit. Instead of expanding roads to accommodate more cars, larger government bodies should rather focus on reducing the number of cars and improving the efficiency of transportation. More on efficient public transport economies can be found in the following section.

Alternatives

This third chapter seeks possibilities to provide alternative travel on infrastructure currently used by the automobile. *Public Transport* was the most occurring theme, followed by *Active Modes* and *Shared Mobility*.

Firstly, *Public Transport* could benefit from infrastructure reclamation, according to all experts. When space from the car is given to public transport, it contributes to attractiveness of the alternative. Experts are convinced that separation of public transport to regular traffic contributes best to the robustness of the system. Stoker gives a heads up that this is sometimes difficult. In compact urban settings, space constraints are often a barrier, whereas safety regulations are a barrier for bus corridors (BRT) integrated on highways. Additionally, national road guidelines (SWOV, 2018) are primarily based on safe automobile networks. In essence, Stoker says that it is about daring to establish an alternative transportation system. Bus lanes are often constructed, but these are often not the perfect solution. Berr and Stoker agree that a tram is more in favour of robustness, because of its high capacity, predictable pattern and permanent space claim, because it has autonomy over the tracks. Although the asphalt between the tracks could allow for busses to use tram tracks, integrated tram tracks can contribute to attractiveness as well:

> Then you can also integrate [tram tracks] into the greenery, so it becomes, it becomes nicer and sexier. [Stoker]

De Wilde sees the quantitative and qualitative demographics in suburban developments problematic for making cost-covering public transport systems, because this dispersed better-off population is often tied to their car to a large extent. Stoker underlines that managing public transport is not about making money, but to fulfil political objectives. Due to the profitable express lines not being able to cover the costs of negative ones, mobility concessions are handed out. Strangely enough, Stoker sees competitive interests in the concession framework, for example with assigning uncompetitive space for private bus operator FlixBus. Therefore, he is a strong advocate for the fact that incentives like FlixBus should be facilitated in the best location in the city, to push for liberating market principles in favour of the travellers.

Secondly, *Active Modes* (e.g. walking and cycling) were deemed better off with infrastructure reclamation. All experts agreed on prioritizing active modes in infrastructural decisions first, rather than accommodating for active modes as an afterthought. De Wilde sees walking as the core of mobility. Furthermore, it decreases the need to travel in the first place, according to Bertolini. Although Berr and De Wilde comply with active mobility being poorly measurable, they ask for a more extensive incorporation of active modes for infrastructural considerations. The difficult step is to view all modes as a whole, rather than a sum of individual components.

Lastly, Stoker sees a future for *Shared Mobility*. Although there is currently no legal framework for collective shared mobility, he sees it necessary that shared mobility services will be included in mobility concessions, covered by collective taxation. When looked at a broader future, Stoker hopes to see a better integration in mobility hubs, where one could find robust public transportation, shared mobility and possibly self-driving vehicles to accommodate for sustainable mobility. These hub systems explained by Stoker are in line with the Gulden Snelweg (Kloppenburg & Buiter, 2023)

Administrative

Finally, this administrative section analyses the quotations of the interviews belonging to administrative aspects of infrastructure reclamation in The Netherlands. Additionally, methods to achieve traffic evaporation within this

executive domain are explored. The most common codes applied are *Spatial Planning*, *Policy*, *Design*, *Politics*, *Topographies*, *Orientation* and *Modelling*.

The experts' quotations belonging to *Spatial Planning* could easily be distributed over the sub-codes of *Quantity* and *Quality* (Appendix 3), which refer to the dominating paradigms in the past and present. Experts agree on that before the introduction of the car, towns grew organically, around the most attractive places, which resulted in walkable and dense high quality urban environments. This can be visualised by typical medieval European villages, where beautiful places were created over hundreds of years. On the contrary, once the automobile got introduced and population boomed, larger suburban developments were planned out. We got so good at this planning, that it caused dispersed trip origins and destinations. Berr hopes on the pre-automobile era to gain ground again. As a result, agglomerations could be self-sustaining, attractive, walkable, which reduces the need to travel. Bertolini sees a chance to use infrastructure reclamation measures and thereby trigger a semi-automatic mobility change.

Berr emphasizes Belgium in making qualitative spaces. As an example, the city of Ghent focusses on creating qualitative spaces with the leading principles of proximity. Consequently, unnecessary kilometres are minimalised. This qualitative kind of Spatial Planning has allowed for the city to implement a circulation plan, that prevents through traffic in the densest places. This made it possible for the city to aim for a decrease in car modal split from 55% in 2012 to 27% in 2030 (Stad Gent, 2015).

The next most prominent code was *Policy*. Experts saw policy visions as an effective tool to achieve infrastructure reclamation, because compared to politics, it is aimed towards the long-term. Especially the policy design guidelines in place were deemed powerful. Berr explains that these guidelines need to be centred away from automobiles, to avoid arbitrary rules that result in North American-like road layouts, which are difficult to reclaim. Thus, experts found it important that the approach in policy papers is correct and agreed on by all civil servants and that they know their limitations and responsibilities. All experts agree that quality of life should be prioritized over automobility in policy papers. To take it to the next level, Stoker and De Wilde underline the importance of integration of different sectors and to pass on effects on these sectors on a network level.

Interestingly, without the interview guiding towards the specific policy paper, The Nieuwe Leidraad Openbare Ruimte (guideline public space) of the city of Groningen was mentioned by all experts. The Leidraad aims to integrate the themes of accessibility, safety, mobility, ecology, experience, climate adaptation, health, economy, social and identity, with the Leidraad being a framework that connects separate policy documents and projects future streetscape impressions (Municipality of Groningen, 2021). Although De Wilde and Bertolini emphasize prioritizing quality of life in the Leidraad, Stoker calls the associated infrastructural changes a lack of choices, compared to real choices as the traffic circulation plan for Groningen in 1977.

The code *Design* was applied to all quotations covering specific street, road and network designs. De Wilde defines the policy as the "what" and the design as the "how". Berr argues that the Dutch road design guideline is so safe for car drivers that it causes "car brain" and should be more focussed towards sustainable modes. To broaden the possibilities to downgrade automobile infrastructure, he proposes a differentiation method to fit the current Duurzaam Veilig (SWOV, 2018) national guideline (Figure 3). He suggests that alongside car-oriented travel surfaces, there should exist a Non Travel Surface category to accommodate staying function and slow active travel modes. Additionally, he suggests having a GOW40, a slower version of GOW50 that makes it safer for cyclists to bike along drivers.

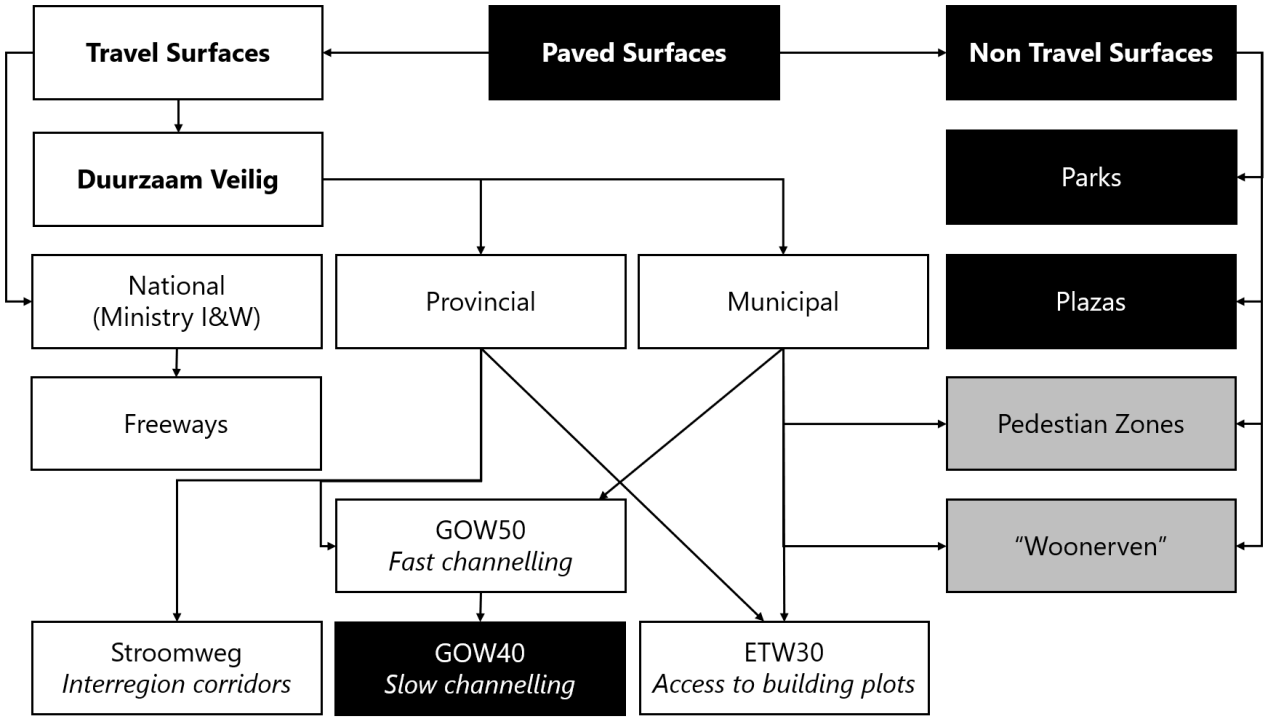

Figure 3: Proposed changes to Duurzaam Veilig by Berr. Introduced road futures are in black. Current road framework (SWOV, 2018) is in white. Grey highlights road futures that Berr aims to redivide under the new category of Non Travel Surfaces (source: Berr & author).

The interviewed experts stressed the importance of adopting standard street guidelines that prioritize public transport and active modes. A good example of a city that adopted these kind of guidelines is Oslo. In their Street Design Manual for Oslo (Figure 4), designers are obliged to follow principles and priorities. Having these standard design guidelines in place, the attention is less focussed on accommodating infrastructure for automobiles only. Oslo's manuals provide a recipe for safe streets and bicycle infrastructure. By 2019, Oslo achieved Vision Zero (Elvaas, 2020). No one was killed or seriously injured within the road transport system (Tingvall & Haworth, 1999).

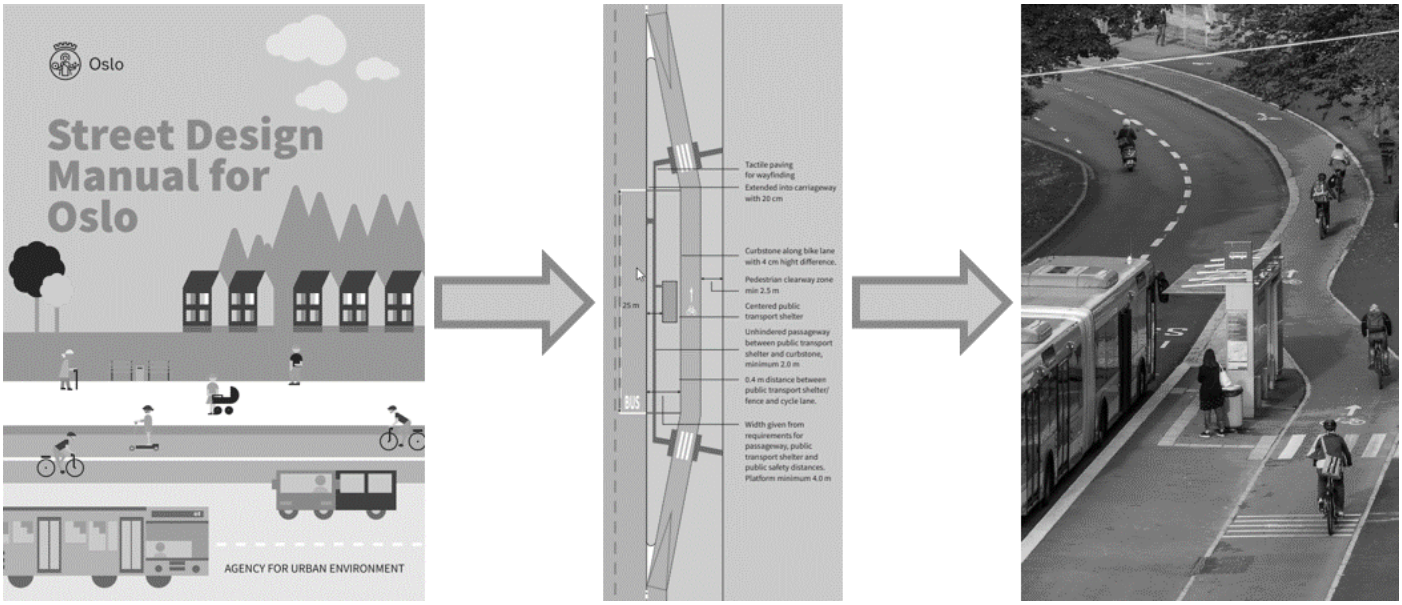

Figure 4: Oslo street design guidelines accommodating for sustainable modes. From guideline to realisation (Kjørven, 2020).

Politics and infrastructure reclamation do not go hand in hand, teach all experts. Reclamation is often the less favourable option. Bertolini calls for more experiments as a way to deal with resistance, because the past has learned us that unfavourable and controversial policies, where at first it seems like there are a lot of losers are preferred when people get used to it (Van Wee, et al., 2023).

A typical example of temporary experiments can be found in the policy papers of Vancouver. The city established a Rapid Implementation Design Guide to procedure infrastructure reclamation (Figure 5). TransLink, the transport agency of the metropolitan area of Vancouver, defines Rapid Implementation as the in-between tactic of tactical urbanism and traditional implementation. The method of temporarily taking away car lanes as a living laboratory triggers political acceptance or even support.

Berr sees the Dutch Polder politics as a benefit to these processes, because people are open-minded and not just accept the defaults. Complementarily, Stoker hopes that government bodies take more central control, due to the difficulties that occur when more permanent car-restricting measures need to be decided upon. He proposes lower quantities of parking spots with higher tariffs nationwide. Additionally, Stoker and De Wilde agree that the right coalitions need to be made. Aligning actors that are close to the action to get things moving. Indeed in politics, but especially on the policy maker level.

> Sustainable developments are somewhat future-proof. Politics, by definition, are not future-proof because it focuses on short-term and medium-term goals. [De Wilde]

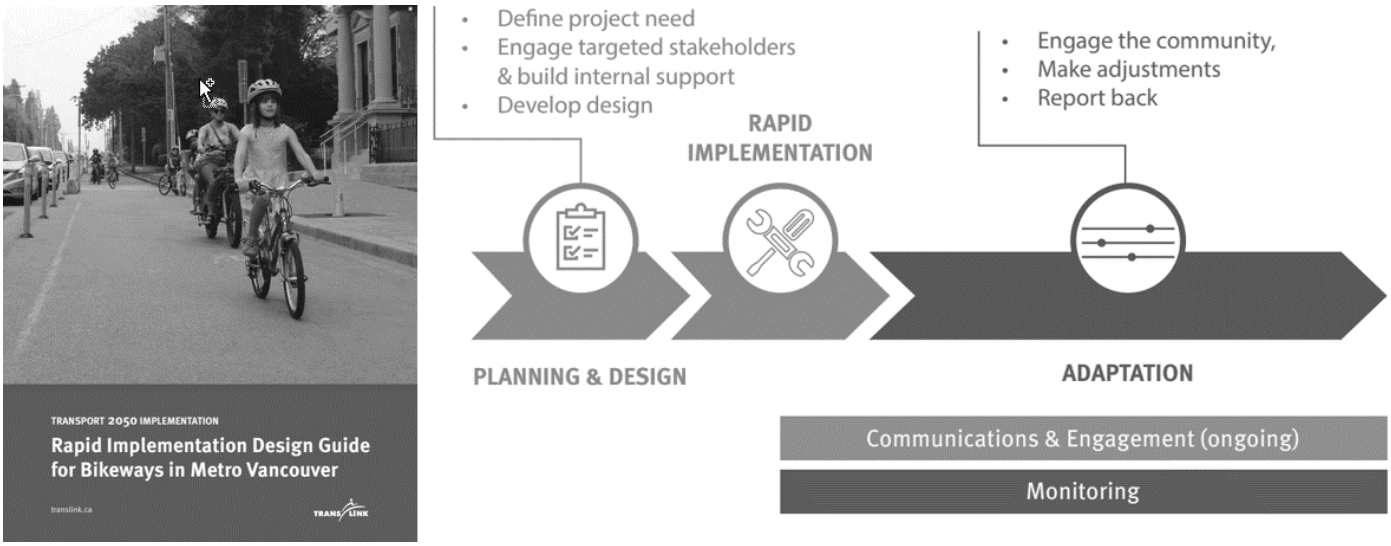

Figure 5: Temporary infrastructure reclamation design guideline in Vancouver (TransLink, 2020)

The relation between rural and urban and the difference in densities is extensively discussed in the above coding analysis. The code *Topographies* however, was applied when associated governance levels related to infrastructural decisions. The national state level is dealing with more ideologic problems, as Bertolini makes clear. Meanwhile, Stoker notes that the national government is as un-steerable as a mammoth tanker, difficult to manoeuvre when it comes to the implementation of sustainable infrastructure. In contrast, he describes good processes on Provincial levels, because traffic congestion and space constraints form less of a problem. Still, he finds it hardest to push for sustainable infrastructure on a municipal level, because there, space constraints are the largest. Contradictory, more cities call for sustainable solutions, because environmental consequences are most pragmatic for municipal bodies.

The code *Orientation* was applied to all codes dealing with the direction of reasoning for the development of infrastructure. According to experts, infrastructural decision making is mostly supply orientated. This predict and provide paradigm, as Bertolini explains, causes induced demand (traffic demand follows growing road capacity supply). To ensure travel time, level of service methods are often used to rate infrastructure. Bertolini and Berr agree on that space needs to be treated as public space for all, rather than for mobility for individuals.

For traffic modelling, problematics arise from the measurability of modes. De Wilde explains that detection loops make it possible to measure quantities of cars fairly simple, which makes the car the most assertive mode in the modelling process, determining the outcome of other modes more difficult to measure, like the cyclist and the pedestrian. In the opinion of De Wilde and Berr, this is one of the reasons why assigning infrastructure for active modes come as an afterthought. Another problem with modelling arises with the calibration; which is done by inputting contemporary traffic volume numbers. A modelled traffic forecast will likely result in an outcome where the car demands a majority of the space again, which results, according to Berr, in autopiloting the established principles.

> It's crucial to understand that with a model: if you put garbage in, you get garbage out. [De Wilde]

De Wilde is working on multimodality, by integrating public transport and active modes (which are relatively hard to measure) into models. Additionally, municipal and national models are being connected, which ensures integration and controllability over each other's infrastructural decisions.

In the following section, the results are discussed and brought into perspective with relevant literature.

Discussion

Prior to this research it was suspected that infrastructure reclamation can contribute to a sustainable system change. Confirmed was that infrastructure reclamation is indeed able to trigger sustainable system changes in The Netherlands, because it can supply space needed to connect multiple mobility niches (Geels, 2012), while the use of motorized vehicles can be reduced.

Results show that quality of life should not be ignored regarding sustainability, because it influences the scarce resource of health.

Instead, as a result of the economic prioritization in the Mobility vision document of the national government (Ministry of Infrastructure and Water Management, 2023), travel time becomes a highly valued premise, which is ought to be reduced (KiM, 2018). Seeing travel time as flexible is not in line with scientific literature. Within the theory of Marchetti (1994) for example, it is suggested that travel time remains constant and it is rather the functions that spread out demanding more and longer trips.

On the contrary, during data collection it became clear that practices from cities around the world follow a narrative which is less tied to economic growth and travel time. The analysis of municipal policy papers underlined the importance of strong local visions that plan for street reclamation (Engwicht, 1999) and even traffic evaporation (Nello-Deakin, 2020).

Although experts were asked the same structured questions, the semi-structured character of the conversations led to more details on their specific infrastructure specializations. Consequently, the interview with De Wilde included much content about traffic modelling and policy creation. Berr contributed to many technical solutions. Stoker gave deep insights into public transport and Bertolini gave an extensive academic background to infrastructure dynamics. As a result, the themes were not equally distributed over the interviews (Figure 6).

A limitation to this research was the small sample size (n=4) for expert interviews. The method of this research is limiting in the sense that expert interviews are just giving a broad understanding of infrastructure reclamation. In addition, future quantitative case studies similar to Nello-Deakin (2022) could be conducted to statistically support full effect sizes of infrastructure reclamation on sustainable system change.

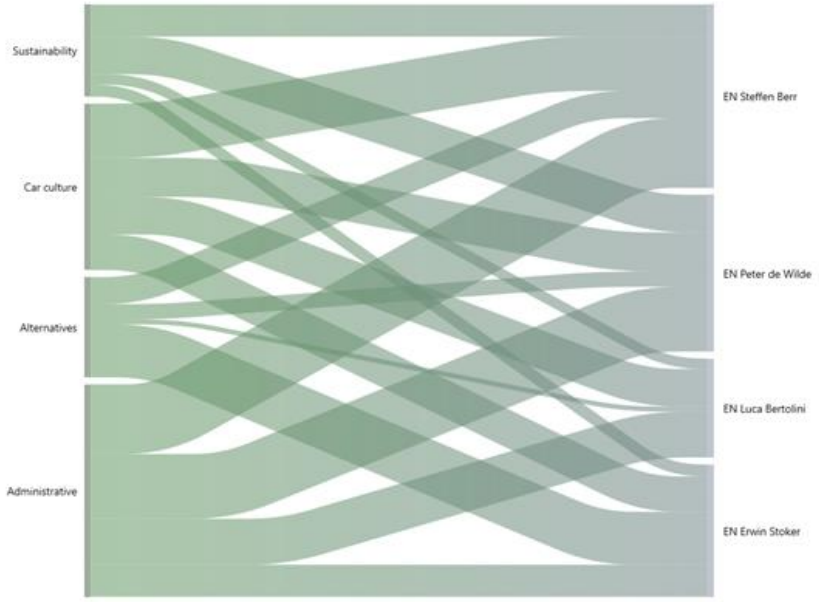

Figure 6: Sankey diagram highlighting theme distribution as a relative amount of codes distributed over the interviews

Conclusion

This thesis explored the process of car infrastructure reclamation in The Netherlands by interviewing experts in the field of mobility. In conclusion, experts see infrastructure reclamation as a fundamental means to reach a sustainable change in mobility patterns. Space, environment and (quality of) life can benefit from reclamation. When space is reclaimed for active modes and public transport, it can contribute to more efficient space usage. Interestingly, these sustainability impacts are not able to influence infrastructural extensions incentivised by the Dutch national government. Road guidelines currently in place seem to prioritize safety, but experts see reclamation as a means to an even safer, healthier and more liveable environment in the future.

According to experts, car mobility is often viewed as a goal in itself and thus ends up in a street design. As a result, car lanes prevent people from crossing roads, limiting the mobility of pedestrians. Experts still saw the role of the car crucial for more rural areas. At city level however, all experts agreed on more regulated, priced and concentrated parking that is connected to a reliable urban public transport network. Experts saw logistic corridors, and economic losses due to traffic congestion as major drivers of infrastructural decision-making. Infrastructure reclamation will trigger a different kind of economy with both winners and losers.

According to experts, public transport as an alternative to the car is a big winner to infrastructure reclamation, because separation of public transport to regular traffic contributes to the robustness and cost effectiveness of the system. Ultimately, tram tracks or BRT lanes have to be constructed, but Dutch institutions make them hard to be implemented. In addition to assigning infrastructure, the provincial level of government plays a crucial role in the success of public transport, to properly manage concession frameworks that make it possible for less-populated areas to also be served by public transport lines or shared mobility, while ensuring competitive liberal market principles in favour of travellers. Experts find it crucial to reclaim more car infrastructure for active modes, because it can prevent car trips from happening in the first place.

Results show the strong relationship between spatial planning and mobility. Periods of high housing demand resulted in spread-out trip origin and destination, leading to car dominance. In these places, reclaiming car infrastructure to high quality public space is even more important, to concentrate functions more. Experts saw long-term policy visions as an effective tool for infrastructure reclamation, as long as limitations and responsibilities are clear. According to experts, design guidelines play a crucial role in infrastructure considerations. Experts suggest that these car-centric guidelines could use an additional non-travel surface category where staying is more important than trespassing. Politics are a major barrier in implementing reclamation as a controversial policy. Aligning the right political and servant actors are needed to cope with the short-term character of political electoral standpoints. Furthermore, experts see experimenting with infrastructure (budgets) as an effective and adaptive policy pathway to infrastructure reclamation. Experts agree on a problem statement difference for different levels of government. Problems that influence infrastructure are more pragmatic at municipality level, compared to more ideologic for larger scale governments. Consequently, infrastructure on national level is still supply orientated based on travel times, criticized by experts interviewed in this thesis. However, established methods used by traffic engineers form a barrier to breaking the status quo.

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Appendices

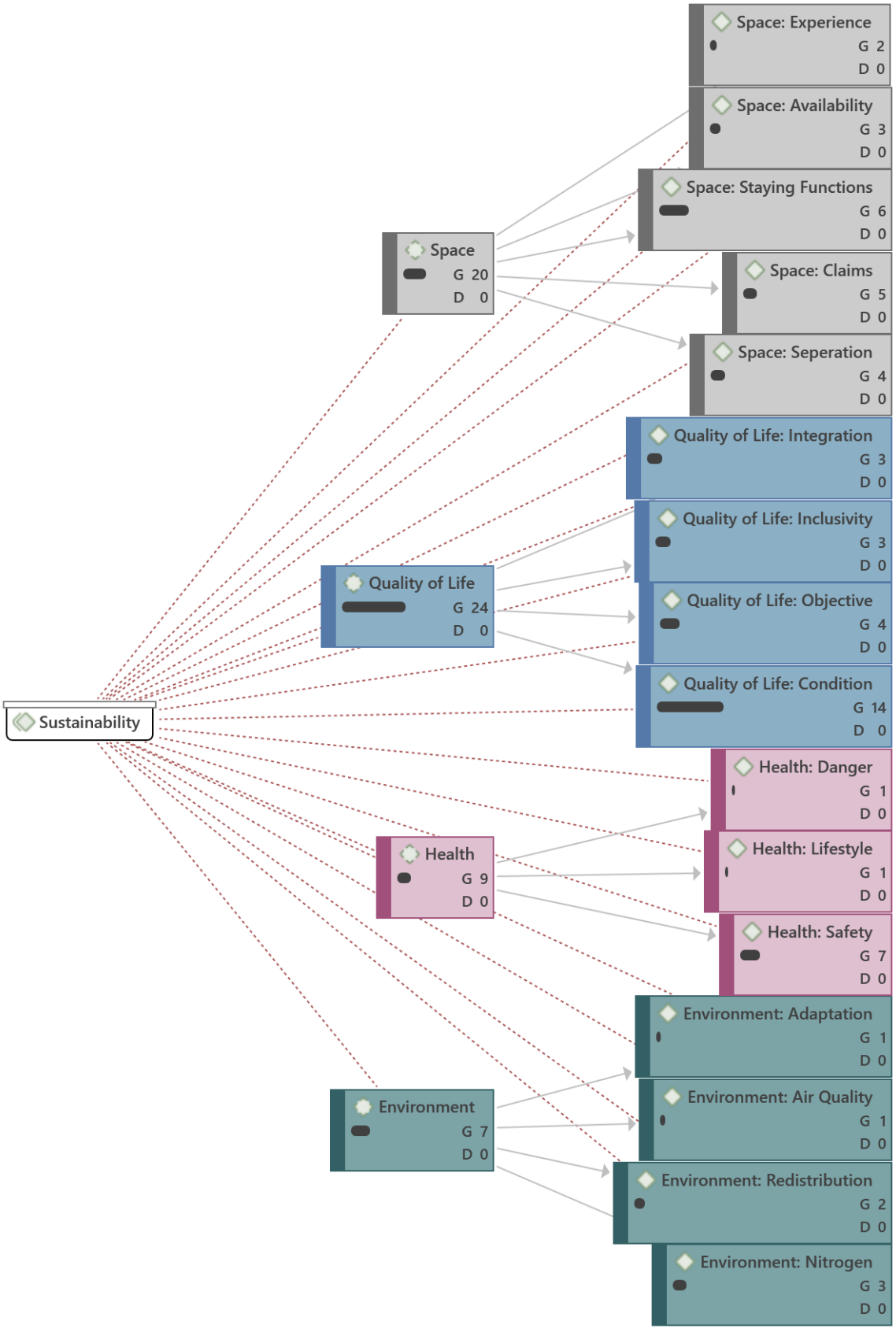
1. Interview Guide

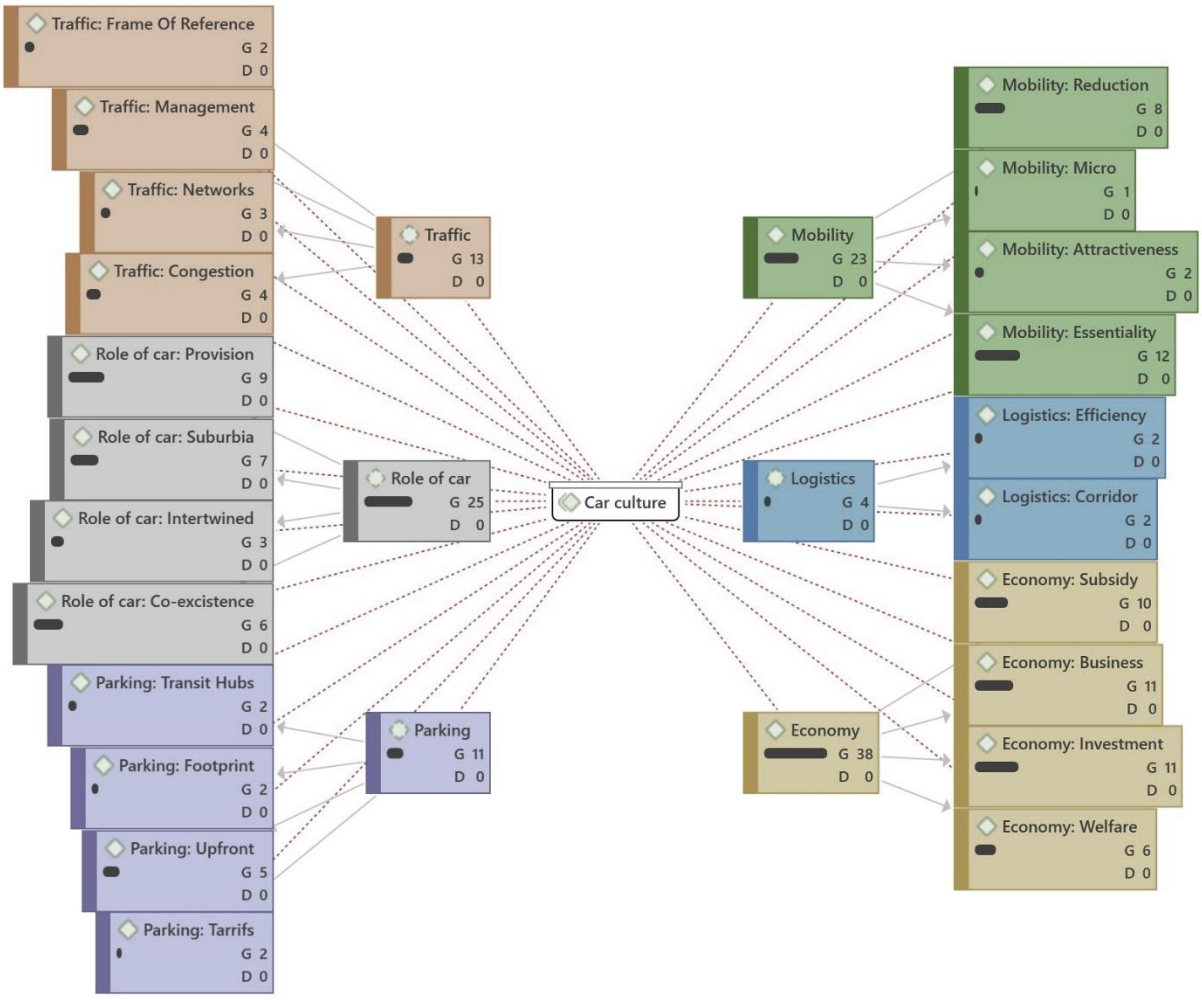
1. What infrastructural decisions do you encounter in your profession?
2. What are important premises in making these decisions?
3. What methods do you use that have an impact on type of infrastructure build?
4. How would you rate current infrastructure system in The Netherlands?
5. What is the sustainability score of this infrastructure?
6. What can be done to increase this score?
7. What kind of redistributions are needed for these changes?
8. What are the barriers/enablers to (systematic) changes that you proposed?
9. What is the difference/relation between rural/urban?
10. What would be the ideal conceptual city in terms of mobility for 2050?

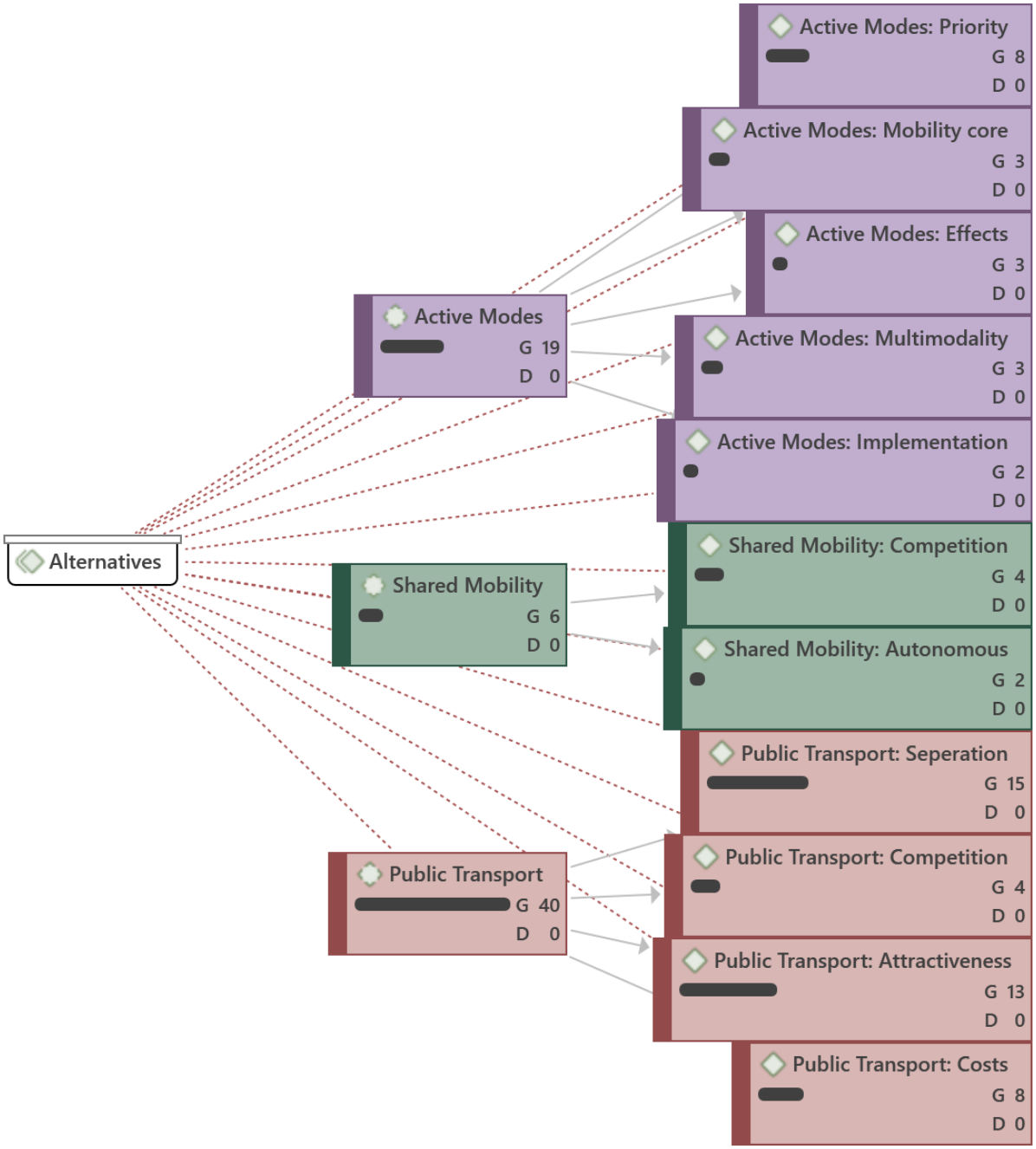
2. Participating experts

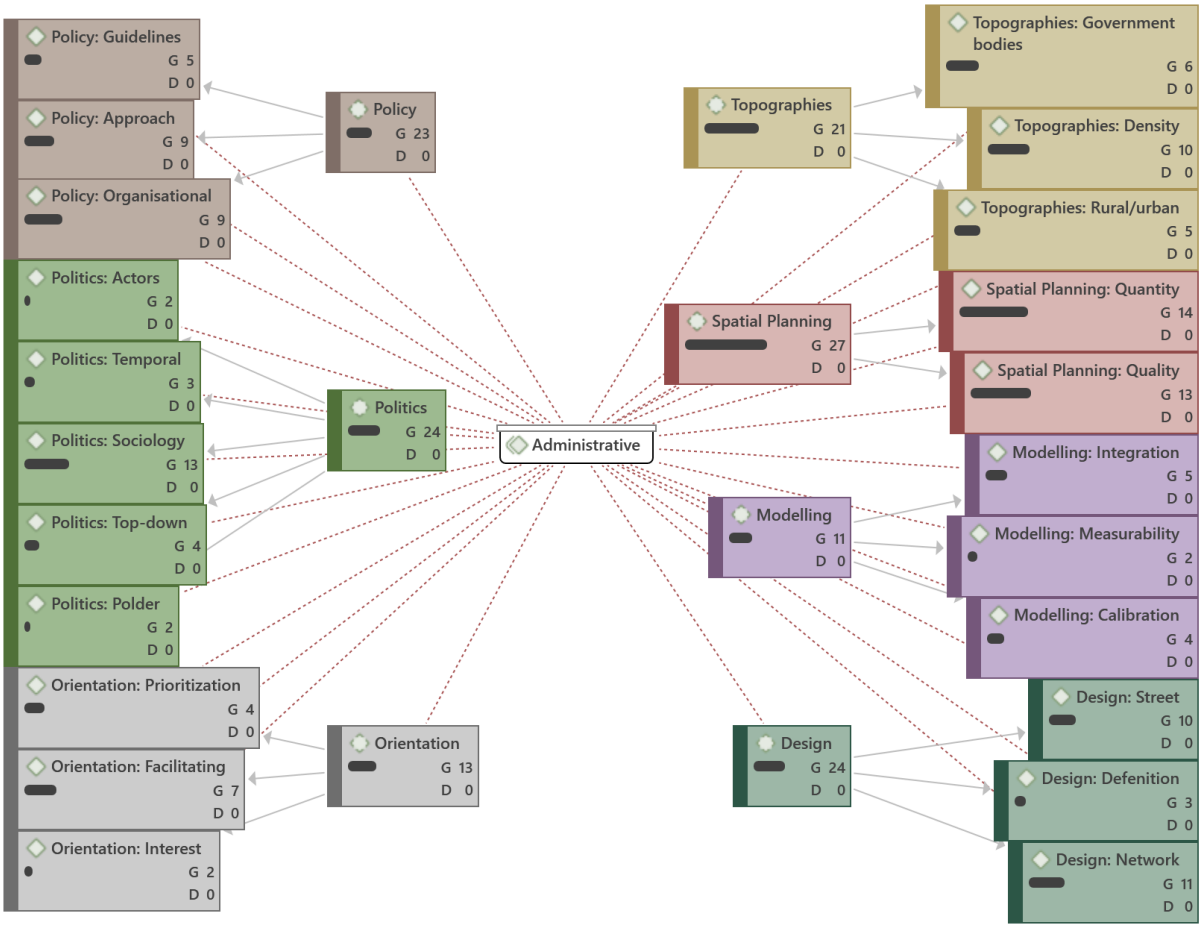
Name	Education	Infrastructure related profession	Organisation	Interview duration in minutes
Peter de Wilde	Traffic engineer (TU Delft)	Strategic traffic designer	Municipality of Groningen	32
Steffen Berr	Civil engineering (California State University)	Civil engineer & designer	Arcadis advisory bureau	61
Erwin Stoker	Civil engineering (TU Delft)	Team coordinator development and market dynamics	Public Transport Bureau Groningen Drenthe	46
Luca Bertolini	Architecture, Philosophy, Urban and Regional Planning (Politecnico di Torino, UvA)	Professor Urban and Regional Planning	University of Amsterdam	38

3. Sub coding trees




Traffic: Frame Of Reference
G 2
D 0
Traffic: Management
G 4
D 0
Traffic: Networks
G 3
D 0
Traffic: Congestion
G 4
D 0
Role of car: Provision
G 9
D 0
Role of car: Suburbia
G 7
D 0
Role of car: Intertwined
G 3
D 0
Role of car: Co-excistence
G 6
D 0
Parking: Transit Hubs
G 2
D 0
Parking: Footprint
G 2
D 0
Parking: Upfront
G 5
D 0
Parking: Tarrifs
G 2
D 0
Traffic
G 13
D 0
Role of car
G 25
D 0
Parking
G 11
D 0
Car culture
Mobility
G 23
D 0
Logistics
G 4
D 0
Economy
G 38
D 0
Mobility: Reduction
G 8
D 0
Mobility: Micro
G 1
D 0
Mobility: Attractiveness
G 2
D 0
Mobility: Essentiality
G 12
D 0
Logistics: Efficiency
G 2
D 0
Logistics: Corridor
G 2
D 0
Economy: Subsidy
G 10
D 0
Economy: Business
G 11
D 0
Economy: Investment
G 11
D 0
Economy: Welfare
G 6
D 0


Alternatives
Active Modes
G 19
D 0
Shared Mobility
G 6
D 0
Public Transport
G 40
D 0
Active Modes: Priority
G 8
D 0
Active Modes: Mobility core
G 3
D 0
Active Modes: Effects
G 3
D 0
Active Modes: Multimodality
G 3
D 0
Active Modes: Implementation
G 2
D 0
Shared Mobility: Competition
G 4
D 0
Shared Mobility: Autonomous
G 2
D 0
Public Transport: Seperation
G 15
D 0
Public Transport: Competition
G 4
D 0
Public Transport: Attractiveness
G 13
D 0
Public Transport: Costs
G 8
D 0


Administrative
Policy
G 23
D 0
Policy: Guidelines
G 5
D 0
Policy: Approach
G 9
D 0
Policy: Organisational
G 9
D 0
Politics
G 24
D 0
Politics: Actors
G 2
D 0
Politics: Temporal
G 3
D 0
Politics: Sociology
G 13
D 0
Politics: Top-down
G 4
D 0
Politics: Polder
G 2
D 0
Orientation
G 13
D 0
Orientation: Prioritization
G 4
D 0
Orientation: Facilitating
G 7
D 0
Orientation: Interest
G 2
D 0
Topographies
G 21
D 0
Topographies: Government bodies
G 6
D 0
Topographies: Density
G 10
D 0
Topographies: Rural/urban
G 5
D 0
Spatial Planning
G 27
D 0
Spatial Planning: Quantity
G 14
D 0
Spatial Planning: Quality
G 13
D 0
Modelling
G 11
D 0
Modelling: Integration
G 5
D 0
Modelling: Measurability
G 2
D 0
Modelling: Calibration
G 4
D 0
Design
G 24
D 0
Design: Street
G 10
D 0
Design: Defenition
G 3
D 0
Design: Network
G 11
D 0