Sustainable mobility concepts in the built environment and De Woningbouwopgave

de Rijk, T.E.J.

Award date:
2023

Sustainable mobility concepts in the built environment and De Woningbouwopgave

Master thesis

T.E.J. (Tom) de Rijk
0949068

First supervisor
Prof. Dr. R. (Ruth) Oldenziel

Second supervisor
Prof. Dr. T.A. (Theo) Arentze

Third supervisor
Ir. R.P. (Robert) van Dongen

On sustainable mobility concepts in the built environment, how they are considered in governance for De Woningbouwopgave, how they can facilitate stakeholder alignment in the design phase and their recognition in favor of the sustainable mobility transition in The Netherlands.

May 11th, 2023
Graduation project Innovation Sciences // Architecture, Building and Planning:
Urban Systems & Real Estate (7Z45M0)
45 ECTS

This thesis has been carried out in accordance with the rules of the TU/e Code of Scientific Integrity

Blank page

Management summary
This thesis sought to examine the current state of literature on sustainable mobility in the built environment. This examination brought forth a list of concepts that represent this relationship. This list of concepts was placed in the context of De Woningbouwopgave. In order to solve the dire housing shortage in The Netherlands, a large budget has been made available by the national government. Project developers and municipalities can submit development plans to receive a part of this budget – granted that they are eligible for the funding. To test for this eligibility, several assessment methodologies are in place. In turn, the aforementioned list of concepts from the literature is compared to these assessment methodologies. The aim of this comparison is to check whether worldwide knowledge and experience is used to foster the sustainable mobility transition through the built environment.

The first part of this thesis focuses on top-down governance in De Woningbouwopgave. There are four main assessment methodologies that test whether concepts of mobility have are used in development projects: the conceptual framework, assessment of mobility in plans applying for project acceleration, similar assessment for the Woningbouwimpuls (Wbi) and the mobility transition menu. Comparison to literature concepts shows results ranging from accurate inclusion, to severe lack of acknowledgement of sustainable mobility insights from earlier research. The mobility transition menu discusses numerous concepts in detail. The menu functions to inform project developers and municipalities about sustainable mobility options in order to have it included in future developments. This indeed presents a hopeful vision for the future, but does not directly influence the current budget decisions. The two mobility assessments (for project acceleration and the Wbi) show recognition for sustainable urban mobility planning. However, this recognition mainly concerns the nature of present infrastructure and the mobility profile of the projected target group.

The good news is that mobility is tested for. However, policymakers do not always assess for sustainable mobility, but rather whether the project requires ‘logical’ infrastructure investments. Despite this lack of top-down steering from the government, projects that apply for these programs show bottom-up incentive in sustainable mobility. Thus, the assessments often show sustainable mobility, but this is inherently present in the plans – not the assessment methodologies. The clearest lack of recognition of earlier knowledge exists in the conceptual framework. The leading parameters are housing construction value and accessibility level. Within the latter, several tools assist in filling in the required criteria. The main tools are the integral mobility analyses (IMA), the urbanization dashboard and the regional urbanization strategies. Even though these tools clearly show recognition for the literature, they are lackluster represented in the framework. Their findings are often watered down to simple textual explanations or to questions that work in the context of the assessment, but do not represent the valuable conclusions that can be drawn from the tools.

The second part of this thesis focuses on applying the literature concepts bottom-up, through design and stakeholder alignment. The thesis presents a way to incorporate literature in design through Analysis of Interconnected Decision Areas (AIDA). This method facilitates urban planners with design solutions that fit stakeholders’ design criteria in sustainable mobility.

A combination of both the top-down and bottom-up approaches will have design and assessment of the design meet in the middle, both based on sustainable mobility insights from the literature. Using the AIDA method in design is one part of the solution. The second part concerns a more accurate representation of the aforementioned tools and better criteria in governance. This cooperation is mandatory for including worldwide knowledge cohesively. These changes will foster the sustainable mobility transition that the Netherlands so desperately needs. It is important to do so because it concerns an enormous budget. A budget that will be used to lay the urban foundations for mobility for decades to come. Not using extensive and worldwide research insights would be unwise and would make budget and development decisions unfounded in science.

Contents

Abstract

Over the coming years, The Netherlands will see a much-needed influx of housing. The growth in urban development is accompanied by an increasing need for mobility. Therefore, this housing challenge provides the perfect opportunity to foster the sustainable mobility transition. This thesis identifies and promotes the inclusion of literature findings on sustainable mobility in the assessment of project development plans. This assessment guides the budget decisions of development projects related to the housing crisis, dubbed De Woningbouwopgave. The literature ends with a list of concepts that represent the literature on sustainable mobility in the built environment. These findings represent existing knowledge and can assist policymakers in making decisions in urban development.

Policymakers follow several methods to examine the role of mobility in the development plans for De Woningbouwopgave. The four main assessment methodologies are compared to the list of concepts to identify their connection to the literature. The main conclusion of this comparison is that this connection is lacking and should be improved to foster the important use of existing knowledge. This is relevant for providing top-down guidance in the sustainable mobility transition that overlaps the current housing crisis. To assist in the inclusion of literature, this thesis also provides bottom-up guidance. It presents a method to include literature concepts in stakeholder alignment through design decisions. In doing so, this thesis presents a two-pronged approach through top-down governance and bottom-up design, allowing for the inclusion of research findings to use De Woningbouwopgave as a way to correctly foster the sustainable mobility transition.

Summary

The Netherlands is experiencing a housing crisis. Decentralization and decreased construction during the past decades, steadfast population growth and changing mobility needs are challenging the residential real estate market. In public discourse, this challenge is called De Woningbouwopgave. To overcome this situation, Dutch ministries have presented a plan. This plan consists of three main goals: (1) to increase the housing stock with 900.000 units before the end of 2030; (2) to construct 100.000 units per year; and (3) to ensure two-third of the new housing are affordable. A housing deficit is not the only crisis. Changing needs for mobility accompany the required housing increase. Existing mobility ecosystems are under pressure and there is a need for a sustainability transition. De Woningbouwopgave should serve as a key event to facilitate this transition. The government has made available € 7,5 billion through the Mobility Fund. This budget should facilitate mobility infrastructure investments that support project developments for De Woningbouwopgave. To divide this budget, the government assess projects and required infrastructure. To facilitate the sustainable mobility transition, policymakers should include sustainable mobility in the assessment process. The national government does not need to reinvent the wheel in doing so. A substantial literature exists about sustainable mobility. This thesis examines if and how the assessments are grounded in the existing sustainable mobility scholarship environment. Following that, the thesis provides recommendations on how to improve on this and why it is important to do so.

Sustainable mobility in the built environment can be divided into four categories: (1) policies, (2) urban planning, (3) technology, and (4) culture & mindset. These four categories describe how the built environment affects mobility. Policy acts as an imposer of limitations and as facilitator of other concepts. Urban planning relates to the physical design of urban areas. Technology supports development in sustainable mobility and provides new insights and advancements. Culture and mindset discuss how the built environment is able to influence behavior and culture, but also vice versa. The literature review concludes with a list of relevant concepts within these four categories. These concepts represent the relationship between the built environment and sustainable urban mobility.

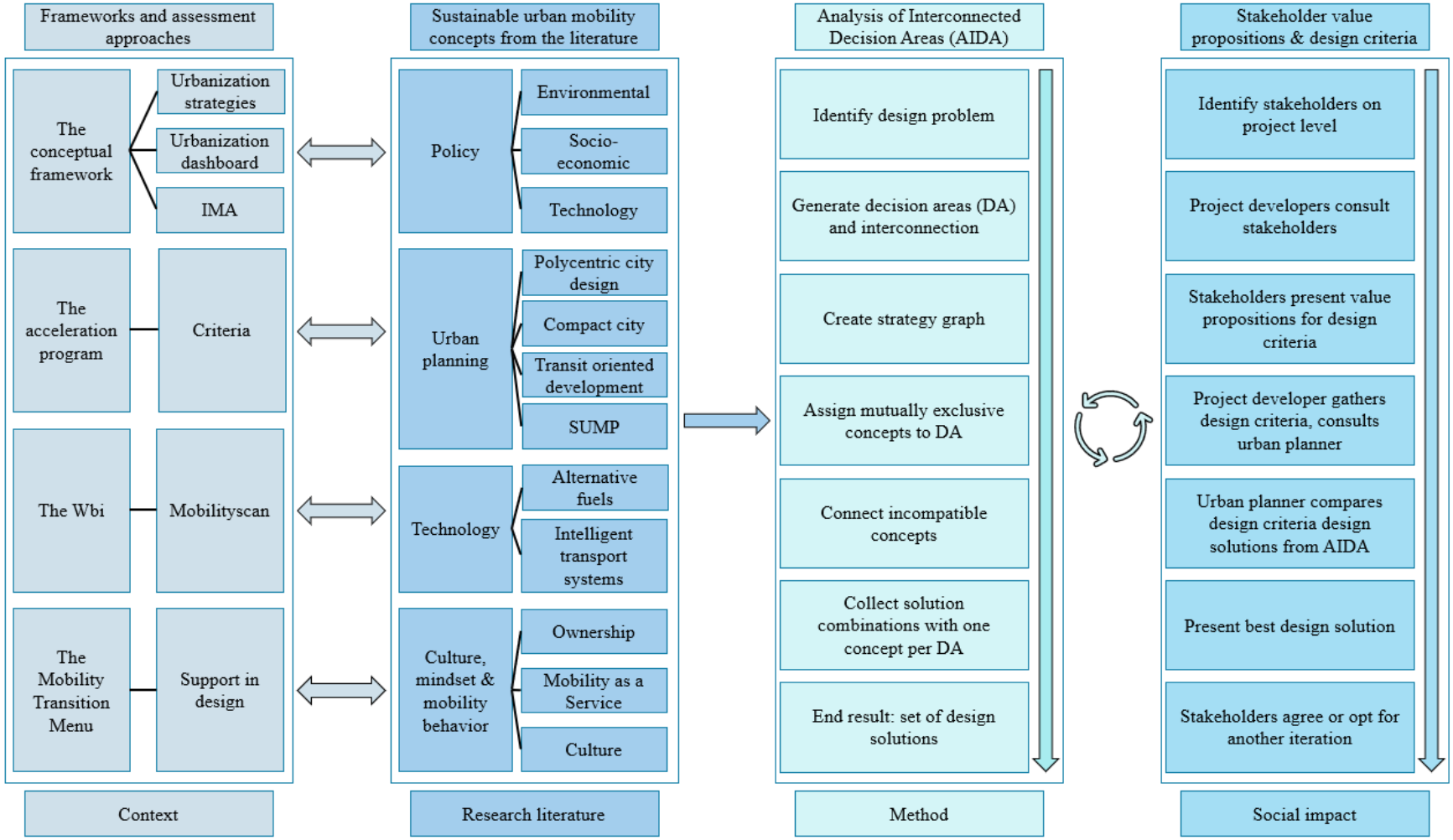
Projects related to De Woningbouwopgave are structured according to their location. There are seven larger NOVEX-regions that include a total of seventeen large NOVEX development areas. Residential development projects will be executed both inside and outside of these regions. The assessment of project developments related to De Woningbouwopgave happens through four different approaches, all including a mobility section. Which approach is applicable is dependent on the location of the project and thus which part of the fund the developers are applying for. The assessment approaches are as follows: (1) the conceptual framework is responsible for assessing development projects in NOVEX-regions. It supports guiding the budget discussion by examining the projects with respect to the urbanization dashboard, urbanization strategies and mobility challenges (IMA). Projects outside NOVEX-regions apply for the (2) acceleration program. Haste is required here. Sustainable mobility only plays a minor role in the assessments. Focusing on sustainability is not within the scope of the assessment. However, most of the applications show a sustainable intention. (3) The Woningbouwimpulse (Wbi) has existed for some years and assists municipalities in constructing essential infrastructure. Applications from municipalities and project developers are examined in a 4-hour mobility scan. (4) The mobility transition menu informs municipalities and project developers about sustainable mobility options for new projects. It functions as an informative tool for new projects rather than an actual assessment of existing plans.

After comparing these approaches to the list of concepts from the literature study, the general idea

is that literature findings are underrepresented. Whereas the transition menu lives and breathes these concepts, the other three approaches are lacking. This is especially the case with the conceptual framework. Despite that the assessment relies on documents that initially emit sustainable mindsets, they are represented by criteria that do not do them justice. The assessments in the acceleration program and the Wbi overlap with the literature here and there. However, they do not seem to fully grasp the concepts' potential. There seem to be bottom-up sustainability incentives coming from the projects, but there is a lack of top-down pressure. Which is peculiar, as this is where policymakers make budget decisions. This is problematic, not even only because as these assessment approaches concern budgets of billions. More so, they have the potential to facilitate infrastructure developments lay the groundwork for a sustainable mobility transition. Including findings from the literature in these assessments represents decades of existing worldwide knowledge and supports arguments in the development process.

Using the literature solely in the assessment does not suffice. The concepts need to be brought into practice. To do so, one should look at mobility developments on a project level. Because of the nature of the built environment, these projects are extremely context-dependent and include numerous stakeholders. Each of these stakeholder (-groups) have their own value propositions they would like to see represented in the new development. One is able to translate these propositions into design criteria. A set of design criteria from the stakeholders forms a design problem. This problem is considered during the design phase of the project development. Here, 'design' implies a strategy or guidelines rather than an actual spatial design. The project developer has to find a solution for this design problem.

This thesis presents an application of a method used for solving these design problems. The method 'Analysis of Interconnected Decision Areas' (AIDA) has been used to make design decisions in the built environment. The method starts with defining the decision areas that exist in the problem. These decision areas can interact with each other in a strategy graph, either limiting or creating options between the two. The decision areas in the current application are: (1) design ideology, (2) role of motorized traffic, (3) road design, (4) use of space, (5) Mobility incentivization, (6) Ownership and (7) zoning. Each area includes a set of mutually exclusive literature concepts that relates to that decision area. It happens that two concepts between these areas cannot be combined in one design because they follow different principles (e.g., a focus on automobility in road design, but designing the area as a car-free superblock). This incompatibility is based on literature and this erroneous combination makes for an unviable design. Picking one concept per decision area and avoiding incompatibilities creates a design solution. The number of chosen design options in the design solution is equal to the number of decision areas. This method and concepts that are mentioned and how the sections interact are found in the visual below:


Frameworks and assessment approaches
Sustainable urban mobility concepts from the literature
Analysis of Interconnected Decision Areas (AIDA)
Stakeholder value propositions & design criteria
The conceptual framework
Urbanization strategies
Urbanization dashboard
IMA
The acceleration program
Criteria
The Wbi
Mobilityscan
The Mobility Transition Menu
Support in design
Policy
Environmental
Socio-economic
Technology
Urban planning
Polycentric city design
Compact city
Transit oriented development
SUMP
Technology
Alternative fuels
Intelligent transport systems
Culture, mindset & mobility behavior
Ownership
Mobility as a Service
Culture
Identify design problem
Generate decision areas (DA) and interconnection
Create strategy graph
Assign mutually exclusive concepts to DA
Connect incompatible concepts
Collect solution combinations with one concept per DA
End result: set of design solutions
Identify stakeholders on project level
Project developers consult stakeholders
Stakeholders present value propositions for design criteria
Project developer gathers design criteria, consults urban planner
Urban planner compares design criteria design solutions from AIDA
Present best design solution
Stakeholders agree or opt for another iteration
Context
Research literature
Method
Social impact

317 Design solutions were filtered from 5.760 potential options. Mediators from municipalities and project developers should consult with stakeholders to identify their mobility design criteria following from value propositions. After gathering the pieces of the design problem, urban planners relate them to one of the 317 sets of design solutions. This solution is presented to the stakeholders to verify the representation of their value propositions. This process repeats until a suitable solution is agreed on and the design and funding phases begin. Through this approach, the literature is included in the top-down assessment of projects. Additionally, it includes literature bottom-up through projects where stakeholders are aligned using the concepts. This will smoothen the cooperation with stakeholders during the development process. In turn, this facilitates the sustainable mobility transition through including literature findings in the built environment.

Introduction

De Woningbouwopgave as premise

An increase in population (CBS, 2022b), a decrease in household size (CBS, 2022a) and a steep rise in housing prices are several causes for the housing deficit in The Netherlands. As a result, there is an ongoing housing crisis. The Dutch Ministry of Internal Affairs (Dutch: Ministerie van Binnenlandse zaken) issued a prognosis. According to the Primos prognosis by ABF-research, the number of Dutch households in need of housing will increase with 850.000 between 2021 and 2035. To accommodate for these new households, new housing units are required. The same publication estimates the housing crisis to peak around 2024. That year, the total deficit of housing units will reach approximately 317.000. Without any interference on the national government's behalf, thousands of households are likely unable to find a suitable space to live.

Prime Minister for Housing and Spatial Development, Hugo de Jonge, leads a new housing development program to counter the current deficit. Together with the Ministry of Infrastructure and Water Management (Dutch: Ministerie van Infrastructuur en Waterstaat) and the Ministry of Economic Affairs and Climate Policy (Dutch: Ministerie van Economische Zaken en klimaat), De Jonge proposed an approach that should enable governments to reach milestones in housing developments. The housing deficit together with the proposed development solutions are discussed as '*De Woningbouwopgave'** (English: The Dutch Housing Challenge). De Jonge mentioned three goals:

- 900.000 new housing units by 2030;
- Growing to 100.000 new units per year;
- Two-third (600.000) affordable housing.

De Jonge aims to create 900.000 new housing units before the end of the year 2030. He aims to accommodate the 850.000 new households (thus facilitating an increase of 12% on the existing housing stock). To do so, the yearly quantity of housing unit construction has to grow from 80.000 to 100.000 units per year. Additionally, most of these housing units, approximately 600.000, has to be available for social housing or fall in the affordable category (rent below €763,46 per month as estimated in 2022). Housing corporations will build one half of these affordable housing units. The other half belongs to the commercial sector and includes both rent- and sales-units.

These three points of action shape the trajectory of De Woningbouwopgave. Alas, the challenge lies in more than just creating nearly a million new housing units. The new residents also need transportation to get to school and work, find leisure, visit friends and family, and such. This increase in mobility will be added to an already extensive and pressured mobility network. This will be a core element of this research.

Increasing and changing need for mobility

Up until now, urban design and planning that considers mobility has focused on the conventional mobility: automobility. This could be the case for housing development projects in De Woningbouwopgave – granted they account for urban mobility.

Together with the rest of the World, The Netherlands faces several sustainability crises. The need for more sustainability in mobility is one of them. Over the past decades, scientists, policymakers, planners, and researchers put effort into developing sustainable solutions towards the mobility crisis. These solutions aim to disrupt different aspects of the automobility regime; some developments aim to steer the fossil-fuel debate (e.g., fuel efficiency, counteracting fossil fuel emissions or change the type of fuel overall). Some work from a socio-political perspective (e.g., changing mobility behavior, subsidize other means of transport or fund intrinsically new mobility ideas). Others have a more systematic approach (e.g. Mobility as a Service and sharing economies). Whereas others focus on the effect that the built environment has on how mobility is accessible to users (e.g. transit oriented development). This

*: Referring to the Dutch Housing Challenge in Dutch accounts for the context and societal debate surrounding the subject. Therefore, this terminology will be leading throughout the thesis.

summation is only to show the diversity of research fields and is by no means a complete list of expertises.

850.000 New households are constructed in urban areas that already have a strained mobility network. Expecting them to depend on automobility is likely to prove problematic and will create additional challenges. Integrating literature findings into the development plans and considering sustainable mobility in De Woningbouwopgave avoids these traditional challenges.

Research objective

This master thesis researches sustainable urban mobility concepts. It investigates what role they could play in housing development projects in De Woningbouwopgave, as well as how these concepts are used to solve design bottlenecks. Essentially, the objective is to study how De Woningbouwopgave serves as a facilitator of the sustainable mobility transition through governance and design. Therefore, the following questions stand at the center of this thesis:

How could sustainable mobility insights and findings related to the built environment be used in the assessment of current development plans and in the design phase of future residential development projects as part of De Woningbouwopgave?

The thesis results in a recommendation towards sustainable mobility inclusion in the assessment approaches used to assess the housing development projects and their proposed mobility infrastructure investments in De Woningbouwopgave. Simultaneously, the thesis provides municipal governments and real estate developers with a stakeholder alignment strategy considering sustainable mobility in future development projects.

Sub-questions

The following questions aim to answer parts of the overarching research question:

- What are the present relevant insights and strategies on sustainable urban mobility in relation to the built environment?
- How are these insights and strategies included in plans and policies for De Woningbouwopgave?
- How could the current sustainable mobility insights be used in the assessment frameworks to examine the sustainable mobility inclusion in development projects?
- Which relevant stakeholders are involved on a project level considering sustainable urban mobility and what are their value propositions?
- How can these stakeholders be aligned through design decisions to create an optimal sustainable mobility approach related to De Woningbouwopgave?

Essentially, these sub-questions summarize the red thread that in this thesis. They serve to answer the overarching research questions.

Relevance of this thesis

The current literature base presents a plethora of sustainable mobility solutions, both urban and rural and focusing on different aspects of mobility. The approach that is proposed here, is to filter sustainable *urban* mobility concepts according to their relevancy. The result of this section is a coherent list of concepts that are relevant in the literature. This section therefore serves as a peer review on present literature that discusses sustainable urban mobility.

The Ministry of Internal Affairs mentions mobility in the program. Several regional and municipal governments expressed the urgency to look at more coherency with sustainable mobility for the development (Metropoolregio Amsterdam, 2022). This increase in awareness urges sustainable mobility to have a position in the new development plans. This thesis strengthens that plea and indicates the

relevance and impact of sustainable mobility concepts and findings. It reviews the assessment frameworks according to their sustainable mobility inclusion. The conclusion presents a recommendation towards including these concepts top-down and bottom-up.

Sustainable mobility has a prominent position in the literature base when it comes to discussing from a fuel-based, mindset or built environment perspective. However, new and greener forms of mobility require more than a mention in articles to become disruptive enough to overturn conventional automobilism. Implementing sustainable urban mobility concepts in De Woningbouwopgave is likely to foster the mobility transition. The housing challenge offers a backdoor for the sustainable mobility transition to hitchhike with sustainable urban environment design decisions.

Even though the challenge itself is recognized and approached on a national level, a lot happens on the lower levels as well. On a project level, a set of actors works together to solve the housing crisis – potentially with an eye for sustainable mobility. When working with different actors with varying value propositions, conflict often arises. This is also the case when viewing the mobility challenges on a project level. This clash of value propositions could be causing project stagnation. Projects could be discontinued or to not come to their full fruition. This thesis provides a method for urban developers and municipalities to create mobility design solutions fit for different conflict situations. Essentially, this thesis is relevant as it adds to the societal debate surrounding the sustainable mobility transition. It does so by providing the stakeholders with design solutions that unify clashing groups and alleviates bottlenecks in project development.

The result of the thesis is not only the analysis of the government's assessment frameworks. The results include a policy and approach recommendation focusing on fostering the sustainable mobility transition through new residential developments. This aligns with the Innovation Sciences-track: Innovation Strategy & Policy. It discusses the governance approach to sustainable urban mobility innovation in De Woningbouwopgave on a strategic level. Eventually, this strategic analysis leads to a more tactical and operational way of stakeholder alignment. The stakeholder analysis is conducted on a project level in municipalities: most conflict in relation to mobility occurs here and specific stakeholder alignment is required. To align these stakeholders, one should examine the alignment barriers and design challenge, leading to an array of design criteria. The thesis will show how literature concepts on sustainable mobility in the built environment fosters stakeholder alignment through design. This approach ties into the Urban Systems & Real Estate (USRE) program with the Built Environment Faculty. This thesis relates to USRE by examining the current state of sustainable mobility in the built environment. It uses that knowledge to create solution packages to assist in urban design challenges.

To sum up: the thesis presents a bipartite guidance approach. This guidance and the recommendation that follows will discuss at the governance (assessment of projects and funding allocation) and the design phase (including the stakeholder alignment through design).

Reading guide

The first chapter in the literature research presents an analysis of what sustainable mobility is and how this plays a role in the built environment. The next chapter identifies the four main categories that overarch the list of literature concepts relating to this urban mobility. The result of this literature review is a cohesive list of concepts that is used in the analysis of assessment approaches in the funding governance of De Woningbouwopgave. This Dutch housing challenge will be examined in chapter 4. This includes introductory information about the funding structure and relevant frameworks and assessment approaches. After this introduction, each assessments is interpreted and further discussed. The potential connections between the approaches and the list of literature concepts is considered after. This is where the connection to the literature and the actual

assessment of the governance is presented, as well as the policy recommendations. The next chapter introduces the stakeholders and their value proposition, leading up to the design criteria on a project level. The following section explains the analysis of interconnected decision areas (AIDA) and relates the approach to the outcome of the stakeholder analysis. This is fundamental to an approach that assists municipalities and project developers in future projects. What follows is a bipartite recommendation that relates to the governance and design phase to provide conclusions. The last chapter discusses the limitations to the literature review, information availability and applied method, as well as future research proposals and improvements.

To summarize, the red thread running through the thesis is as follows:

- Introduction to the thesis
- Chapter 1: Sustainable mobility
- Chapter 2: Sustainable mobility concepts in the built environment
- Chapter 3: De Woningbouwopgave
- Chapter 4: Assessment methodologies in De Woningbouwopgave
- Chapter 5: Stakeholder analysis and Analysis of Interconnected Decision Areas
- Conclusions and Recommendations
- References and Appendices

1. Sustainable Urban Mobility Scholarship

The following chapter discusses how the sustainable mobility discussion developed over the past centuries. Starting with an EU white paper from 1992, followed by halfway observations discussing sustainable mobility around 2010 before ending with a state of the science discussion. This chapter focuses on the current course of the debate. It includes a typology and narratives of sustainable mobility concepts to be further used throughout the thesis for the conceptualization.

1.1 Need for sustainable mobility

Moving around the city is paramount for citizens live in an urban area. People should be able to go about their daily tasks, go to work, fine leisure, and go on social visits. Even more so, having the capability to move around and be mobile is seen as a general human right (Logan et al., 2018). Over the past century, mobility by (private) car was seen as the regime. Having access to a private vehicle to travel long distances presented a feeling of freedom, safety and status. People's ability to travel wherever they want at a given time has played a major role towards the popularity of private automobilism. As a result, there are now an estimated 1.450 billion cars in the entire world (Bonnici, 2022).

However, depending on automobility has numerous downsides. This has become increasingly apparent over the past decades. Since the far majority of car sales still concern fossil-fuel based automobiles (Abnett, 2022), they take a prominent role in the unsustainability discussion surrounding the enhanced climate change debate. Even more so, new EU climate change deals prohibit the sale of new fossil-fuel based cars by 2035 to counteract climate change (Abnett, 2022). An EU publication from 1992 addressed this ecologically detrimental effect of mobility for the first time. The EU Green Paper on the impact of transportation on the environment was the first to discuss the idea that battling climate change required more than trying to solve the problem with an end-of-pipe approach. It required solutions at what the root of the problem: human behavior (European Commission, 1992). The EU argues that unsustainable patterns of consumption are at the core of current environmental problems. Fundamental changes are required. They highlight the need to reduce the 16ffectts of the transport sector by promoting fast, safe and convenient urban and regional transport services and reducing car traffic (European Commission, 1992).

Since mobility is paramount to properly experience life in urban and rural areas, new mobility concepts have been gaining attention. With automobility as the ecologically unsustainable means of mobility that it is, researchers, policymakers and urban planners started to examine alternatives. These alternatives have the common classification "sustainable mobility". The EU green paper presents sustainable mobility as a 'common strategy' to place transport into a general pattern of sustainable development. Sustainable development implies the Brundtland definition: to meet the needs of the present without comprising the ability of future generations to meet their own needs (Brundtland, 1987). This need for change in urban transport was urged by the 1990 EU green paper on the urban environment (Commission of the European Communities, 1990).

The 1992 paper argues that relying on technological solutions will not suffice. To show the need for adaptations on several fronts, the authors propose a CO_2 – and energy-tax. They also propose a shift in transport balance with a focus on favoring public over private transport. In short, the proposed terminology is best summarized as follows: "[sustainable mobility is part of] a strategy on a global approach that will require different kinds of initiatives: standardization, market organization and cost-charging measures as well as research initiatives" (European Commission, 1992).

The overall action plan from 1992 included the following framework points:

- Strict environmental standards motorized traffic;

- Environmental measures for strict water- and air-quality levels and limits for pollutants;
- Transport and community policy measures for optimal use of existing transportation capacity. Allowing new and environmental-friendly modes to ensure CO_2 stabilization;
- Safe transport of people and (dangerous) goods;
- Fiscal and economic instruments and frameworks to promote environment-friendly transport;
- Guidelines community infrastructure development and assessment to enable and incentivize people to use environmental-friendly transport modes and to promote conversing and upgrading conventional infrastructure to facilitate new transport modes. This includes 'soft' transport (now called "active mobility mode" of cycling and walking);
- Guidelines community research programs to promote development of environmental-friendly transport technology. Includes transition from fossil-fuel to 'clean' bio-fuel based and hybrid transport and efficient traffic schemes;
- Guidelines awareness campaigns about ecological crisis and rational private mobility use, focusing on environment-friendly alternatives and active mobility.

This framework shows that there are indeed several aspects to sustainable mobility: advancements in technology, changes in mobility behavior and promoting environmental-friendly means of mobility. These were already seen as vital to foster the mobility transition and to alleviate the environmental pressure. That was thirty years ago. The following paragraph will elaborate on what the current state of the literature is. Additionally, it will discuss any potential additional action points to this framework as proposed by the EU in 1992.

Let us start roughly halfway this period of thirty years. David Banister, emeritus professor of transport studies, argues that despite the efforts of governmental policies to foster sustainable urban transportation, there has been an increase in automobility (David Banister, 2008). The argued cause of this increase is the lack of acknowledgement in the governmental policies of the complexity of cities and urban areas. Horizontal urban sprawl has increased trip distances and has created a transport-led future. This complexity of urban areas is the leading cause of user behavior in transportation. Banister proposed a paradigm where land use, urban spatial design, social networks and participation have a major role in fostering the change from conventional to sustainable transport. Banister recognizes the importance of decreasing trips, model shift, distance reduction through coherent land-use and technology-led solutions. However, these aspects of mobility exist within a paradigm where conventional means of passive persuasion will not be enough. He argues for actively including all actors and recognition of how an urban area is more than a spatial structure. The spatial element is important. However, changes will only occur if the social networks, acceptance, behavior and adopting alternatives get attention too.

Next to Banister, there are a plethora of articles written by authors that agree with the framework proposed by the EU in 1992. Some articles discuss the importance of policy-based transition (Gallo & Marinelli, 2020; J. Köhler, 2006; Jonathan Köhler et al., 2009), others believe in technological solutions (Anastasiadou et al., 2021; Dash et al., 2022; Sagaria et al., 2022), a modal shift (G. Santos & Nikolaev, 2021; Šoštarić et al., 2021) and changes in behavior (Acheampong & Siiba, 2020a; Aguilera-García et al., 2022; Berkowsky et al., 2017). The 1992 sustainable mobility framework discusses the importance of transport infrastructure to foster the sustainability transition. The authors argue that the built environment has an influence on users' transport decisions. An approach that uses adaptations in the built environment to influence mobility patterns does not influence mobility directly. It influences the incentive, accessibility and efficiency per transport mode. Using the built environment to steer mobility has been discussed concerning land use policies (David Banister, 2008; Marshall, 2000), physical structure and planning (Basiago, 1996; Loo & du

Verle, 2017) and active transportation (Fonseca et al., 2022; Jarass & Heinrichs, 2014).

1.2 Development of the literature base

The definition of sustainable mobility and the 1992 framework have changed. Still, the proposal from the EU green paper stands – albeit in a much more elaborative and interdisciplinary form. A review article by Holden, Gilpin & Banister (2019) addresses how the concept of sustainable mobility has changed over the past 30 years. They make a distinction between four generations of literature. The first generation (1992-1993) focused on limiting negative externalities of transport through techno-fixes. The second generation (1993-2000) discussed reducing transport intensity and addressed the social aspect of mobility. The third generation (2000-2010) focused on congestion, economic impacts, and different travel typologies. The fourth and most recent generation (2010-2018) focuses on dimensions of sustainability, decarbonization and shared economies (Holden et al., 2019). A more elaborate definition of the generations are found in table 1 (Holden et al., 2019):

Table 1: Four literature generations on sustainable mobility (Holden et al., 2019)

Dimension	**First generation (1992-1993)**	**Second generation (1993-2000)**	**Third generation (2000-2010)**	**Fourth generation (2010-2018)**
Research & (EU) policy focus	Limit transport volume	Reduction transport intensity	+ Congestion, equity, competitiveness	+ Decarbonization
Transport impacts	Environmental impact	+ Social impact (Quality of Life)	+ Economic impact, accessibility, distribution	All dimensions of sustainability
Travel categories	Production travel (work)	+ Reproduction travel (non-work by car)	+ Leisure-time travel (long-distance car and plane)	+ Shared mobility, autonomous driving and electromobility
Scientific disciplines	Environmental engineering, planning, transport geography and economy	+ Sociology	+ Psychology, anthropology, political science, history, etc. (interdisciplinary)	+ Innovation studies, sustainability transitions
Methodological approaches and theories	Environmental impact assessment, quantitative modeling, regression analysis	+ Qualitative analysis	+ Case studies, interviews, qualitative modeling, institutional and historical analyses	+ Multilevel perspective, technological innovation systems, big data
Research questions	How to increase efficiency different modes of transport?	+ How to manage traffic demand	+ How do actors' motivation, opportunities, and abilities to change differ?	+ How to create synergies between environmental effects and health and inequality impacts?
+ indicates broadening scope of former cell				

According to Holden et al. (2018), conceptual changes in six different areas compare to the 1992 framework on sustainable mobility:

- **Research and (EU) policy focus:** instead of addressing a decrease in transport *volume*, the focus changed to a decrease in transport *intensity* in the second generation. Changes in volume often referred to a decrease in distance, fuel consumption and global emission.

Changes focusing on intensity addressed fuel per kilometer and local emission – the scope changed from traveling less to traveling more efficient. The third generation shows an increase in attention for reducing local pollution, congestion, increased competitiveness, and a higher quality of life (QoL). A 2011 EU white paper discussed that decreasing mobility might not be possible and that other solutions needed investigation (European

Commission, 2011). It proposed a new goal: decarbonization. The paper spurred an increase in technological research focused on this and started viewing the sustainability transition from a broader point of view;

- **Transport impacts:** over the first two generations, the scope changed from a sole focus on environmental impacts to considering social implications of mobility. The third generation also included economic effects;
- **Travel categories:** the 90's saw a distinction between work-based, shop-based and leisure-based trips. Studies in the first generation mainly focused on work-based trips. Researchers broadened their view to the other two typologies towards the end of the second generation. Leisure-based trips found a prominent role in the third generation. The number of trips from that typology experienced a steep increase. The fourth generation saw a new triptych of mobility typologies, including: shared mobility, autonomous vehicles and electromobility. Although they are not strictly seen as typologies, they do discuss a vital detail as to *how* the trip is executed, rather than *why*;
- **Scientific disciplines:** during the last two generations, scholarship has grown interdisciplinary. Especially during the last generation, there has been an increase of focus on innovation and transition studies. These studies no longer focus on mobility alone. They include other disciplines and discuss the sustainability transition from a more meta-level point of view. This again indicates how the scope of sustainable mobility concepts has increased;
- **Methodological approaches and theories:** instead of focusing on environmental impact, modeling, and regression analyses as in the first generation, the second wave of literature focused on scenario-narratives. Together with the increase in interdisciplinarity concerning more scientific disciplines in the third generation, the approach and theories broadened as well. The fourth generation saw the result of including different disciplines. Because of the transitional and innovative scope, new frameworks and approaches were placed over the ones from the former generations. Transition management (TM) (Rotmans et al., 2007), strategic niche management (SNM) (Hoogma et al., 2005), multi-level perspective (MLP) and technological innovation systems (TIS) (Geels, 2002; Geels & Schot, 2007) achieved a lot of traction in the field of sustainable mobility. Using these frameworks in transition studies helps researchers and policymakers to analyze the current state, what needs to be done and how positive influences are fostered through protection and nurturing of new technologies. Additionally, access to data-based resources has drastically changed research approaches, as deeper analyses were now possible.
- **Research questions:** with an increase in disciplines, researchers asked multiple-component questions as opposed to the more basic questions posed in the first generation. The first questions focused on how mobility could improve to become more efficient and sustainable and largely left out the scale or scope of the problem itself. Research questions from the second generation sought to create a better balance between public and private transport. They now addressed aspects that went beyond the efficiency of automobility. The third generation recognized that the course of mobility was walking away from sustainability. Researchers recognized that they needed to change course concerning how the problem was handled in the former two generations. Researchers started to include a wider range of actors into their research questions. They agreed that to solve the mobility problem, they had to focus on the transition, acceptance

and behavior change. This showed a symbiotic relationship with the increase in disciplines as discussed in the former conceptual areas. With new disciplines and approaches, also came new questions to be answered. The fourth generation shows that mobility is no longer ‘just’ mobility and includes much more than moving around. Research questions now include QoL, lifestyles, behavioral change, and different scopes, although they still discuss technology and modal shift to a great extent.

All in all the 1992 EU green paper and the points of action in their framework have created a foundation for future literature. The concept of sustainable mobility and its numerous aspects is now an amalgamation of decades of research and are interpreted as follows:

Sustainable mobility is a common strategy for sustainable development and an initial reply to the ecological unsustainability of conventional means of transport. Sustainable mobility requires careful thought for: fuel, efficiency, traffic intensity, (balanced) mode choice, a modal shift, transport alternatives, consumer behavior and the influence of policies and the built environment on how mobility is experienced. Over time, sustainable mobility has developed from an ecological response to an interdisciplinary strategy that includes environmental, social, and economic aspects of mobility.

2. Sustainable mobility concepts in the built environment

This thesis focuses on sustainable mobility in the built environment. To discuss sustainable mobility in this context, it has to be conceptualized. The following chapter will introduce the connection between the two and will elaborate on the relevant categories in the literature.

2.1 Concept typologies

Now sustainable mobility is defined, it is time to examine how relevant sustainable mobility concepts manifest anno 2023. As established with the changes in literature scope and focus throughout the four generations (Holden et al., 2019), sustainable mobility is a broad subject. It consists of different aspects, has a relationship to numerous fields and are observed from different points of view. This also accounts for the solutions that aim to foster the sustainability transition. These solutions relate to different aspects of sustainable mobility. The following paragraphs summarize these fields to create 'concept typologies'. These concept typologies are used throughout the thesis.

Holden et al. propose three different grand narratives that serve as enveloping narratives to the other, smaller ones. These three grand narratives are built on two important principles (Holden et al., 2020). (1) large actions need to be undertaken, little bits of effort towards sustainability here and there will not be enough. (2) We have all the technologies and frameworks we need; we need not put more effort into researching new solutions but rather work with the resources we have. The three grand narratives are as follows:

- **Electromobility:** this grand narrative focuses on replacing fossil-fuel based mobility with more environmental-friendly fuel alternatives. Specifically, it focuses on electric vehicles. Electric vehicle technology as a concept manifests in numerous forms and sizes. This includes all types of technology that discuss the electrification of automobility propellant. These technologies aim at an increased efficiency and lowering greenhouse gas emissions. The grand narrative discusses the need for development of these technologies. They also discuss their 'grooming' for adoption as well as the adoption process itself;
- **Collective transport 2.0:** current mobility standards are too individualistic. A focus on public transit is preferred and required, but this narrative also discusses a change in ownership. Private ownership of mobility will change into usership. Rather than 'owning' a vehicle, people should become accustomed to 'owning' mobility. Shared mobility (Castellanos et al., 2022) increases in popularity and Holden et al. discusses several shared economy principles related to how it fits into the mobility transition. Careful implementation regarding policies, technology and user management is required;
- **Low-mobility society:** this narrative challenges lifestyle rather than means of mobility, shared mobility economies or fueling. The question that is posed in this narrative is: 'how to assess if a trip is necessary to fulfill this goal, or that it could be substituted by an option that does not require travel?'. One of the terms that stands at the core of this narrative is 'car-free'. Additionally, the focus is on decreasing trip frequency and length.

These grand narratives are guidelines or strategies towards sustainable mobility and overarch other narratives. They categorize other, more precise narrative solutions. According to Holden et al., fields of mobility where change is possible and required are: policies and funding (environmental, socio-economic and technological), urban planning (structural and zoning), technology (fuel and efficiency), mindset (awareness of sustainability and trip consideration), ownership (MaaS and

shared mobility) and trip attributes (necessity, duration, one mean or multimodality).

Holden et al. (2020) introduce nine key narratives that aim to explain main concepts of achieving sustainable mobility. According to the authors, there is a need for distinctions between strategies (*what*?), agents (*who*?) and a combination of these two that result in the nine narratives (*how*?). Holden et al. combines these three distinctions into one table, where the strategies occupy the rows, agents occupy the columns, and the narratives consist in the cells where the former two intersect. This table is shown in table 2:

Table 2: Sustainable Mobility Narratives (holden et al., 2020)

		Agents (Who?)		
		Leave it to the experts	Leave it to the people	Leave it to the firms
Strategy (What?)	Efficiency (improve)	Green government	Green purchaser	Clean vehicles
	Alteration (shift)	PT provider	Responsible traveler	Shared mobility scheme
	Reduction (avoid)	Compact city	Essential life	Traveling electrons

Each column header shows an approach as to who has to take action. From left to right; column one leaves the action to the experts (e.g., politicians, bureaucrats, and scientists), the second column discusses leaving action to the people (bottom-up approach, initiative is with the public). The third column focuses on power with the market mechanics and firms.

Table 2 shows three rows that distinct between what must be done. From top to bottom; efficiency (to improve) is on the first row, alteration (shift, change) the second row and reduction (avoid) the third.

Where these rows and columns intersect, is where the crux for this paragraph is found: nine narratives discuss how responsible agents apply these three strategies. The nine narratives are:

- **Green government:** a top-down approach on all three levels of government. It considers taxation of unsustainability and funding of environmental-friendly alternatives of mobility;
- **Green purchaser:** awareness among the public will incentivize them to choose for cleaner mobility alternatives within their regular patterns. Therefore, decarbonization and electrification of automobility lies closer to this combination between agent and strategy than opting for mobility alternatives;
- **Clean vehicle:** companies will aim to play into market opportunities and focus on developing fostering cleaner technology alternatives for mobility;
- **Public transit provider:** governmental interference provides room for public transit alternatives to grow in the sense of infrastructure and funding.
- **Responsible traveler:** people consciously opts for more sustainable means of mobility. They aim to change their behavior to more environmental-friendly patterns, active modes of travel and overall lifestyles.
- **Shared mobility schemes:** firms now direct their focus on market opportunities related to disruptive technologies rather

than improving on conventional and established ones. New developments could include adaptations of existing sustainable alternatives or completely novel ones;

- **Compact city:** a narrative that focuses on urban planning and mixed zoning. High-density urban environments with a focus on public transit usage and a mix of activities and zoning fosters active modes of transportation and sustainable, public alternatives;
- **Essential life:** this narrative discusses a change in assessing needs and reduction of trips to what is necessary (essential) for daily tasks. Digitizing the workforce and trends in online communication foster this narrative It allows for new and efficient use of digital communication. This reduces the number of trips required;
- **Traveling electrons:** like the *essential life* narrative, this narrative focuses on the role of digital communication. It does so from a market perspective.

These nine narratives tell different stories but have some overlap as well. Since some of the narratives discuss similar subjects, they are assigned to overarching categories – the three grand narratives.

To discuss sustainable mobility concepts in the built environment, it proves useful to divide them into a typology or category. These narratives support that. Most sustainable mobility concepts found in the literature fall within the three proposed grand narratives. They are often categorized further into the nine more precise narratives. These trajectories that Holden et al. propose are useful to create a sense of structure within the array of available concepts. The result of this chapter is a cohesive list of relevant sustainable mobility concepts. These concepts are categorized as follows. Table 3 gives an overview of the overarching concepts that will be discussed and will be further elaborated on in the coming subchapters.

Table 3: Categories and overarching concepts in the literature

Sustainable Mobility Concept	Concept subject
Policies	**Environmental** Keywords: (1) air pollution & greenhouse gasses; (2) active mobility promotion; (3) eco-driving; (4) noise; (5) landscape & Surroundings.
	Socio-economic Keywords: (1) equity; (2) pricing, taxes & incentives; (3) transit improvements & public transit; (4) safety; (5) e-commerce & teleworking; (6) vehicle capacity occupancy.
	Technological Keywords: (1) fuel alternatives; (2) shared mobility; (3) intelligent transport systems.
Urban Planning	**Polycentric City Design** Keywords: (1) shorter distances; (2) high density; (3) public transit; (4) active mobility.
	Compact City Keywords: (1) density; (2) diversity; (3) destination accessibility; (4) distance to transit; (5) design; (6) vehicle hours traveled.
	Transit Oriented Development Keywords: (1) public transit; (2) active mobility; (3) zoning diversity; (4) three pillars of sustainability.
	Sustainable Urban Mobility Planning Keywords: (1) vision and participatory approach; (2) all transport modes; (3) reiterative process; (4) travel demand management.
Technology	**Alternative fuels** Keywords: (1) (PH-)EV's; (2) HFC's; (3) LFG's.
	Intelligent Transport Systems Keywords: (1) communication and sensors; (2) traffic control; (3) traffic efficiency; (4) driver assistance.
System change, ownership & Mobility Behavior	**Ownership** Keywords: (1) private ownership; (2) sharing economies.
	Mobility as a Service Keywords: (1) public transit; (2) sharing economies; (3) ICT (4): multimodality.
	Culture Keywords: (1) car-centric; (2) residential self-selection; (3) dissonance; (4) culture-shift; (5) mindset.

2.2 Sustainable mobility policy topics

Starting with policies as sustainable mobility concepts is helpful. Policies act as targets, guidelines, limitations, or enablers for the other concepts. This chapter therefore establishes a knowledge base as a foundation for other concepts to build on. None of the other concepts can be fully explained by knowledge of policies. However, it is useful to have grasp what drives concepts and what are potential barriers or enablers to adoption. The sub-chapter starts with establishing the macro-role of policies in setting international targets. A distinction between policy categories is presented, followed by an elaboration on the policy topics per category.

As is the case with a lot of concepts around us, transportation is heavily affected by and dependent on mobility-related policies. Sustainable mobility is widely discussed in the transport policy discussion (Gallo & Marinelli, 2020). The 2011 EU white paper on transportation (European Commission, 2011) describes goals concerning emission reduction to support limiting climate change below two degrees Celsius. The paper concludes that the transportation sector will have to reduce more than 60% in greenhouse gas emissions in 2050 compared to 1990. The white paper discusses ten targets that aim to facilitate the 60% emission decrease. These targets have a different range of policy topics, including transportation type and fuels, transport safety, technological

advancement and infrastructure development. A reflection on this white paper was released by the EU in 2016. They strengthened the urge to act in accordance to the targets posed by the original paper (European Commission, 2016). The paper presents a strategy to target low-emission and underlines the importance of countering the effects. Four main action points are presented (European Commission, 2016; Gallo & Marinelli, 2020):

- Optimizing the transport system and improving its efficiency;
- Scaling up the use of low-emission alternative energy sources;
- Moving towards zero-emission vehicles;
- Supporting low emission mobility through horizontal enablers.

These points of action correspond to the overall Action Plan on Urban Mobility (European Commission, 2009). 20 More concise points of action were presented. This shows that policy discussions can happen at a high,
overarching level such as with the European Commission. The result of these discussions often takes the form of targets, limitations, and guidelines. Authorities should consider these overarching implications when creating local policies.

Sustainable mobility policies are categorized in three different groups: environmental, socio-economic and technical (Gallo & Marinelli, 2020; Holden et al., 2019; Jonathan Köhler et al., 2009). They categorize different policy topics within these three categorize. Table 4 shows the distinction based on their works:

Table 4: Policy topics by category (based on Gallo & Marinelli, 2020)

Topic/Theme	*Environmental*	*Socio-economic*	*Technological*
Air pollution	X	X	X
Car-sharing	X		X
Connected and automated vehicles	X	X	X
Cycling promotion	X		X
Ecodriving	X		X
Electric and hybrid vehicles	X		X
Equity		X	
E-commerce	X	X	
Fuel	X		X
Greenhouse gasses	X	X	
Intelligent transportation systems	X		X
Micro-mobility	X		X
Noise	X	X	X
Pricing	X	X	
Public transit promotion	X	X	X
Safety		X	X
Taxes and incentives	X	X	
Teleworking	X	X	
Traffic lights	X		X
Transit improvements	X	X	
Walking promotion	X	X	

Table 4 shows that most policy themes in one category corresponds with other categories. This shows the complexity of policy coverage and how intertwined the concepts of sustainable mobility are. The following sections will analyze the topics per category and elaborate how the current scholarship considers them relevant. The first

section will discuss environmental policies, the second focuses on socio-economic and the third on technological.

2.2.1 Environmental

Table 4 shows that almost all topics are related to environmental sustainability policies. Only 'safety' is not seen as an environmental focal point. The remaining policy topics relate to the environment in different ways. Gudmundsson (2003) presents a distinction between how policies are related to environmental sustainability. Sustainable mobility policies relate to: energy, climate, air quality & emissions, land & nature, water & sea & soil, noise, accidents & risks, hazardous materials, waste & recycling, material input and visual impact (Gudmundsson, 2003). All of the environmental policy topics (Gallo & Marinelli, 2020) in table 4 are linked to these distinctions. This is not always a direct connection.

The table distinguishes between policy foci. It suggests a measuring and limiting approach of how mobility affects the environment in various ways. To understand how measuring environmental impact works, one will encounter the sustainable development goals (SDG's). These were proposed during the United Nations Conference on Sustainable Development, held in Rio de Janeiro, Brazil, 2012. According to Bebber et al. (2021), the International Organization for Standardization have created two ISO standards corresponding with three SDG's. These ISO standards envelop a couple of dimensions that also discuss how urban mobility affects the environment and climate change. The ISO standards proposed by Bebber et al. are *ISO 37120 (on sustainable cities and communities – indicators for city services and quality of life)* and *ISO 37122 (on sustainable cities and communities – indicators for smart cities)*.

The three dimensions that these standards share are transportation, environment and climate change and urban planning. According to Bebber et al. there is an overlap with three SDG's:

- **Goal 3:** good health and wellbeing;
- **Goal 9:** Industry, Innovation, Infrastructure;
- **Goal 11:** Sustainable cities & communities.

Within these overlaps, there are numerous indicators per standard. These indicators show how policies that adhere to the ISO's in turn correspond with the SDG's. The environmental indicators that are identified by Bebber et al. correspond with how and where policies have to mitigate negative environmental impacts. According to the authors, these indicators are a tool to lead urban policy decisions by governments and to help urban planners. This shows the top-down approach in the development of sustainable mobility policies (from SDG's to city-level governance).

Zooming in on environmental policies corresponding to these standards and the topics presented in table 4 is likely to show certain trends: according to the information above (Bebber et al., 2021; Gallo & Marinelli, 2020; Gudmundsson, 2003), the topics can be divided into groups:

Air pollution and Greenhouse gasses

Air pollution includes negative changes that are applied to the default air quality due to human interference. Greenhouse gasses focuses on an increased concentration of natural greenhouse gasses (including CO_2), leading to an enhanced greenhouse effect. Another difference is the scope; air pollution has local effects, whereas an enhanced greenhouse effect impacts on a global scale. There are plenty of possible policy interventions to lower the air pollution and greenhouse gas emission. Policies related to themes in table 4 focus doing so by either changing vehicles through technology (e.g. electric or hybrid vehicles and lower-emission automobility), fuel (e.g. introducing other types of fuels), user behavior (e.g. incentivize, adjust pricing or behavior campaigns) and management of mobility (e.g. traffic control, smart cities).

Cycling and walking promotion

Advocates promote walking and cycling as active or soft mobility modes. They argue this requires reforming the urban environment. Active mobility modes occur over smaller distances. These

advocates and active mobilists rely on walkability, priority lanes, connectivity, and function mixes. Not only does active travel foster a healthy lifestyle, it also no negative environmental effects. Active transportation is environmentally sustainable because the non-existence of greenhouse gas emission. Gallo & Marinelli (2020) propose that there are several policy options to promote these active mobility modes, including: assigning zones aimed at a certain mode or limiting others, increasing safety, maintaining and increasing the quality of available infrastructure and incentivize citizens (Fistola et al., 2020; Jou, 2011; Yang et al., 2019).

Ecodriving

Ecodriving concerns either promoting sustainable transport modes or providing sustainable public alternatives. The question here is: how does someone travel the same distance, but with lower emission rates and fuel consumption? Apart from simply changing the transport mode, changing a travelers' behavior is also seen as ecodriving. This is accounted to the difference in emission rates between driving styles. Five behavior-based actions are presented: anticipate on traffic flows and signals, maintaining a steady speed, drive non-aggressively, checking tire pressure, gear changing and limited use of additional car features. Policies related to ecodriving should rather be called 'promotion' than actual policies. For that reason, policymakers consider them 'soft' policies. They promote or (dis-)incentivize behavior rather than prohibiting or limiting mobility.

Noise

Traffic noise reduces the quality of life for households living close to areas where traffic is intense. Research towards noise pollution includes models, case studies, technology (including noise through engines) and mitigation methods. Policies related to noise pollution focus on limiting noise levels in certain areas, on motorized travel by intervening in engine technologies, applying mitigation strategies (e.g., noise barriers) or rather avoid residential zoning next to noise-intense areas.

Landscape and surroundings

Road- and railroad construction often impacts the environment, particularly in rural areas. Environmentally friendly policy interventions regarding sustainable mobility influence how, when and where these new media are constructed, or where it is prohibited. These policy interventions are grounded in environmental protection of an area or ecosystem.

2.2.2 Socio-economic

Referring to table 4, this section will discuss: pricing, taxes, external costs and incentivization. Just as with the environmental policy topics, they categorize as follows:

Equity

This policy topic refers to equal distribution of access to mobility. Jones & Lucas (2012) agree with Gallo & Marinelli (2020) that equitable distribution of transportation resources (e.g. infrastructure and transit systems) contributes to achieving social equity, producing important impacts on wellbeing and quality of life. However, equity and equality should not be seen as equals. Equality refers to equal treatment of all people, despite their starting position. Equity does consider this starting position and is mostly concerned with offering everybody the opportunity to achieve goals like others. From a policy perspective, equity is fostered by implementing measures in environmental impact of transportation. Everybody should experience the same level of environmental effects. People should have similar opportunities to use transportation and to experience no social exclusion. They should also possess the availability of infrastructure, facilities, and urban environment of similar quality.

Pricing, Taxes, and Incentives

Pricing and taxes are often used to affect people's mobility means of choice. Think of congestion charges, toll roads, road taxes, parking costs and increased prices on fossil fuels or vehicle ownership. Pricing measures aim to make people think of their mobility choices. They incentivize people to opt for more environmentally sustainable

alternatives. Incentivization also occurs the other way around. Economical support is provided to people who want to make the shift towards these environmentally sustainable mobility means, for example electric or other alternative fuel-based cars that are subsidized by the government.

Transit Improvements and Public transit

Public transit only serves as a suitable replacement to private automobility if the infrastructure and service provision are of adequate quality. Public transit is the most common form of collective transport and the direct competitor of automobility. The latter is the most well-known form of private mobility. The privacy and safety of one's own space in a car provides a lot of comfort. Public transit only proves to be a competitor when it is able to provide the user with a similar level of comfort and safety. From a socio-economic perspective, policies affect people's mobility choices by economically incentivizing them (lower ticket prices, subsidized public transit or frequency assurance) or by changing their mindset towards public transit, for example by initiating PR-campaigns.

Safety

According to the Dutch Central Bureau of Statistics, 582 people died in traffic-related accidents in the year of 2021(CBS, 2022c). Even though this is significantly lower than at the beginning of the century (1166 victims in 2000, 48% decrease), traffic safety still has a priority in policymaking. To foster the socio-economic sustainability of mobility, policy implications include measures in infrastructure (e.g. road layouts, crossings, safety barriers and lighting), vehicles (e.g. structural integrity, appropriate lighting, airbags and belts) or behavior incentivization (e.g. campaigns, licensing and sight testing).

E-commerce and Teleworking

Instead of trying to *change* mobility, one can also try to *reduce* the overall trip frequency. For instance, by promoting e-commerce. E-commerce, more commonly known as online shopping, describes using an online platform to shop for leisure or groceries. By ordering from home, the trip to the store or shopping center is no longer required. When more people make use of e-commerce, the only logistical impact is that of the courier that delivers the packages. Another example of trip reducing is related to new ways of working. Teleworking has gained an increase in popularity in The Netherlands (Centraal Bureau voor de Statistiek, 2020). This is likely due to the Covid-19 outbreak starting at the end of 2019. Because of the popularity of teleworking and the pandemic, a decrease in trips was experienced over the past few years (McNally et al., 2023). However, one has to consider that this does not only concern trips by car, but also includes trips made by public transit (Parker et al., 2021). Policies related to teleworking include urging companies to provide their employees with a workplace of their choice and the materials to work efficiently.

Vehicle capacity occupancy

Another socio-economical problem is that of the suboptimal use of vehicle occupancy. It is seen as a socio-economic problem because it concerns both mindset (e.g. not wanting to carpool or rideshare) and misallocating economic resources (e.g. drivers traveling in half-loaded trucks because of their operators or contracts) (M. J. Santos et al., 2021). Because of this inefficient resource allocation, more private cars and trucks are mobile at the same time. Policy interventions target misallocations in the freight logistics sector, for example by increasing road tax on suboptimally loaded trucks or fining operators. Another policy example is implementing High Occupancy Vehicle (HOV) lanes. These lanes allow cars with more than two people to use a different highway lane. This gives them an advantage over others as a reward for carpooling (Menendez & Daganzo, 2007).

2.2.3 Technology

Technology policies aim to influence mobility by making adaptations to existing technologies. Additionally, technology fosters growth for new, niche concepts in the field. This does not only concern cars or sustainable alternatives such as

public transit, but concerns systemwide implications. The following topic groups are best represented in an assembly of technology policies:

Fuel alternatives

To make mobility more sustainable, one can replace the conventional fossil fuel regime by a fuel alternative. According to a 2015 report by the European Commission, there are several fuel alternatives that are deemed as relevant competitors to the conventional fossil fuel. These include natural gas, liquefied petroleum gas, hydrogen fuel cells, electric and hybrid vehicles. These technologies have gained popularity and traction in the mobility market (authorities estimate the amount of electric vehicle sales in Europe at 2.3 million in 2021, 17% of total car sales that year). Still, their technological savvy needs to be fostered, nurtured and protected to grow. This is important to compete with fossil fuels as the regime (IEA, 2022). Policies positively influence the growth of these technologies. They provide funding the research and create a safe space for the technologies to grow. Policies foster their adoption by subsidizing the sales of cars that use them. Another policy example related to alternative fuels is one of providing advantages. Users of electric or hybrid vehicles gain benefits because of their sustainable choice. These benefits include special EV-lanes, tollgate allowances or the permission to use bus lanes (Kanamori et al., 2012).

Shared mobility

Shared mobility shifts the type of ownership of a vehicle -be it a car, bicycle, or scooter- from private to shared. The vehicle belongs to the company that provides the scooter on location. They provide a person with mobility rather than with a vehicle itself. Shared mobility comes in different shapes and sizes. The most common forms of shared mobility manifests itself in car-, bike- or scooter-sharing. One uses an app or platform to reserve a vehicle that is parked close by to make a trip and pay for the distance traveled. Shared mobility policies often relate to free-floating (whether shared vehicles have a set of predetermined parking locations or not), app technology and payment structures.

Intelligent transport systems

Intelligent transport systems (ITS) are integrated systems of people, roads, and vehicles. They are designed to significantly improve road safety and efficiency. Additionally ITS foster environmental protection by relieving traffic intensity (Andersen & Sutcliffe, 2000; Jarašūniene, 2007). Following this definition, ITS does not rely on the roads or the cars. It depends on the integrated cooperation between technology surrounding mobility. In doing so, ITS increases the sustainability of mobility by making sure it runs smoothly. According to Gallo & Marinelli (2020), ITS has three main pillars: efficiency, eco-friendliness, and safety. ITS balances these three pillars by using technology to influence traffic (e.g., congestion and traffic flows). Looking at ITS from a policy perspective, most policies foster the development ITS-technology. However, since ITS is quite data-intensive, privacy also finds a role within the policy debate.

2.2.4 Sustainable mobility policy topics: review & conclusion

In this policy landscape, there are three main pillars that overarch topics among these policies: environmental, socio-economic and technology. Within these groups, several topics are identified. Each of these topics is explained concerning how policy interventions foster their success. Consider that not all three of the policy groups aim to reach their goals in the same way. Environmental policies aim to reduce negative externalities, change behavior and mindset. Socio-economic policies aim to (dis-)incentivize certain mobility choices through funding or taxes. Technology-based policies seek to foster sustainable mobility by nurturing new technologies and give them the space and resources to grow, as well as easing their implementation.

Despite their varying impacts and approaches, all three of these policy trajectories are relevant in the sustainability discussion. That is why this

sustainable mobility concept was discusses before the others. These policies aim to strengthen the position and implementation of the other concepts. To understand their position, one has to understand how concepts are supported and how to avoid political or socio-economic roadblocks. It proves important to stress that these policies do not always affect sustainable mobility in the built environment directly. Often, they serve as important facilitators for concepts that do indeed exert that effect. Nevertheless, they are of such importance to those concepts that is within reason to include them in the list of concepts.

2.3 Urban planning

This chapter examines how urban planning plays a role in the sustainable mobility discussion. The chapter starts by discussing the increasing demand for urban mobility planning and how this has manifested in new fields of research. It will present different approaches for urban planning and how it is able to influence sustainable mobility accessibility, promoting and mindset.

Over the past century, especially from the first half to just after the Second World War, car-centered urban sprawl was the regime in urban development. Horizontal sprawl caused dependence on automobility. Because of this focus on automobility, the majority of cities was designed to facilitate this. This led to path dependency in mobility (Schipper et al., 2020).

Sofeska (2016) argues that sustainable urbanization through urban planning has to recognize the requirement of new spatial structures and the way that we view mobility as a part of the built environment. The conventional models of horizontal urban sprawl and the path dependency that it brought forth will no longer suffice. To create and take care of a sustainable urban environment, urban development has to take place in close cooperation with the community. Top-down approaches might no longer suffice as the conventional way of planning. To meet the increasing demand for housing, amenities, facilities and mobility, urban planners need to design cohesively and include bottom-up ideas and incentives.

New models of sustainable urban development are required (Sofeska, 2016). The following section identifies a typology or categorization for new models that exist in the literature. These are deemed to positively add to the sustainability of urban planning.

Sustainable transportation and Sustainable Urban Mobility Planning (chapter 2.3.1)

Maintaining and developing a coherent street network, promoting modal shifts or multimodal travel as well as technological advancement helps to either reduce unsustainable travel or limit the negative externalities of an increase in traffic. Urban planning can add to this by making sure that cohesive transportation planning is integrated and considered during the urban development planning.

Polycentric urban development (chapter 2.3.2)

Instead of having one central point in a city where most of the social and economic capital is situated, a city that is developed along principles of polycentric urban development has several, relatively smaller city centers. This approach decentralizes the city. Because of these smaller, widespread city centers, the concentration citizens and mobility is spread as well. Polycentric urban planning creates more and smaller ‘cities’ or neighborhoods in a network, rather than one large city.

The compact city (chapter 2.3.3)

A compact city model is an answer to distance and relates to the balance between intensity of urban development and density. Compact cities are characterized by a high density of mixed function buildings, public spaces, and greenery. The people living in such a city tend to gravitate towards public transit or active mobility modes rather than private automobility.

Transport oriented development and transit centers (2.3.4)

New urban development offers the opportunity for new citizens to live in an area that fits their lifestyle or preferred mobility behavior. Living close to a transit center is often a preferred location. This is especially the case for people that prefer to use public transit systems or active modes of mobility. Transit oriented development (TOD) is a form of sustainable urban development that creates urban areas centered around a public transit hub, focused on walkability, mixed function zoning and green public spaces. Automobility takes a back seat, whereas physical activity and public transit are promoted through high availability and facilitation.

2.3.1 Sustainable Urban Mobility Planning

Urban planners have to consider sustainable transportation during the development of the area. The former typologies discuss how the built environment affects mobility in various ways. The first type (SUMP) discusses how sustainable transportation is included during the development process.

To adhere to the sustainable development goals (sustainable infrastructure (9) and smart cities (11) will require planning for sustainability. Sustainable urban mobility planning (SUMP) is an answer to this requirement. Wefering et al. (2014) introduce the following definition: *"A sustainable urban mobility plan is a strategic plan designed to satisfy the mobility needs of people and businesses in cities and their surroundings for a better quality of life. It builds on existing planning practices and takes due consideration of integration, participation, and evaluation principles."*. Urban planning with a sustainable mobility mindset ensures key accessibility of safe and secure transport to all citizens. It focuses on reducing pollution, emission, and energy consumption, improves the efficiency and cost-effectiveness of transport. It seeks to contribute to enhancing the quality of the built environment.

SUMP is the result of a strategic process and has the following characteristics (Wefering et al., 2014):

- **Long-term vision and implementation plan under participatory approach:** focusing on private and public, passenger and freight, (non)-motorized vehicles, moving and parking. Short-term implementation following from the long-term vision including a timetable, budget ,and project planning. A SUMP follows a participatory approach, transparent communication and involvement of all stakeholders;
- **Integrated development of all transport modes:** create a balance between all available transportation modes. SUMP includes actions that foster public transit, active mobility, inter-modality, road safety, mobility management and ITS.
- **Vertical and horizontal integration:** different levels of government have to cooperate to create and execute the SUMP. They have to commit to sustainability as a part of the integrated planning process. Government should consult with all departments, rely on interdepartmental discussion and coordinate activities between actors;
- **Iterating assessment process current and future developments including monitoring, viewing and reporting:** continuous reviewing and adapting plans according to monitoring reports. Measurable targets have to be set and reviewed periodically. Findings and adaptations need to be communicated to relevant stakeholders and full transparency needs to be safeguarded and guaranteed;
- **Consider all external costs transport modes:** a SUMP should contain a cost and benefit review for all involved transport modes. Policymakers and urban planners should consider societal costs and benefits.

Wefering et al. present ten benefits of successful integration of mobility in development plans through SUMP, including:

- Improving QoL;
- Creating economic benefits by cutting costs;
- Contributing to healthy, better environment;
- Integrating mobility and improving access;
- Using limited resources effectively;
- Fostering public transit;
- Planning cohesively;
- Implementing effective legal obligations;
- Synergizing and creating relevance;
- Integrating new mobility cultures.

This relates to the former subchapter on policies and the introduction to sustainable mobility. These ten benefits tie into various sustainable mobility policies and the nine smaller narratives posed by Holden et al. (2020). Therefore, this shows a clear synergy between policies and urban planning. Rather than emanating urban planning itself, SUMP presents a policy approach to urban planning on a local or regional level.

There are articles that propose a sixth dimension of urban design, next to the ones introduced by Ewing & Cervero (2010). Berman & Radow (1997) and Ogra & Ndebele (2013) agree that travel demand management is important for urban design and functions behind the scenes. Berman & Radow (1997) describes travel demand management as all the activities, methods or programs that reduce vehicle trips, resulting in more efficient use of transport resources. Meyer (1999) argues that travel demand management supports discussing different policy interventions related to sustainable mobility. It does not always focus on the built environment as much as the other five. Travel demand management exists on different levels. This includes site-level (regulating and promoting sharing economies in one neighborhood). It also occurs on a wider, area-level (area growth management or variable peak travel times). Meyer (1999) discusses this dimension follows: how to better manage existing urban transportation systems to satisfy increasing travel demand without increasing capacity? Evidently, this is more of a political and managerial dimension as the ones proposed by Ewing & Cervoro (2010). Therefore, this dimensions of urban design and sustainable mobility is related to SUMP's, rather than TOD or polycentric and compact city designs.

2.3.2 Polycentric Urban Development

In most urban regions, the inner-city areas have a higher population and building distance in comparison to the outer regions. Where people live, work and facilities are needed. Because of that, these inner-city areas are likely to have a higher number of jobs and facilities. Since a larger amount of people would live in or close to this core and have all their necessities close by, trip distance is likely to be shorter (Wolday et al., 2019). These shorter distances also influence the choice of transport mode. When opting for either one means or the other, the user often considers what their travel time from location to location will be. If they live close to a public transit access point (e.g., bus stops, train or metro stations) and their goal location (e.g. work, leisure, shopping) is located on a public transit node, it might prove useful for them to travel by public transit. Despite them having a private car available. Because of the higher population density, these vibrant city cores are often attractive service locations for public transit providers. By locating their services in these areas, they attract a larger amount of people when working with the same service area coverage. The inverse is also true; because of the lower population density, public transit is often available to a lesser degree the further you move away from the city center. As a result, people living in those areas are more likely to travel to their goal location by private car. Additionally, traffic flow, parking spaces and pricing might be more benevolent for the car user in suburban cities than in a downtown core.

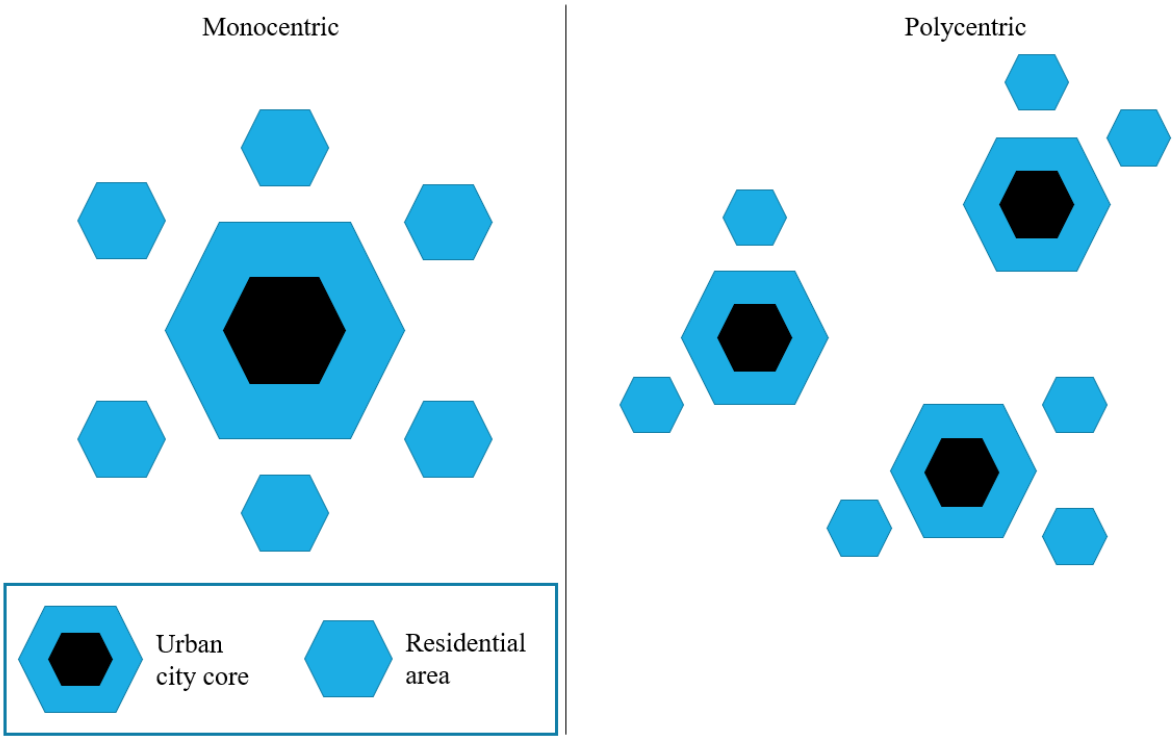


Figure 1: Monocentric and polycentric urban area.

A city or an agglomeration of several cities can have more than just one 'core'. This area is interpreted as polycentric rather than monocentric (figure 1, respectively right and left). This polycentricity exists on different scales (Shaw & Sykes, 2004) that have both vertical and horizontal dimensions. One can view polycentricity of urban areas on a larger scale by compiling countries within a continent in one urban structure where larger cities or cityscapes in countries are connected and function each as one of these cores (e.g. central Europe) (Davoudi, 2003). One could also move along the vertical axis and look at collections of cities (also called megalopolis or extended metropolitan region) and identify cities as the connected cores in the polycentricity (e.g., Randstad, The Netherlands). Another level lower, and you are discussing the numerous cores and sustainable concepts that exist within a city itself. On a city level, creating several (smaller) city cores with a higher population, job and facility density creates mobility advantages. By ensuring that public transit and other sustainable mobility means are concentrated throughout the city by thoroughly locating them in these cores, public transit availability is spread throughout the urban areas in between just as well. Another sustainable urban planning concept that facilitates sustainable urban mobility and is fostered by creating polycentric cities, is the concept of the '15-minute city' (Allam et al., 2022). The 15-minute city is a sustainable urban planning concept that focuses on four dimensions. This includes proximity (proximity to nodes within a city), diversity (mixed functions and multiculturality), density (compact cities) and digitalization (supporting the other three dimensions through technological development). Polycentric urban development allows people living in or close to these various cores to reach their destination quickly and without relying on conventional automobilism.

2.3.3 Compact city

Compact cities are another urban planning concept that answer to the call for sustainable development. Næss (2022) argues that compact cities and compact urban development provide accessibility to facilities through proximity as opposed to using automobility to reach a destination. People living in suburbs are more likely to use the car, whereas people living in compact inner-city areas prefer public transit. Additionally, a higher degree of densification fosters the natural landscape protection and biodiversity. This in contradiction to horizontal urban sprawl. Essentially, the compact city overlaps with the general view of urban

development and mobility as introduced by Cervero & Kockelman (1997) and elaborated on by Ewing & Cervero (2010). This general view of urban development and travel demand discusses five dimensions that explain how the built environment influences travel demand and behavior. These five dimensions are:

- **Density**: variable of interest spread over area (e.g., population, facilities or dwellings);
- **Diversity**: different land uses in given area;
- **Destination accessibility**: how a destination is accessible through available mobility means or within a given time. Often measured on different levels, including local versus regional;
- **Distance to transit:** average of shortest routes to travel from a starting location (e.g., residence, workplace) to public transit access point;
- **Design**: urban area structure regarding road networks, connectivity, mobility infrastructure, etc.

Naturally, these 5D's as discussed by Ewing & Cervero are prone to change and differences in interpretation. However, they are still seen as important principles or dimensions in the urban development landscape. Concerning compact cities, it is clear that the concept promotes active and sustainable travel by increasing (density, diversity, and destination accessibility) and decreasing (distance to transit) the characterizations of these dimensions through the last dimension, design.
Essentially, the compact city uses these five dimensions to lower the vehicle hours travelled (VHT) and promotes active and sustainable alternatives (Lee et al., 2015).

The compact city is often named in cooperation with new urbanism (Grant, 2003). Even though there are numerous interpretations of new urbanism as a mainstream approach to urban planning, the general idea is that new urbanism was introduced to halt horizontal urban sprawl and focus on inner-city development, whereas it now additionally aims for urban regeneration (Adelfio et al., 2022). Both new urbanism and the compact city follow the five dimensions posed by Ewing & Cervero (2010) and try to lower the number of VHT by changing the urban structure. However, new urbanism takes a broader view considering the effects of the built environment than focusing solely on its effect on mobility.

According to Bertolini (1999a), one can plot this relationship between public transit accessibility and distance. Together with the Faculty of Geographical Sciences of the University of Utrecht, Bertolini developed a model that describes the relationship between a public transit access point as a place and a node (figure 2).

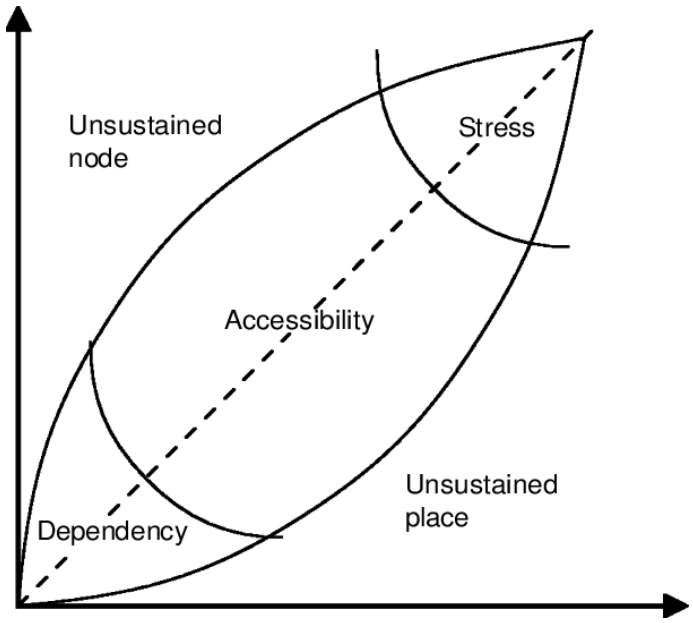


Figure 2: The node-place model (Bertolini, 1999a)

The y-axis of the models shows the node-sense of the area. This axis indicates to what extent the area is accessible and eligible for human interaction. The x-axis of the model shows the place-sense of the area and indicates the amount of activity that occurs. The model identifies several cases of this interaction taking place. An area can have a strong place and node. This indicates that there is a high but balanced degree of interaction (i.e. lots of public transit and urban activity happening). Areas could also have a low but balanced degree where not much is happening at all, but just about enough

to sustain the area. Likewise, there are two unbalanced situations possible. Either public transit accessibility or urban activity can be more developed than the other.

By concentrating more sustainable mobility means such as public transit and active mode facilitation in one area, a superblock is created. Superblocks are defined as part of a strategy to reclaim public space for people, reduce motorized traffic, promote sustainable and active mobility and green, as well as mitigating the effects of climate change (Mueller et al., 2020). Like polycentric cities, designing an area along compact city principles will allow for 15-minute cities to exist.

2.3.4 Transit oriented development and transit centers

Transit oriented development (TOD) is generally defined as follows: "[TOD] concentrates urban development around stations to support transit use, and development of transit systems to connect existing and planned concentrations in development." (Curtis et al., 2009). Kamruzzaman et al. (2014) describes TOD as a relatively new neighborhood development ideology. TOD stems from 1990, (Bertolini, 1999b; Breheny, 1993). TOD is characterized by moderate to high density development that supports and promotes the use of public transit systems, a mix of land uses to facilitate and attract active lifestyles. TOD often includes an interconnected street network. Because of land use mix and the focus on active transport facilitation, citizens living in the TOD area no longer have to rely on motorized transportation to reach their destination within the area. Sufficient green, social spaces, job opportunities and shops have a positive effect on that. When citizens have to travel to other parts of the city, they rely on the transit hub. As such, TOD areas are more than just neighborhoods based where public transit hubs are; they are seen as social, vibrant and sustainable areas with a high quality of life (Kamruzzaman et al., 2014).

TOD is a development approach that is context-dependent and there is no "one-size-fits-all" implementation. Since TOD principles apply to both brownfield and greenfield development projects, the existing structure of the urban development within and surrounding the area has to be considered. This causes differences in typologies regarding TOD-suitability of an area. Together with these differences in readiness, there are also differences as to what extent sustainable mobility through the built environment is possible or present. These four typologies are based on their potential or existing degree of public transit accessibility levels (PTAL's), socio-demographic characteristics and built environment policy indicators. These typologies as presented by Kamruzzaman et al. are:

- **Neighborhoods requiring both land use and transport investment to qualify as TOD:** these areas lack public transit-related services, access points, the required density and land use mix. This type has a rather low potential to become a TOD. It needs other types of input to promote sustainable mobility through built environment practices;
- **Neighborhoods featuring quality of potential TOD's:** significant efforts are needed to increase the dwelling density of these areas. An increase in PTAL, job density and road network connectivity is needed to transform these areas into well-developed TOD's, but there is potential;
- **Neighborhoods featuring quality of existing activity center TOD:** these areas already feature qualities of a TOD, as they have adequate PTAL, density and land use mixes already present. This type of TOD is an activity center TOD. The land use mix is developed to promote an active way of living (including shopping, work, leisure, etc.);
- **Neighborhoods featuring quality of existing residential TOD:** areas like these also have adequate PTAL and land use mixes. However, they generally focus on a higher dwelling density compared to the activity center. Because of this focus on

residential zoning, jobs are located closer to the outer boundaries of the TOD or in other areas completely.

From a mobility perspective, the latter two are most likely to affect mobility behavior and foster the adoption of more sustainable and active means. They provide a focus on public and active transportation. Also, these types provide a disincentive for automobilism because of their location around transit centers and higher PTAL's.

2.3.5 Urban planning: review & conclusion

Urban planning and sustainable mobility are related in the sense that the built environment is designed to influence mobility availability, accessibility and behavior for citizens. The five dimensions discussed by Ewing and Cervero (2010) (*density*, *diversity*, *destination accessibility*, *distance to transit* & *design*) heavily influence how environment planning is practiced considering mobility and travel demand. Each of the typologies that were discussed in this chapter are, in some form, representing one or more of these five dimensions. SUMP relies on an iterative, inclusive, and strategic approach for urban planning that provides numerous benefits when implemented. This concept is related to a sixth dimension in urban design for sustainable mobility: travel demand management. This dimension manages existing urban transportation to make it more efficient. Polycentric urban development has a role in urban planning on various levels. It focuses on creating several city cores as opposed to one central hub. Urban planners use mixed functions and a focus on public transit to decrease the trip distance and foster the use of active modes and public transit. Planners focusing on the compact city decrease the trip distance and vehicle hours traveled by providing a function mix as well. They focus on other areas of the city than just the core. Transit oriented development and transit centers describe a city planning approach where residential or activity centers are constructed around a public transit hub. Planners focus on active modes and public transit, a function mix and improving the quality of life by providing a green and social environment. At last, sustainable urban mobility planning integrates a coherent sustainable transportation strategy into urban planning principles.

According to the literature, all four of these typologies add to the goal of sustainable mobility through urban planning and are seen as relevant. They are backed by sustainable mobility policies from various backgrounds, as described in the former chapter, and often overlap in their approaches, strengthening their coherence.

2.4 Technology supporting sustainable mobility

After discussing the relation between urban planning and sustainable mobility, it is time to look at how technology plays a role. Another main concept in the sustainability discussion is furthering the cause for sustainability through technological advancement. When discussing sustainable mobility technology, emission and pollutants are often at the center. According to Leach et al. (2020), approximately 25% of global CO_2 emissions belong to transportation. They predict that at least 85% of energy usage in transportation will be from conventional fossil fuel-based engines up until 2040.

New forms of mobility demand better roads. Better roads diminish emission and noise pollution and provide increased travel efficiency. At this moment, just as for the last decade, internal combustion engines have been the main propulsion mechanism. These internal combustion engines make use of the conventional fossil fuels (Di Blasio et al., 2022). Development of new technologies and advancement of current ones often aim at replacing these conventional fuels or challenge the current propulsion mechanics.

A different approach to shift to sustainable mobility, is through technological advancement regarding traffic flow and efficiency. Traffic congestion and fuel-inefficient driving behavior are often seen as contributors to the unsustainability of

traffic (Ziyad et al., 2021). Intelligent Traffic Systems (ITS) makes use of principles related to the Internet of Things (IoT) to improve planning, design, efficiency and management of transportation systems (Yorio et al., 2018).

The coming paragraphs elaborate how technological advancement fosters sustainable mobility – still considering the built environment.

2.4.1 Fuel technology

A main opposing technology to the use of conventional fossil-fuel based propulsion is the use of electricity. As opposed to vehicles using an internal combustion engine (ICE), electric vehicles (EV) use an electric engine for propulsion. These EV's are often referred to as battery electric vehicles (BEV). These battery electric vehicles solely rely on electricity for propulsion. Their main energy supply comes from a charging infrastructure. The infrastructure consists of outlets throughout the area to charge batteries. These batteries in turn propel the electric vehicle(Gallo & Marinelli, 2020). Because of this reliance on electricity rather than using fossil fuels, emission rates from the vehicle itself are brought to a minimum. Without the internal combustion, there is no greenhouse gas emission. Because of that, EV's are often deemed the sustainable alternative for automobility and are experiencing an increase in global sales (Paolo & Gull, 2022). Next to fully electronic vehicles, there are hybridizations of different propulsion techniques. These hybrid vehicles often combine electric propulsion with the conventional fossil fuels and are called (plug-in) hybrid electronic vehicles (PHEV) (Emadi et al., 2008). ICE vehicles are reliant on having a fuel infrastructure available to them in the sense of gas stations. Similarly, so do the EV's and PHEV's. Electronic vehicles rely on charging stations. However, they have a significantly lower range compared to the conventional fossil-fuel based cars (Gallo & Marinelli, 2020). Technological advancement concerning an increase in engine efficiency or capacity would facilitate electronic vehicles adoption. Especially when combined with research into faster charging stations. The built environment would be able to support these new, sustainable propulsion techniques by increasing the number of charging stations, or by making sure that their service areas are spread most efficiently spread throughout the area (Anjos et al., 2020).

Another competitor to conventional fossil-fuel based engines is the use of hydrogen-based fuel cells. Hydrogen fuel cells (HFC's) also use electricity to fuel the vehicle but have an on-board means of energy generation. HFC's use energy that is generated by a chemical reaction that includes hydrogen and has several advantages over BEV's. Research often compares HFC's to the plug-in hybrid version. The former is likely advantageous due to the use of one single engine compared to the latter. However, since the technology supporting HFC's is still in early stages, the adoption is still relatively slow (McDowall, 2016).

There is another group of alternative fuels that is loosely based on the processing of crude oil. This group of crude oil byproducts exists largely of natural gasses (available as compressed natural gas / CNG) and liquified petroleum gas (LFG). The generation of these two fuel alternatives remains based on fossil fuel extraction. Research is often aimed at combining these byproducts with other means of fuel generation. One example of this is the hydrogen-induced approach to fuel generation, where CNG is diluted with hydrogen (HCNG). Positive results have shown that using this type of fuel indeed leads to lower emission rates. However, the discussion remains whether it makes a significant ecological difference compared to conventional fuels due to the connection to crude oil extraction.

2.4.2 Intelligent Transport Systems

Intelligent transport systems exist in different shapes, but all have the shared idea of increasing traffic efficiency. ITS uses a combination of existing technologies. This includes GPS, wireless networks, short-range communication, radio-waves and beacons, traffic signals and mobile telephones. With these combinations, several types of ITS are possible:

Advanced Traveler Information System (ATIS)
This system provides travelers with information to make time- and fuel-efficient mobility decisions. This information concerns decisions made before or during the trip. Think of information regarding current congestion, traffic flow or road construction.

Advanced Traffic Management System (ATMS)
ATMS aim to increase and maintain traffic flow, rather than influence user decisions. Transportation management centers gather information regarding the current congestion and crowdedness of roads to monitor and publish traffic bottlenecks. Another ATMS example is using traffic regulation signals to influence traffic flows. An example of this application uses the car's position, speed, and drivers' behavior to create 'green waves' amongst traffic signals. This creates a more efficient flow of traffic and promoting sustainable fuel consumption (D'Orey & Ferreira, 2014).

Cooperative Intelligent Transport Systems (CITS)
These systems are best described from an IoT-perspective. CITS are vehicle-to-vehicle (V2V) or vehicle-to-infrastructure (V2I) communication systems and use continuous digital communication between road users and the environment. In an optimal application of CITS, driving is completely automatized and fostered by continuous digital synergy between cars and infrastructure to increase fuel- and time-efficiency. To a lesser intrusive extent, CITS are already present in other forms. An example is a driver advisory system that intervenes when a crash happens in front of the car. It takes over the controls and ensures that the situation is dealt with appropriately. In a way, automation is present, but the main control is still in the hands of the driver.

Advanced Public transit System (APTS)
This ITS application provides real-time information on public transit usage. With efficiency in mind, APTS provide the user with tailored information based on their current location, requested destination, and preferred mobility means, including public transit.

Smart city approaches
Smart cities are defined in many ways. That technology plays a vital role. The European Commission defines smart cities as follows: "A smart city is a place where traditional networks and services are made more efficient with the use of digital solutions for the benefit of its inhabitants and businesses" (European Commision, 2015). When it comes to ITS and the role it plays in smart cities, Bielińska-Dusza et al. (2021) argue that travelers use it for parking space appointments, online tickets and real-time information on traffic flows. ITS adds to the 'smartness' of a city by combining existing networks of technologies and data-streams and foster sustainable and efficient transportation.

Intelligent transport systems are closely related to the built environment. They not only rely on input from the car and driver, but also on sensors and measurement tools integrated in their surroundings (D. Banister & Hickman, 2006).

2.4.3 Technology: review & conclusion
Most technological advances in sustainable mobility is related to fuel or propulsion techniques and measuring and influencing the flow of traffic. Both have the potential make considerable contributions to the case of sustainable mobility. Advancement in fuel alternatives is seen as relevant in the literature base. However, the extent depends on the different approaches. The electronification of the vehicle fleet through regular battery based EV is currently viewed more viable compared to hydrogen fuel cells (Gallo & Marinelli, 2020). This is mainly because HFC's are not as developed. From a built environment perspective, alternative fuel technologies manifest in an increased need for charging station and service area coverage, especially when discussing the electronification of the private vehicle fleet. Another example of how alternative fuels influence the built environment was discussed earlier in the *policy* section. Drivers of alternatively fueled cars gain access to a special EV-lane, giving them benefits over conventional fueled cars (Kanamori et al., 2012). When it comes to ITS, all versions are receiving a lot of attention

from a technological perspective and from the built environment.

2.5 System change, ownership, and mobility behavior

The following chapter has a twofold focus: it discusses system change (1) by explaining how mobility changes through ownership and the implications thereof. Mobility behavior (2) discusses the way mobility is perceived. Mobility as a Service and sharing economies will both be discussed in the perspective of a system change. Mode choices, culture and perceived safety are discussed as part of the explanation of mobility behavior.

Mobility system changes start with changing the way we perceive the current mobility system. Currently, privately owned cars make up for the majority of the vehicle fleet in this mobility system. So, to discuss potentially required changes to this system, we should start with private car ownership. There is a plethora of research towards household decisions to have private ownership over a car (Zhou et al., 2020). The decisions to have this private automobility available as a household is made for numerous reasons. The study of these decisions has led to three mainstream models of private automobility (Anowar et al., 2014):

- **Vehicle purchase:** this model quantifies household characteristics or preferences when it comes to mobility. Using these preferences, it explains a recent car purchase or predicts future ones. It examines why a household makes the decision for a type of mobility, specifically aimed at automobility;
- **Vehicle holding:** this type of model expands on the vehicle purchase model. It explains the likelihood that a household has a number of private vehicles based on their characteristics and travel behavior. It does not aim to explain why a household buys a car, but rather how many they have;
- **Vehicle transaction:** this model again builds on the former. It provides reasons why a household acquires or sells private vehicles based on characteristics or and events. Exemplar event could be a decrease or increase of the household size, increase in acquired salary or moving to an area where alternative mobility is available.

These three mainstream models of ownership try to explain how and why households make a decision that is paramount for their daily mobility behavior. From a built environment perspective, the study of private vehicle ownership is interesting for several reasons. There is a symbiotic relationship between where households prefer to live and how the area is designed. This phenomenon is called residential self-selection (Cao et al., 2009). Households prefer to reside in areas that reflect their preferred way of living and mobility preference. Relating to the presented models of car ownership: households with a higher vehicle holding level (owning several cars) are likely to live in an environment where there is ample infrastructure to execute this mobility preference. This is a symbiotic relationship, because households that prefer private automobility are likely to prefer living in built environments that facilitate this. Similarly, the built environment is designed to attract households by facilitating these types of travel. For example by increasing the number of parking lots in the area. Studying private vehicle ownership from a built environment point of view is important, as there is a clear significant relation between built environment characteristics and mobility decisions of the households living in these areas (He et al., 2022).

Private automobility has been the mean ever since cars became popular. However, there is a new form of ownership that increases in popularity. Shared ownership of vehicles as a part of sharing economies has been on the rise for the past decade (Cohen & Kietzmann, 2014) Shared mobility is shared use of transportation that allows users to gain short-term access to transportation modes on

demand (Shaheen et al., 2016). Sharing economies in mobility make use of ICT to facilitate bike-, car- and ride sharing. Shared ownership as opposed to the conventional private automobility is seen as a form or agent of sustainable mobility because of numerous aspects:

- **Active mobility:** shared ownership of a car or participating in a sharing economy has both social and environmental benefits, as it fosters an active and healthy lifestyle (Musso et al., 2012). When there is no car available at the preferred location, car-sharers might reconsider their mode choice and opt for an active alternative. This only accounts for short trips where the distance is indeed reasonable to travel actively, but it has potential health- and environmental benefits due to the active and eco-friendly nature of these alternatives;
- **Smaller fleet:** since there would be less need for privately owned cars due to the shared car system, there will be less cars on the road at the same time. Yes, the non-availability of shared cars at a given moment might lead to other mobility choices and thus reduce the number of cars. However, there is also no longer a need for *owning* a private car when you have the option to share and rent one with other people. This leads to a smaller fleet overall. Less cars on the roads leads to lower levels of congestion – with all the accompanying social, economic and environmental benefits (Acheampong & Siiba, 2020b).
- **Lower costs:** due to the sharing economy, fixed costs are no longer of the essence for the consumer. This would be the case for private automobility. When opting for shared ownership, a consumer will be paying the default usage fee and the travel costs, but no longer has to pay for the vehicle itself, providing substantial economic benefits. The latter is especially the case for groups of users that have a car but leave it stationary for a longer period of time as they want to make use of other, more sustainable alternatives already (Zhou et al., 2020). There is also a social aspect to these lower costs. Because of the lack of fixed up-front payment but a subscription-based business model, lower income households suddenly experience an increase in mobility options and flexibility.

Relevant examples of how shared mobility is manifesting in the general mobility system often exist in wider implications. These wider implications take the shift in ownership and other concepts into consideration and try to form a new type of system where sustainable mobility is fostered through a combination of these concepts. The most well-known mobility systems that makes use of the sharing economies in mobility is Mobility as a Service.

2.5.1 Mobility as a Service

Mobility as a Service (MaaS) combines shared mobility and other sustainable mobility concepts. Understanding how requires comprehensive understanding of what mobility as a service actually entails. Based on Hensher et al. (2020), MaaS is often used as a buzzword. This is comparable to ‘smart’ and ‘sustainable’ and how they are often used without proper definition. According to Hensher et al., this is mostly due to the fluent nature of MaaS. This nature makes it rather difficult to construct one single definition that completely encapsulates the idea. An important principle of Maas is that it is context-dependent, rather than clear-cut and ready to be implemented anywhere. Each time MaaS is defined and used for a product, accepting its fluent nature will foster coherent development. There is one definition that is generally seen as the most coherent and complete (Hietanen, 2014):

“[Mobility as a Service] combines different transport modes to offer a tailored mobility package, similar to a monthly phone contract and includes other complimentary services, such as trip planning, reservation, and payments, through a single interface”

This definition includes the multimodality, personalization of trips, single interface and beginning-to-end service including planning and payment. Still, this definition does not specify the potential implications that MaaS has for the built environment. MaaS exists as a system change that focuses heavily on the combination between public transit and shared mobility. Both are facilitated by infrastructure in the built environment.

MaaS offers increased access to sustainable mobility by combining shared mobility, public transit, and active means of transportation in a multi-modal tailored trip advice for a single fee per trip. It provides this service through an ICT-based infrastructure. The built environment must facilitate this as well. MaaS uses the infrastructure for these transportation modes and is most successful where the built environment is suitable to an extent that benefits of MaaS will outweigh the benefits of privately owned vehicles.

Mouratidis et al. (2021) discuss how sharing economies in mobility including MaaS affect the built environment. According to the authors, MaaS implementation in the built environment will lead to a reduction in cars and parking spaces, an increase in space for green, social and leisure and a better infrastructure and facilitation for both shared mobility, public transit and active mobility means (Hensher et al., 2020b). Because of these effects, MaaS is in line with compact city design for the built environment.

2.5.2 Mobility mindset, culture, and adoption

The second segment of this twofold chapter is aimed at identifying a system change in mobility behavior. This is built on what was explained in the former paragraphs. With a system change in ownership and travel mode choice, there is a shift in mobility mindset and culture. This part of the chapter will discuss all three subjects in relation to sustainable mobility, focusing on how they relate to the built environment.

Mindset and culture are important aspects of mobility. As discussed by Cao et al. (2009), a person's mindset towards mobility, mode choice and the mobility behavior they show are strongly related to their residence area of preference. Certain infrastructures are preferrable to people who want to make use of the corresponding mean of mobility. However, there are some nuances in how influential the built environment is on mindset or attitude when mode choice is considered. According to Kamruzzaman et al. (2013), travel behavior and mindset might be significantly more influential on mode choice than the built environment. Their article discusses residential dissonance and mode choice. A person that lives in an area that is not representable of their preferences is called a dissonant (Kamruzzaman et al., 2016). Residential self-selection is not an airtight phenomenon. Citizens might make the decision to move into an area not because it suits their preferences, but out of necessity. This necessity materializes as a housing shortage, increasing prices or gentrification.

A prime example by Kamruzzaman et al. (2013) that shows the behavior of these dissonants relates to areas developed along the principles of TOD (Curtis et al., 2009). The Authors discusses TOD-dissonants as people living in TOD's although this does not represent their preferred mobility behavior. They also introduce the opposite. Non-TOD-dissonants are people that prefer public and active transportation, but living in non-TOD areas would have them adapt their behavior to the promoted means of mobility in the area. Public and active transportation are promoted in TOD's, whereas automobility is the mean in non-TOD's. This research was based on two multinomial logistic regression models and was carried out in 2009 and 2011. A two-year difference allowed for measuring the change in attitude and behavior. They found that TOD-dissonants and non-TOD-consonants (people not living in TOD and preferring it that way) are more likely to use the car than TOD-consonants and non-TOD-dissonants in 2009. This is in line with current research. It agrees with residential self-selection: if you prefer traveling by car, you prefer living in an area that promotes that. In 2011, TOD-dissonants did show

that they were more likely to opt for active transportation. However, there was no apparent change for public transit usage. Similarly, non-TOD-dissonants who usually liked to travel by public and active means, increasingly opted for the car 2011. This shows that, even you do not live in an area that suits your preferences, the built environment will affect your mobility behavior to suit the area. However, the authors argue that adopting available mobility and adaptation of attitudes is slow and requires further research. TOD's only function to their full extent when TOD-consonants are be actively recruited to live in such areas. They will make better use of the sustainable transport means.

Pritchard (2022) argues that there is a dominant car-centric 'culture' in most global societies. The car-centric culture is seen as unsustainable and needs a shift towards sustainable mobility. This culture is unsustainable on several fronts:

- **Economic:** having a car gives people the ability to move to and from work. Still, there are economic drawbacks to relying on cars as for mobility. There are high up-front costs, infrastructure costs and fluctuating gas prices. Then, there are costs that exist because of inefficiency, such as congestion, and safety, including the costs of accidents;
- **Ecological:** the environmental unsustainability of automobilism is already widely discussed in the former chapters but deserves continuous acknowledgement. Internal combustion engines and the greenhouse gasses they emit construct a large portion of the unsustainability discussion;
- **Social:** societies relying on automobility lock out households that cannot afford a private car. Because of that, car-centric cultures act as constraint-based systems that make it very difficult for some groups to participate in daily activities. Lower-income households therefore become marginalized and have to rely on other, less promoted means of transport. Additionally, inequity exists in the sense that everyone is sharing global impact of unsustainable behavior. The impact affects lower income households disproportionately.

Additionally, living in a car-centric culture is a self-reinforcing mechanism. Since having access to a (private) car is seen as paramount, cars become a goal rather than the means. Over the past century and even now, private cars have been seen as a status symbol to show welfare and is even seen to increase car use (Fitt, 2021).
The shift to sustainable mobility alleviates the pressure points described in this summation. Moving away from this car-centric culture requires more than a change in mindset or attitude. It requires changes in the built environment. From a built environment perspective, relying on automobility takes up a lot of space. Much of the built environment follows this car-centralism and thus facilitates a mobility culture that is deemed unsustainable. As a part of the required mobility shift, sustainable mobility concepts have been gaining momentum. Adopting new means of sustainable is a also a part of letting go of that current culture and embracing the shift. There is already a plethora of scientific literature on sustainable mobility adoption and regarding the former chapters. This indicates that this adoption is occurring on different levels.

- **Policies:** as discussed, sustainable mobility in politics has gained traction after the EU whitepaper from 1992. Over the past 30 years, the framework that was proposed in the whitepaper has developed and started including more disciplines. The challenge and measures proposed in that paper and all subsequent ones have indeed found governments to aim for sustainable mobility in their policies – thus indicating the need for this sustainable shift;
- **Urban planning:** even though urban planning originated centuries ago, cohesive urban planning from a

sustainable point of view started to counter the urban sprawl. Over the years, more sustainable urban planning principles (e.g. multi-core cities, TOD and compact cities) have been gaining attention. A large part of this adoption has culminated in sustainable urban mobility planning;

- **Technology:** attention for alternative fuels for cars and the usage of other types of mobility has been increasing. Not only in the market and in governments, but with consumers as well. The percentage of global EV sales increasing compared to the year before (Irle, 2019). This shows an increasing electronic vehicle adoption amongst the public.

From a built environment perspective, adopting sustainable mobility exists in an increase in residential self-selection preferring sustainable alternatives. The built environment has to reflect the mobility preferences of the people that live in it. If the built environment is designed with sustainable mobility in mind as this is deemed suitable and reflective of the peoples' preferences, the built environment is arguably reflective of sustainable mobility adoption.

2.5.3 System change, ownership, and mobility behavior: review & conclusion

This chapter discusses system changes. These system changes aim to move away from the established regime of automobility and give way to a new system of mobility. This new mobility system preferably includes a mix of public transit, shared mobility, and active means of transportation. Since these systems often exist as a collection of other sustainable concepts, they function as overarching developments. Because of this overarching nature, they are interesting grounds for research and are therefore seen as very relevant in the sustainable mobility discussion. Furthermore, these system changes heavily influence the built environment. This is because they are often related to available infrastructure and transport facilitation. Thus making them even more relevant to this research. An important combination of these concepts results in multimodality. Essentially, multimodality describes the idea of a person traveling through several means of transport. Multimodality plays a large role in MaaS. A MaaS-based trip is likely to depend on several vehicles outside of private ownership. Because it is such an important and overarching concept, multimodality has to be included in the list of concepts.

Contrarily to the chapters on urban planning and technology, this chapter presented sustainable mobility concepts that are a lot more abstract. One could say the same about policies. The results of the policy discussion are observed and measured, whereas peoples' behavior and drives remain something we can only estimate. Changes in the car-centric culture and mindset are required for sustainable mobility to gain momentum through adoption. Therefore, understanding user behavior and mode choices is an important part of the sustainable mobility literature base. Through changes in residential selection and behavior, the built environment is influenced as a result. Therefore, keeping these developments in mind is just as relevant as looking at system changes.

2.6 Relevant sustainable mobility concepts

This chapter will shortly discuss each mobility concept typology and the subsequent principles that were discussed in the former chapters. The result of this chapter will be a coherent list of sustainable mobility concepts. This list will be leading throughout the rest of this research. These sustainability concepts are an estimated representation of the current literature base on sustainable mobility. They are used as comparison material for the frameworks discussed later in this thesis.

There are several policy-related concepts regarding sustainable mobility. These policies relate to three overarching landscapes: environmental, socio-economic and technology. Within each of these landscapes, several policy options were given. These policy options are all directed to regulate

mobility aspect related to their landscape. Within the environment category, researchers often focus at alleviating the pressure on environmental eco-systems, lower emissions and slowing down climate change. Socio-economic policies aim at creating equity and safety in mobility, taxing unsustainable mobility behavior, and promoting sustainable alternatives. Technological policies discuss the urge for sustainable mobility through fostering technological advancement. They discuss alternative fuels, new types of mobility and intelligent traffic systems.

From a built environment point of view, policies assist sustainable mobility in numerous ways. When used correctly, policies foster changes in the built environment, regardless of whether they are of an environmental, socio-economic, or technological nature as they often overlap. Environmental policies for the built environment include policies that discuss: sound barriers, limitation to construction in eco-systems or areas. A social policy that overlaps with this, is the increase of accessibility to public transit by increasing PTAL's or providing funding for lower-income households. In this way, equity in mobility is created through a sustainable approach and changes are observable in the built environment. Other social policies that would infer physical changes include safety measures or promote transportation that acts as competitor to conventional automobilism. Technological policies manifest as an increase in charging stations throughout an area to foster EV adoption or the ITS implementation. Policy as a sustainable mobility concept is such a broad subject that it requires a chapter on its own. Even more so, policies often function as catalyzers or for new sustainable developments or limiters for conventional regimes. Their relevance in the built environment therefore has to be recognized. Because of their catalyzing nature, environmental, socio-economic, and technological policies belong in the list of relevant concepts.

Sustainable mobility through urban planning manifests in numerous ways. Urban planning concerns the built environment and might be the most closely related of all sustainable mobility concepts in literature. The subchapter on urban planning discussed four main concepts that foster sustainable mobility: polycentric urban development, the compact city, transit-oriented development, and sustainable transportation. The first three concepts approach sustainable mobility in different yet similar ways. Polycentric urban development concerns city planning with numerous nuclei as opposed to one, singular and big city center. Decreasing trip distance is at the core of this concept to decrease car dependency and increase public transit usage. The compact city is similar and uses the 5D's of urban development to do so (Ewing & Cervero, 2010). These 5 D's (density, diversity, distance to facilities, design and distance to transit) represent what urban planning with a sustainable mobility mindset is. Transit oriented development does something similar, but on another scale. TOD transforms old or creates new areas surrounding transit hubs. TOD planners use mixed zoning, social and green areas to promote public transit usage and active mobility, while simultaneously disincentivizing people to travel by car. Whereas the first three are directly related to improving sustainability through actual city planning, sustainable transportation aims at cohesive and cooperative planning of sustainable mobility as the goal itself. The principles of this concept pose sustainable mobility is applicable in every part of urban development. A shared vision is a prerequisite for this, though.

Even though there are some criticisms and implementation barriers towards all of these concepts, they are deemed to be relevant in the literature. This is the case, because they all seem to share principles of the 5D's that are representative for sustainable mobility through urban planning. Polycentric development, compact cities and TOD all use principles that are deemed relevant and that are directly applicable to the built environment. This makes them relevant and includes them in the list of concepts. Sustainable urban mobility planning discusses a planning mindset and an approach rather than a clear-cut application to the

built environment. Nonetheless, this mindset on increasing the sustainability of mobility through cohesive urban planning has to be present in the list as well.

Technological developments affect the transition to sustainable mobility in numerous ways. A lot of technological development aims to increase the efficiency of cars or chases replacing conventional fuels by alternative ways of propulsion. This often manifests in the electronification of the fleet, as EV's are the most technologically well-developed alternatives to conventional fossil fuel. Next to car-based technologies, technology also targets efficient traffic and control systems. Intelligent transport systems make use of technology to inform the user or traffic control of current traffic situations. This information is used to create advises or regulate traffic in a certain way to promote efficiency. Technological developments in relation to the built environment manifest in several ways. As discussed, an increase in charging stations for alternative fuels transforms areas into electric and sustainable neighborhoods. Additionally, alternatively fueled vehicles are allowed to use special new EV-lanes that exist next to existing highway lanes. Intelligent transport systems exist as a part of the built environment and are therefore paramount in influencing the sustainability of mobility, leading to 'smart' mobility. This makes ITS incredibly relevant when discussing the sustainable mobility transition from a built environment perspective. Due to their relation to the built environment, both charging stations for alternative fuels and ITS are included in the list of relevant sustainable mobility concepts.

Discussing mindsets, cultures and behavior is a lot more abstract. The former subchapter discussed how most of the world's population lives in a car-centric culture where we all rely on automobility. This car-centric culture has environmental, economic, and social disadvantages. Moving towards sustainable mobility is one approach to solve these disadvantages but requires a culture-shift. Mindset towards mobility is also discussed. People aim to live in an area that suits their mobility preferences. This phenomenon is called residential self-selection. An article by Kamruzzaman et al. (2013) discusses how ones mobility mindset is influenced by the built environment they live in. This presents the overarching argument that, when constructed successfully, a built environment that is aimed at sustainable mobility will nudge people living there to sustainable mobility behavior. Next to that, system alternatives such as MaaS and multimodality have gained momentum in the literature base and are therefore seen as relevant concepts for sustainable mobility in the built environment.

According to the former, the following table represents sustainable mobility from a built environment perspective:

Table 5: Literature concepts on sustainable mobility in the built environment

Sustainable Mobility Concept	**Concept subject**	**Built environment relation**	**Literature**
Policies	**Environmental** Keywords: (1) air pollution & greenhouse gasses; (2) active mobility promotion; (3) eco-driving; (4) noise; (5) landscape & Surroundings.	(2) cycling highways, active mobility zones, maintaining and increasing quality active mobility infrastructure. (4) strategic zoning, applying mitigation barriers. (5) eco-system and environmental protection, infrastructure, construction and zoning consideration	(Bebber et al., 2021; Fistola et al., 2020; Gallo & Marinelli, 2020; Gudmundsson, 2003; Yang et al., 2019)
	Socio-economic Keywords: (1) equity; (2) pricing, taxes & incentives; (3) transit improvements &	(1) provide similar quality infrastructure, increased and equal PTAL's. (3) increased PTAL's.	(Gallo & Marinelli, 2020; Jones & Lucas, 2012; McNally et al., 2023;

	public transit; (4) safety; (5) e-commerce & teleworking; (6) vehicle capacity occupancy.	(4) safety measures and infrastructure. (6) high occupancy vehicle lanes highway	Menendez & Daganzo, 2007; Parker et al., 2021; M. J. Santos et al., 2021)
	Technology Keywords: (1) fuel alternatives; (2) shared mobility; (3) intelligent transport systems.	(1) charging stations for alternative fuels, special EV permissions. (2) coherent shared mobility regulation, parking zones. (3) foster development and implementation of ITS.	(Andersen & Sutcliffe, 2000; Gallo & Marinelli, 2020; Kanamori et al., 2012)
Urban Planning	**Polycentric City Design** Keywords: (1) shorter distances; (2) high density; (3) public transit; (4) active mobility.	(1) more city core centers, facilities in each, and public transit concentration at cores. (2) population concentrated close to city cores, public transit, and facilities. (3) high PTAL's with high population density; connections between city cores. (4) active mobility infrastructure, short distances facilitate active mobility.	(Allam et al., 2022; Davoudi, 2003; Mueller et al., 2020; Wolday et al., 2019)
	Compact City Keywords: (1) density; (2) diversity; (3) destination accessibility; (4) distance to transit; (5) design; (6) vehicle hours traveled.	(1) short and walkable distances. (2) mixed zoning. (3) numerous available transport modes and high PTAL's. (4) high PTAL's, many access points. (5) high connectivity, cohesive road network, few cul-de-sacs, Superblocks (6) 15-minute cities.	(Adelfio et al., 2022; Bertolini, 1999a; Cervero & Kockelman, 1997; Lee et al., 2015; Næss, 2022)
	Transit Oriented Development Keywords: (1) public transit; (2) active mobility; (3) zoning diversity; (4) three pillars of sustainability.	(1) high PTAL's, development centered around public transit hub. (2) cycling highways, safe walking & cycling environments, pedestrian zones. (3) mixed zoning, shopping facilities and work close to residential. (4) social spaces, space for green, gentrification awareness.	(Bertolini, 1999b; Breheny, 1993; Curtis et al., 2009; Kamruzzaman et al., 2014; Mcleod et al., 2017)
	Sustainable Urban Mobility Planning Keywords: (1) vision and participatory approach; (2) all transport modes; (3) reiterative process; (4) travel demand management.	(1) up-front inclusion mobility in urban design, design from mobility perspective. (2) all transport modes included in development plans.	(Berman & Radow, 1997; European Commission, 2013; Ewing & Cervero, 2010; Meyer, 1999; Ogra & Ndebele, 2013; Wefering et al., 2014)
Technology	**Alternative fuels** Keywords: (1) (PH-)EV's; (2) HFC's; (3) LFG's.	(1) charging stations, EV-lanes.	(Anjos et al., 2020; Emadi et al., 2008; McDowall, 2016; Paolo & Gull, 2022)
	Intelligent Transport Systems Keywords: (1) communication and sensors; (2) traffic control; (3) traffic efficiency; (4) driver assistance.	(1) sensor and communication installations. (2) smart traffic regulation. (3) less congestion, less road occupancy. (4) less congestion, mode choice assistance and mix.	(D. Banister & Hickman, 2006; Bielińska-Dusza et al., 2021; D'Orey & Ferreira, 2014; European Commision, 2015)
System change, ownership & Mobility Behavior	**Ownership** Keywords: (1) private ownership; (2) sharing economies.	(1) high road occupancy, congestion, parking in urban design, driveways in urban design. (2) shared mobility hubs, lower road occupancy.	(Anowar et al., 2014; Zhou et al., 2020)
	Mobility as a Service Keywords: (1) public transit; (2) sharing economies; (3) ICT (4): multimodality.	(1) increased PTAL's, more access points, better public transit infrastructure. (2) shared mobility hubs. (4) high connectivity, close to stations, cohesive network coverage.	(Cohen & Kietzmann, 2014; Hensher et al., 2020a; Hietanen, 2016; Mouratidis et al., 2021; Musso et al., 2012; Shaheen et al., 2016)
	Culture Keywords: (1) car-centric; (2) residential self-selection; (3) dissonance; (4) culture-shift; (5) mindset.	(1) high road occupancy, congestion, parking, driveways.	(Cao et al., 2009; Fitt, 2021; He et al., 2022; Kamruzzaman et al., 2013, 2016; Pritchard, 2022)

		(2) people living in areas suiting their travel behavior, areas designed to attract groups with certain behavior. (3) migration or behavioral adaptation. (4) adapting to new mobility preferences.	

The compiled list that is shown in table 5 shows the four sustainable mobility typologies, their concept subjects, and examples on how they relate to the built environment. All concept subjects include keywords. These keywords are numbered to correspond with how they manifest in the built environment within that concept subject. Per concept subject, the numbers correspond only to the row they are in. See table 6 for an example:

Table 6: Sustainable mobility concepts excerpt

Sustainable mobility concept	**Concept subject**	**Keyword and number**	**Built environment relation and number**
Policies	Socio-economic	(3) transit improvements & public transit	(3) increased PTAL's.

This list of concepts is used after the description of De Woningbouwopgave and the corresponding assessment procedures for the funding structure. This list represents the literature on sustainable mobility in the built environment and will be compared to concepts from these assessments to examine the literature representation. Essentially: to what extent are assessments of sustainable mobility in the built environment made based on former research and knowledge in the literature?

3. De Woningbouwopgave

This chapter will provide an analysis of the context of De Woningbouwopgave. This chapter provides the reader with a cohesive view of what De Woningbouwopgave entails. It explains why it is necessary to solve the housing crisis and what the current plans are. This chapter serves as an introduction to the frameworks that are used to assess urban development plans – including the mobility aspect of the built environment. This chapter introduces the first section of the bipartite guidance and focuses on governance.

3.1 Context

There is a housing deficit in The Netherlands. This deficit is caused by two phenomena. Decreased housing construction is the first cause. According to the Centraal Bureau Statistiek (CBS, Central Bureau of Statistics), Dutch housing construction peaked during 1988. In that period, there was a net housing stock increase of around 114.000 units per year (De Jong et al., 2019). Just before the turn of the century, the yearly housing construction and change in the total stock started to decline. The yearly construction and yearly change in stock are not similar, as there are also dwellings that are demolished each year. Because of that, the number of constructed houses per year is typically higher than the change in total housing stock.

In 2000, the yearly increase had dropped to 65.000 new units. This led up to a local low point in 2003, when just 49.000 new housing units were constructed. After that period, the housing stock experienced two local high points in 2008 and 2013, with a yearly increase of 81.000 and 86.000 respectively. Figure 3 shows that this increase in 2013 is an outlier case. The yearly increase in stock is higher than the number of units constructed. This does not represent an actual increase (Centraal Bureau voor Statistiek, 2022) but is an administrative correction. However, a new decline started after this period, with a low point in 2016. During this year, the overall stock grew with less than 45.000 new units. This was the lowest increase since 1948. After 2016, the numbers start to increase again. This was not sufficient to keep up with the increasing population. In part, this leads to the current situation.

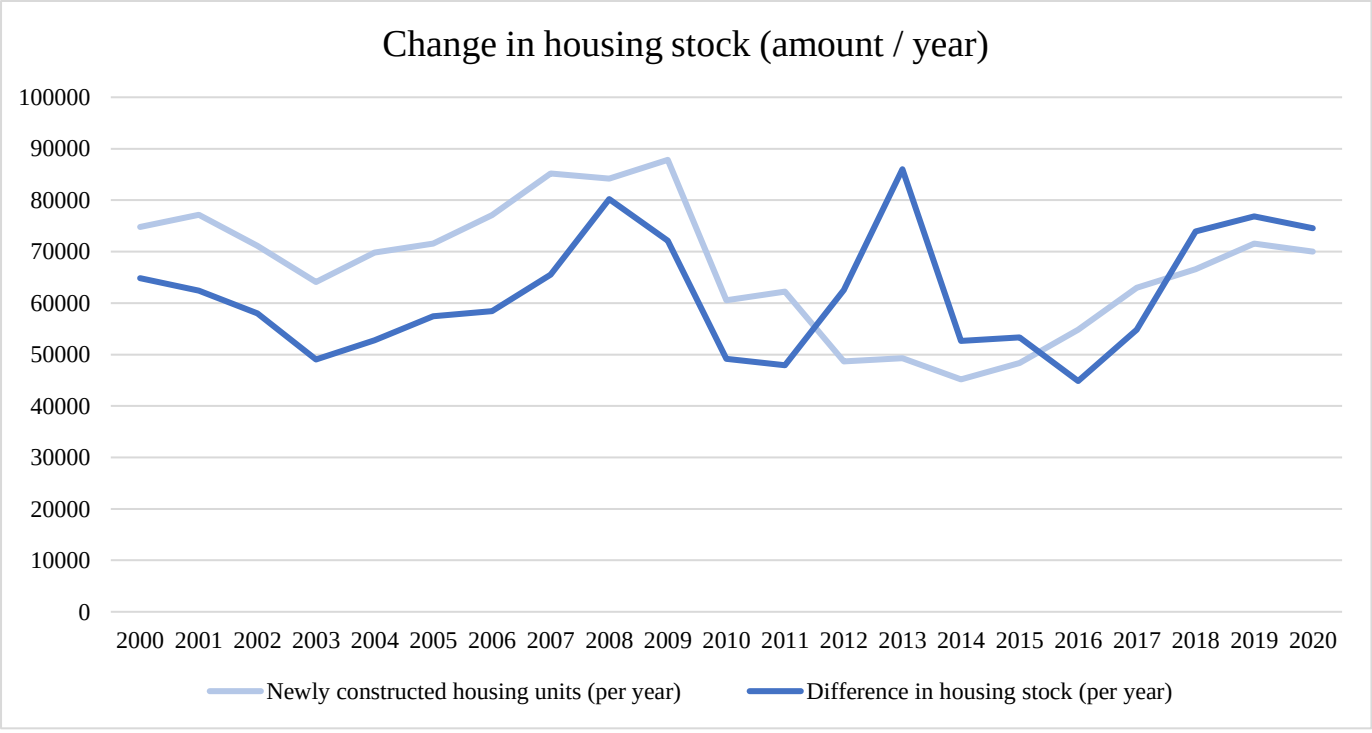


Figure 3: Yearly change in housing stock (CBS, 2022)

Whereas the first cause related to the lack of construction, the second cause is related to a decrease in average household size in The Netherlands. This affects the number of people living in one housing unit, thus increasing the overall required number of houses. According to the CBS, the number of households consisting of only one person is ever-increasing. Simultaneously, the population is increasing. Thus, even though the number of single households increases along with the population, the average household size decreases. Figure 4 shows what this decrease has looked like over the past 22 years.

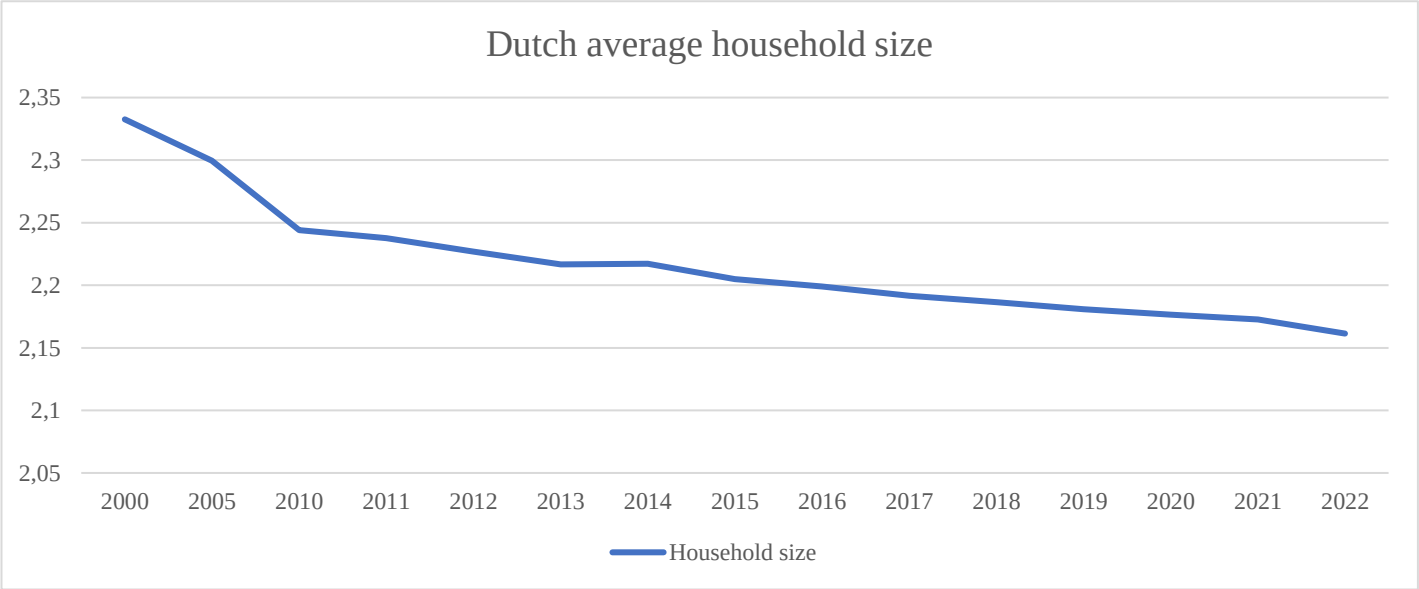


Figure 4: Average Dutch household size (CBS, 2022)

At the beginning of the century, the average household size in The Netherlands was 2,33 people per household. At the time of writing (2022), this average has dropped to 2,16 people per household. Each household needs a place to live. With an increasing population but a decreasing average household size, the number of houses required to provide residence increases disproportionately. Combined with the slacking increase of housing stock in the past decade, these are likely to be the overarching causes that have caused the housing crisis that The Netherlands finds themselves in.

However, it should be noted that this is not the first time that The Netherlands has encountered housing problems. Looking at the number of households per residence during the 1960 compared to 2020, more separate households used to live together in the past. A mismatch between the number of households and available housing resulted from war-related demolition of the housing stock and increased household sizes (Centraal Bureau voor Statistiek, 2022). How is the current housing crisis different to the one that occurred in the post-war period? The reasons for the current crisis explain the difference. Decentralized housing construction, disbandment of the former Ministry of Housing and Spatial Planning in 2010 and a different role housing corporations are partly to blame (Boelhouwer & van der Heijden, 2022). Housing construction slowed down and less support from housing corporations was received because of their new role in social housing. Additionally, the socio-demographics continue to change as just explained, thus changing the housing demand.

This brings us to the current situation. A governmental report from 2021 discusses the current state of the housing market. The housing shortage will reach a peak in 2024, with a shortage of 3.9%. In this publication, they cite the 2021 and 2022 Primos prognosis reports and the numbers therein. These prognoses were conducted in commission and are used as leading for government decision regarding the housing crisis. The first prognosis, presented on the 19th of July in 2021, shows a general overview of the state in that year and the outlook for the coming decade per province. Table 7 summarizes this prognosis.

Take note that the ‘construction’ column concerns transformation and divided single residences. The ‘demolishing’ column includes changes in function and conjoining of residences.

Table 7: Estimated housing shortages

	Estimated shortage		Housing need increase			Challenge 2021-2030			Estimated shortage	
Province	2021		2021-2025	2026-2030	Total	Construction	Demolishing	Net stock increase	2031	
Groningen	2,20%	6.200	7.600	2.600	10.200	16.500	4.500	12.000	1,80%	5.400
Friesland	1,40%	4.400	7.200	4.300	11.500	15.300	4.500	10.800	1,90%	6.000
Drenthe	1,90%	4.200	4.600	2.700	7.300	9.900	3.000	6.900	2%	4.700
Overijssel	2,30%	11.700	19.000	13.000	32.000	41.600	7.100	34.500	1,80%	9.800
Flevoland	5,40%	9.400	16.200	14.800	31.000	35.400	800	34.600	3,10%	6.500
Gelderland	3,80%	34.900	44.100	32.900	77.000	94.900	10.000	84.900	2,80%	28.300
Utrecht	4,50%	26.600	39.200	37.300	76.500	92.700	7.400	85.300	2,90%	19.300
Noord-Holland	4,80%	65.000	86.400	71.000	157.400	199.800	23.900	175.900	3,30%	50.400
Zuid-Holland	4,00%	67.000	96.500	81.900	178.400	230.200	36.900	193.300	3,00%	56.700
Zeeland	0,00%	0	3.700	1.400	5.100	7.100	2.600	4.500	0,40%	800
Noord-Brabant	3,50%	40.500	59.100	44.300	103.400	130.600	11.200	119.400	2,10%	26.700
Limburg	1,60%	8.800	6.100	-1.400	4.700	18.400	5.900	12.500	0,70%	3.800

In the second prognosis, presented on the 19th of September 2022, the current housing crisis is sketched. The statistical housing shortage is estimated at 315.000 houses. This is 3,9% of the total housing stock. In contradiction to the governmental report released in 2021, the housing shortage has reached this peak of 3,9% in 2022, as opposed to the prognosed 2024. The acceptable average level of housing shortage is 2%. The population will increase with 8,2% over the coming fifteen years. The total number of households is set to increase with 10,6% (+858.000). This is indicative of the decreasing average household size. To accommodate for this household increase and to solve the housing shortage, an estimated total of 1.213.000 new housing units are required. Constructing 91.000 per year up until 2030 is within reason and should suffice to accommodate the increasing population.

This prognosis presents the context for De Woningbouwopgave and the challenge that is posed to Minister De Jonge. To overcome this challenge, a guiding plan of action is required. This plan of action has to account for more than just housing construction, as the housing crisis entails the entire built environment. This thesis discusses sustainable mobility and the place it has in De Woningbouwopgave. The housing construction program (Dutch: Programma Woningbouw) is a plan to give direction to this housing challenge and will be discussed at length in the following sub-chapter.

3.2 The housing construction program

To accommodate the increasing population and to assist the slacking housing market, a plan is required. The housing construction program was presented as a cooperative plan by the Ministry of Internal Affairs, the Ministry of Economics and the Ministry of Infrastructure and Water Management, led by Minister of Housing and Urban Planning Hugo de Jonge. This program is part of a set of six programs. These programs aim to increase the housing quality and overall quality of life in The Netherlands over the coming years. This set of housing programs consists of:

- Housing construction program;
- Home for everyone;
- Affordable living;
- Livability and Safety;
- Sustainable Built Environment;
- Living and care for the elderly.

The housing construction program is central to this thesis. On March 2022, Minister De Jonge presented three targets that are crucial to alleviating the housing deficit. These three targets are as follows (Ministerie van Binnenlandse Zaken en koninkrijksrelaties, 2022b):

- **Realizing 900.000 new housing units until end 2030:** to accommodate the increasing population and increase the overall housing stock (i.e. account for the demolishing and change of function by new construction), an estimated 900.000 new units have to be constructed. An estimated 125.000 housing units will be demolished or change in function. To facilitate for this, the net housing stock increase should to reach 775.000 by the end of 2030. This estimation is iterative and will be re-evaluated each year according to the current progress and changes in socio-demographics;
- **Increasing construction to 100.000 per year:** as of the beginning of the year 2022, the housing construction rate was at roughly 80.000 new units per year. The housing construction program aims to increase this to 100.000 units by increasing financial support and providing a more centralized direction. The aim is to realize this increase by the end of 2024, based on permits and currently planned construction projects. To achieve this increase, more than construction is required. The program increases the number of flexible living opportunities, foster transformation and function change;
- **Two-third of new units as affordable:** the aim is to have at least 600.000 new units in the affordable category. This affordable category includes all the social housing, units in the middle-segment (rent under the market price of € 1.000 per month). This includes houses that have a mortgage guarantee (i.e., require a mortgage lower than € 355.000). 250.000 of these new housing units have to be social housing and will be constructed by social housing corporations. 350.000 units will be made available corresponding to the other two requirements. Within that group, housing corporations are responsible for at least 50.000. This is a region-based point of action and does not concern housing projects internally. It will also not affect current housing projects, but will rather become the norm for new housing projects after the year 2025. Other monetary support for starters is presented in the program ‘affordable living’.

Basically, these three goals describe the main requirements of the solution to the crisis. The housing construction program includes four ‘red threads’ that aim to alleviate the current housing crisis and fulfill these three goals. These threads are united under a single vision. They each discuss parts of this vision and split it into more apprehensive lines of action. The first line of action is to *provide direction*. Through several milestones, guidance and appointing responsibility, the government ensures that the three pillars of the housing construction program will be adhered to.

To increase the housing development rate, clear goals and cooperation strategies are required. This starts with generating an idea of what the challenge entails, the current realization capacity and stock, what we need and how to get there with our current resources. Every region in The Netherlands has to construct their 'fair share' of housing units. The national government will take the reins and form agreements with each province about the number of new units they will construct. Up until the 1st of July, 2022, the national and provincial governments have created these indicative agreements. Policymakers have checked these agreements in feasibility and sustainability. In a letter written by the Minister of Housing and Spatial Planning, these indicative agreements have been considered and solidified. Table 8 shows how the 900.000 new units are distributed per province. Housing corporations and municipal governments are included in these agreements. Each will take on their fair share of the number of houses assigned per province. These fair shares will be part of what are called 'regional housing deals'. These deals are not to be confused with the similarly named housing deals from 2019-2020, made under former Minister of Internal Affairs, Kajsa Ollongren (Omtzigt, 2021).

Table 8: Provincial 'fair shares' of housing units

Province	Units until the end of 2030
Drenthe	13.631
Flevoland	39.193
Friesland	17.500
Gelderland	100.000
Groningen	28.359
Limburg	26.550
Noord-Brabant	130.600
Noord-Holland	183.600
Overijssel	42.300
Utrecht	83.500
Zeeland	16.500
Zuid-Holland	235.460

The current regional housing deals are cooperative agreements between all three levels of government (with a supporting role for the national level), corporations and market parties. These actors create these regional housing deals to appoint segments of the provincial housing task to certain areas within the provinces on a more practical level. These were finalized by the end of 2022. These deals connect the regional housing goals to the other three lines of action. They discuss how projects or regions need monetary support or optimization. The last part of this line of action is the Taskforce Housing construction for Corporations (Dutch: Taskforce Nieuwbouw Woningcorporaties). This taskforce provides direction and support in public administration for housing corporations to foster and optimize the development process.

The second line of action concerns *increasing the efficiency of the development process*. Realizing a housing project is a difficult and lengthy process. This process starts with taking the initiative. This line of action shortens and optimizes this process to foster the development of new housing units. The current development process takes an average of 10 years. The process consists of the following steps: finding and analyzing a location, creating a plan and conducting market and location research, validating or adjusting the zoning plans, prepare for construction and ending with the construction itself. The aim is to optimize this process by providing expert support. The government increases the number of employees concerned with the development process and stimulates and standardizes innovation in construction. This line of action helps to avoid delays or stagnation. It does so by enabling resources to optimize the bureaucratic process and to foster innovation.

Rapid housing construction is the third line of action in the housing construction program. The focus is on assisting municipalities in realizing housing projects through monetary support. Often, development projects stagnate or cannot be initialized at all because of a lack of funding or economic incentive. These projects ow gain monetary support from government funds. A prerequisite for these projects, is that they are past the stage of location research and that a plan is developed. Several instruments are required to fund these projects. The Woningbouwimpuls (Wbi, in English: Housing construction impulse) fosters

housing development. It consists of a sum of € 1.25 billion and will be used to create 200.000 new housing units. The Wbi has already been used in three other opportunities (tranches). This resulted in 140.000 units currently in development in 93 projects, next to 200.000 future units. The agreement concerned with these first three opportunities, is that construction has to start within three years of granting the funds. The fourth tranche supports the development of 135 new projects. Development projects are viable for the Wbi funding when they tick several boxes. One of these boxes is the accessibility of the development areas. This is where mobility plays an important role. Next to the Wbi funding, a part of this line of action is to prioritize development of projects. Here, additional attention is given to the connection to the surrounding areas in favor of accessibility. Additional support is available in the form of the € 7,5 billion Mobility Fund. This fund is concerned with what the national government deems to be all conventional means of mobility (car, public transit and bicycle). Projects are viable for this funding when they adhere to certain design principles concerning mobility, among others. These mobility-related principles are:

- Municipalities and regions are responsible for the 'last mile';
- Development plans in areas that have plenty of mobility capacity available are prioritized over areas where mobility networks are already experiencing pressure;
- Effects on existing main roads and rail networks has to be minimal;
- Several aspects of sustainability in the built environment have to be taken into account (e.g. energy, air quality and sound pollution).

These principles lay the groundwork for a set of frameworks and assessment approaches that assign the budgets of the Mobility Fund and the Wbi. These will be discussed in the next chapter.

In the allocation process that the Mobility Fund is concerned with, two sets of meetings play a large role. These meetings occur twice in a yearly cycle and are called the Directive Consultations for the Built Environment (Dutch: Bestuurlijke Overleggen Leefomgeving, BOL) and the meetings concerned with the Multi-year program for Infrastructure, Planning and Transport (Dutch: Meerjarenprogramma Infrastructuur, Ruimte en Transport, MIRT). Generally, the BOL is held each year for every larger region of the country. The aim of these consultations is for policymakers to discuss plans related to the NOVEX regions (table 9), discuss a shared vision for future projects and to allocate funding. The first meeting of this cycle (BOL) took place in June 2022 and was centered around determining and reflecting on the list of locations applied for additional funding. The second meeting (BOL-MIRT) concerns allocating the first round of investments according to the findings of the preceding meeting.

Another aspect of this line of action is the increased construction of flexible housing. Flexible housing units are a short-term solution for local housing problems and only temporarily exist. An estimated 15.000 flexible housing units will be constructed each year and will remain for a currently indeterminate time. Examples of this type of housing include tiny houses or other forms of pre-fab living spaces. Additionally, temporarily changing the existing building functions and transforming them into residences is a part of this line of action as well. Similarly to flexible living spaces, yearly transformation results in 15.000 units. The last aspect of this approach is the full deployment of the Central Government Real Estate Agency (Dutch: Rijksvastgoedbedrijf). This is the real estate department of the national government. They are responsible for support and guidance because of their real estate development knowledge and expertise. Additionally, they will be responsible for locating areas suitable for 2.000 flexible living spaces per year.

The fourth and last line of action is *assigning larger construction zones*. Different areas require

different approaches. There are larger regions that need specific housing projects to fulfill the requirements of the municipalities. With larger development projects, local challenges become regional ones. This is where coherent planning and guidance is paramount. The government identified seven regions in need of larger development projects. These NOVEX-regions are: Metropool-regio Amsterdam, Zuidelijke Randstad, Stedelijk Brabant, Metropool-regio Utrecht, Regio Arnhem-Nijmegen-Foodvalley, Regio Zwolle and Regio Groningen-Assen (Ministerie van Binnenlandse Zaken en koninkrijksrelaties, 2022a). The aim is to construct up to 600.000 units in these areas before the end of 2030. Within these seven regions, seventeen large development areas were identified. Table 9 shows a summary of these seventeen areas and their overarching regions.

Table 9: NOVEX-regions and development areas

NOVEX-region		**Housing development area**	
1	Metropoolregio Amsterdam	1	MRA West
		2	MRA Oost
		3	Havenstad Amsterdam
2	Zuidelijke Randstad	4	Oude Lijn Leiden-Dordrecht
		5	Rotterdam Oostflank
		6	Den Haag CID-Binckhorst
3	Stedelijk Brabant	7	Eindhoven Internationale Knoop XL
		8	De Brabantse Stedenrij
4	Metropoolregio Utrecht	9	Utrecht Groot Merwede
		10	Amersfoort Spoorzone
5	Arnhem-Nijmegen-Foodvalley	11	Nijmegen Kanaalzone
		12	Nijmegen Stationsgebied
		13	Spoorzone Arnhem-Oost
		14	Foodvalley
6	Regio Zwolle	15	Zwolle Spoorzone
7	Regio Groningen-Assen	16	Groningen Suikerunieterrein
		17	Groningen Stadshavens

In these seventeen larger development areas, some form of construction has already started before the year 2022. These areas are chosen because they are in need of special attention precisely because development has stagnated. But also because they are deemed unfit to cope with the grow in population over the coming years. To help these areas, the government has enabled the Mobility Fund for connection to the surrounding areas. The Wbi will strengthen development incentives from an economic perspective. € 475 million is allocated as an extra fund to support where necessary.

With the relevant zones identified, it helps to shortly discuss the ‘chain of command’ that the housing construction program is concerned with. The national government is responsible for determining the severity of the national housing challenge. They take the reins in optimizing the construction process and provide financial support. The provincial governments translates the national housing challenge into a sum of housing units to be constructed in that province. Additionally, they assist the national government in optimizing the construction process and providing financial support. This is where the housing deals exist. On a regional level, these provincial sums are translated into concrete plans per NOVEX-region. This is also where a practical application of the construction process optimization and funding will be assigned. Municipal governments are responsible for making sure that there are development plans in the development areas. Additionally, they involve housing corporations and construction companies. Project developers assist the municipality with that goal.

However, the NOVEX-regions are not the only areas that require development. Each province has regions that are located outside of the seven larger NOVEX-regions but still require an increase in housing. The housing deals include both the required development in the NOVEX-regions and the development outside of these areas. The

projects in both regions are assessed in a different way and funded through different structures.

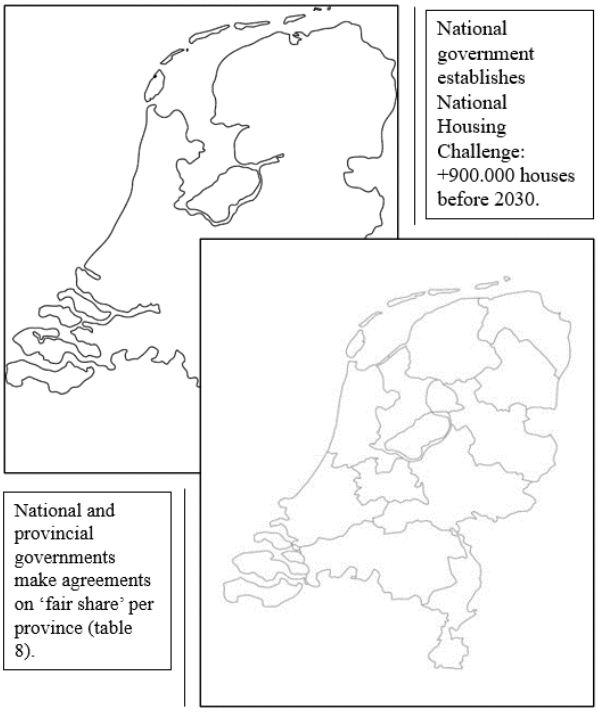


Figure 6: National housing challenge scope

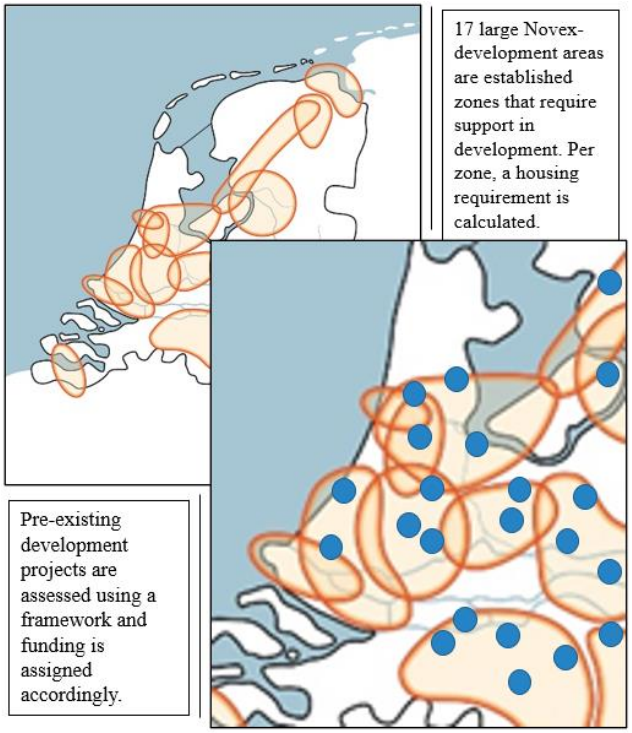


Figure 5: NOVEX-regions and development projects

This chapter elaborated on the scope of De Woningbouwopgave and the structure in the housing construction program. The following chapter discusses each of the frameworks and assessment approaches and accompanying funding structures. The leading focus in the frameworks and assessment approaches that will be discussed, will always be mobility in the urban environment. For some of the assessments, aspects of the funding procedure that are not related to mobility are left out, as they are not within the scope of this research.

4. Assessment methodologies for mobility in development projects

Mobility has a place in the housing construction program and Woningbouwopgave. There are different assessment structures connected to different types of funding, leading to changing project requirements. These funding structures allocate funding to projects as part of the housing construction program. They asses how mobility has a role in the upcoming developments. This chapter will clearly explain each assessment approach with a focus on mobility. Thereafter, each approach is interpreted. What follows is a comparison to the sustainable mobility concept list from chapter 3.

4.1 Context and current developments

As a part of De Woningbouwopgave, the housing construction program is a first step to solving the housing crisis. Constructing 900.000 new housing units before the end of 2030 requires coherent funding and guidelines for the involved construction projects and infrastructure. There is a national set of agreements concerning the funding structure, including mobility. Based on MIRT administrative consultations, the following national agreements considering mobility are identified. The concepts in italics indicate the measurement approaches or frameworks. Because of the nature of either the frameworks or assessment approaches, these terms are used interchangeably throughout the thesis. Over the coming ten years, € 7.500.000.000 (€ 7,5 billion) is made available under the Mobility Fund to improve the accessibility of urban areas (Ministerie van Infrastructuur en Waterstaat, 2022a). € 1,5 billion of the € 7,5 is allocated to increasing the accessibility of the larger housing locations. The infrastructure investments for these development projects are assessed as part of *the program for accelerating housing construction* under the housing construction program. The remaining € 6 billion is allocated to increasing the accessibility of the seventeen NOVEX-regions. To distribute the € 1,5 billion, each project is discussed in the MIRT consultations and subjected to a *conceptual framework regarding housing and accessibility.* The Mobility Fund exists to provide an impulse to the overall mobility of the country. After the housing construction program, each constructed area should be reachable by car, bike, and public transit. Therefore, it is important to note that the budget of € 7,5 billion is not meant for housing construction. It purely serves to increase the accessibility of the areas.

A part of the budget is set to be distributed in the form of mobility 'packages'. These care packages are only distributed to areas and plans that adhere to three overarching questions related to the mobility measures. These three questions are at the core of a *mobility scan.* This scan is performed by two independent mobility consultants to assess the quality of the mobility plans. Next to the € 7,5 billion Mobility Fund, there is an additional € 475.000.000,- (€ 475 million) available for area development. The maximum funding that will be provided by the national government is 50% of the required project funding. The remaining 50% is the responsibility of the municipal government. Not so much as a framework or assessment approach for funding allocation but more of a guiding tool is the *mobility transition menu.* This tool will be introduced to municipalities and project developers to provide guidelines and provide bottom-up consultation on how to include sustainable mobility in new project developments. This tool will be discussed in this chapter alongside the other approaches.

To understand how these funds are distributed, one should dive into the decision frameworks used during the governmental discussions. Since the scope of this research is on mobility, the following subchapters will solely discuss the relevant mobility frameworks concerned with the budget allocation decisions.

One important notion concerns the role of mobility and the built environment before De Woningbouwopgave. Mobility and the built environment have been on the governments'

agendas long before this national housing crisis. All three levels of government together conducted research analyses and created strategies grounded in these analyses. These strategies show how the country and regions aim to develop concerning mobility infrastructure. As will become clear in the upcoming sections, each framework and assessment approach has to be aligned with these overarching strategies, policies and researches. For the seven overarching NOVEX-regions (table 9), the national and regional governments have created general urbanization strategies (Dutch: verstedelijkingsstrategieën) for urban development, including mobility. These strategies are document as part of the national spatial development vision (Dutch: Nationale Omgevingsvisie, or NOVI). Box 1 shows a summarizing example of the urbanization strategy for the province of Utrecht.

Urbanization strategy Metropolitan region Utrecht – 'Utrecht Nabij'
Utrecht, both as a province and as a provincial capital, finds success in its central position. Because of that central position, it is an attractive place to settle and work, as it comes with strong mobility benefits. This strong mobility position also comes with a huge responsibility as a central node, leading to an overload of traffic. To accommodate for the 83.500 new residences as part of De Woningbouwopgave, Utrecht needs a concise urbanization strategy that facilitates this influx in activity.

Utrecht Nabij (English: Utrecht close by) is the name of the strategy that focuses on urban development where existing facilities for work, leisure, shopping and transport are already present or easily developed. The strategy presents seven principles that lead the development vision:

1. Concentrate new residences and jobs in city cores and around public transit hubs;
2. Invest in green spaces and increase their accessibility;
3. Increase living- and job-density between city cores;
4. Develop attractive city cores at edges of metropolitan area;
5. Focus on strengthening economic clusters;
6. Organize smart, safe mobility networks with sufficient alternative modes, with focus on active mobility, public transit, distribution of clusters and new ways of working;
7. Transform to a cohesive mobility network that fosters multimodality and is in line with preferred mobility behavior.

The focus is on multinuclearity, having different city cores surrounding the city of Utrecht on a regional scale, but also within the municipality itself. Public transit networks and connectivity between cores needs to be increased in quality. Urban development will be centered around locations where public transit is highly available. Together with promoted active mobility, this will make for an attractive sustainable mobility environment. Automobilism will not be completely abolished, as increasing the main road networks still has a high priority. However, parking facilities will decrease and, together with cultural and behavioral measure will be promoted to change unsustainable mobility behavior.

The national, provincial, and municipal governments need to work together to manifest this vision into concrete steps to make the metropolitan region of Utrecht futureproof with additional room for development.

More information can be found on:
https://www.denationaleomgevingsvisie.nl/publicaties/overige+publicaties+gerelateerd+aan+de+novi/handlerdownloadfiles.ashx?idnv=210

Box 1: Urbanization strategy Utrecht

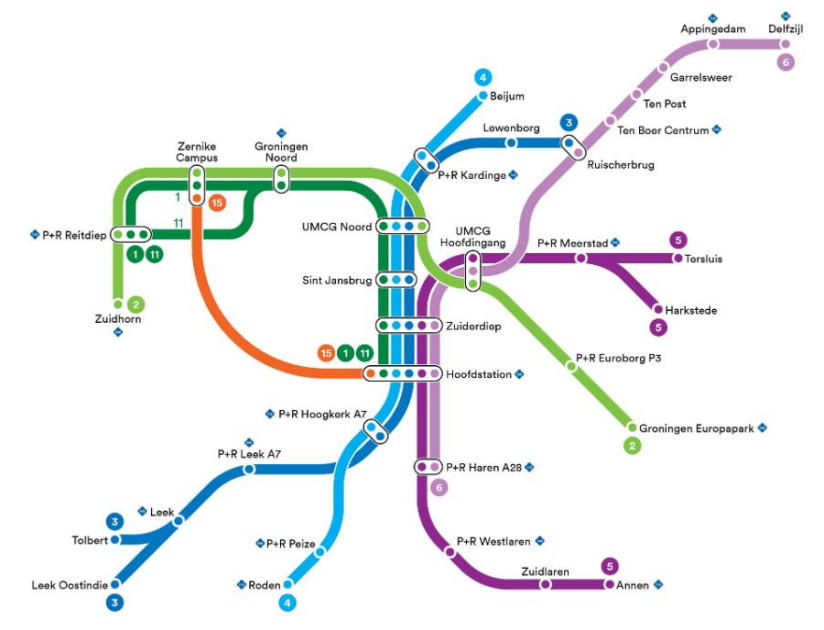
Box 2 has a similar function for the Groningen-Assen region:

Urbanization strategy Region Groningen-Assen (RGA)

The region of Groningen and Assen finds their power in diversity. They pride themselves in the amount if diverse living environments in such proximity. Urbanization therefore has to occur on different levels. The foreseen housing increase in the area, coherent planning is required. As a result of this increase, the region aims to develop with short distances and proximity of facilities in mind. Active and sustainable mobility are likely to play a major role in this. Due to the urgency, transformation of zones with redundant functions is also held in high regard.

The idea is to create and enhance what is called 'De Groene Contramal'. This serves as a buffer of green space between city cores (on a regional level, mainly between cities and smaller urban areas, villages) to preserve the quality of life in the region. To do so, greenfield development outside of city cores is avoided and the preference is given to grey- and brownfield. This also fosters the idea of building in proximity of city cores, creating compact urban areas with facilities close by. Because of this, polycentric development principles are likely to be found in the region: bigger city cores surrounded by multiple smaller ones connected through public transit.

The RGA benefits from the development of the Q-link and Q-liner, bus-rapid transit systems between city cores in the region. Bus stops along the Q-link are designed to that they promote multimodality and allow for easy transfer. This system also facilitates urban development in areas where extensive public transit is already present, functioning as a 'spine' for transit-oriented development. Automobility is recognized to support the accessibility of public transit in more rural areas, but is ideally to become unnecessary in the more urban areas. Here, active mobility and sharing economies are appointed to take the lead as main means of transportation.



On a more local level, sharing mobility hubs and smart mobility (e.g. providing real-time travel information) will play a key role. Mobility as a Service is also recognized to be an upcoming mobility concept, but is likely to depend on the development of a more sustainable shared mobility system.

For more information:
https://www.denationaleomgevingsvisie.nl/publicaties/overige+publicaties+gerelateerd+aan+de+novi/handlerdownloadfiles.ashx?idnv=2103881

Box 2: Urbanization strategy Groningen-Assen

Urbanization strategies discuss the future development vision for the region. Mobility plays an important role in that vision and development. There is another way to discuss mobility that is fundamentally important for the frameworks in this chapter: the integral mobility analyses, or IMA (Dutch: Integrale Mobiliteitsanalyses). These analyses identify potential challenges for mobility and accessibility. This also concerns the development of mobility infrastructure and how these mobility challenges might affect mobility behavior and pressure in each region. The following is a summary of these IMA challenges (Ministerie van Infrastructuur en Waterstaat, 2021):

- **General mobility development:** people- and freight-logistics will increase, accompanied by challenges concerning climate, air and sound pollution;
- **Accessibility development:** depending on the scenario, accessibility of jobs and facilities will either decrease or increase. Developments have to be aimed at carrying the effects of both options;
- **Potential challenges urban agglomerates:** urban agglomerates will experience an increase in jobs and job accessibility over the coming years. Active mobility and public transit see an increase inwards and outwards of the agglomerates. This leads to potential overshoots in the capacity of infrastructure and services. Increasing mobility is accompanied by higher congestion on main roads, leading to lower automobile accessibility;
- **Potential challenges between and surrounding urban agglomerates:** mobility between agglomerates will increase. Modal split for commutes is about fifty-fifty between cars and public transit. In suburban areas, automobilism will increase for long-distance trips. Congestion will increase, but will be compensated by an increase in available jobs and facilities, shortening necessary trips. On the edges of the urban agglomerates, infrastructure and services are unlikely to have the capacity to carry the increase in mobility need;
- **Potential challenges in rural regions:** the accessibility of jobs will decrease, causing a decrease in population over time. Because facilities and jobs are relatively further away, automobilism and congestion are set to increase;
- **Potential challenges international people transfer:** depending on the scenario, car travel for work between countries will either decrease or increase. Public transit for work is set to increase in both scenarios. International train lines have room for development;
- **Potential challenges freight-logistics:** both national and international freight-logistics will increase, posing challenges for the transportation corridors. Water transport requires infrastructure and maintenance investments. Rail transfer is not used to its full potential or does not have sufficient capacity on important corridors. Road transfer experiences negative effects from increasing congestion. There is potential for a modal shift towards more water-based transfer through in-land canals. This creates opportunities on new parts of the rail network;
- **Potential challenges safety:** the number of deadly traffic accidents on the road is set to decrease. However, the number of traffic accidents with minor or major injury will increase, likely because of the aging population. Train- and bus-stations will likely be overcrowded with injury as a result;
- **Climate challenges on networks:** climate change is likely to affect all transportation networks in different ways. Heavy rainfall, road degradation and landslides are some of the foreseen examples of these effects. Extra attention should go to the rivers and surrounding areas;

- **Emissions:** decreasing use of fossil fuels will have a positive effect on transport emissions. Climate agreements will put limitations on freight-related emissions. Nitrogen and particulate matter require more attention but are likely to increase due to policies and technological advancement.

The urbanization strategies are often used as foundation for project development plans and these strategies are thus preliminary to the plans. The IMA create a context for mobility infrastructure. This infrastructure could lack, disabling any development. The upcoming assessment frameworks examine project proposals that require additional infrastructure investments. They will have to be tested in their alignment with the challenges and opportunities identified within the IMA.

Figure 7 gives a visual preview of the frameworks and assessment approaches and their main method of analysis. There is still a nuance in how these frameworks and assessments fit into the division between NOVEX- and not NOVEX-projects. At the end of the chapter, the frameworks will be summarized visually in that context.

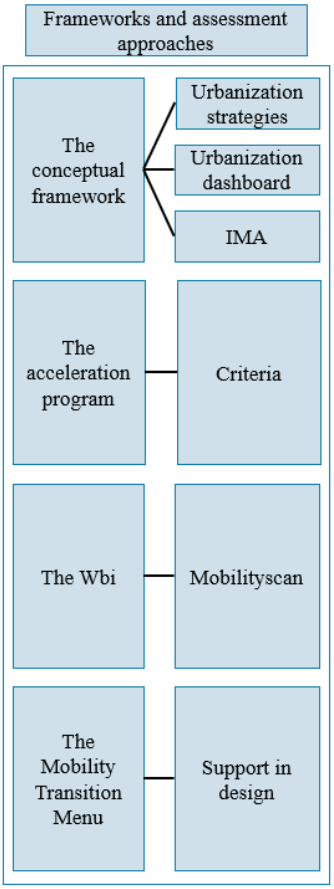


Figure 7: Assessment methods

4.2 Conceptual framework housing and accessibility

4.2.1 Explanation

In commission of the Ministry of Internal Affairs, two mobility consultant bureaus created a framework to assess housing projects considering 'accessibility'. Studio Bereikbaar and Rebel Group were commissioned to provide the Ministry with a framework. Policymakers would use this framework to assess if the relationship between accessibility and housing was present in the plans that applied for the budget reserved for the NOVEX-regions. The framework would then be used during the MIRT consultations to support budget funding decisions. The framework is used to guide the discussion on mobility through asking certain questions and testing assumptions in the plans. Contrarily to the construction acceleration program concerning the remaining € 1,5 billion for short term housing, these projects have a timeline that runs up to and sometimes even beyond 2030. Much of the information in this chapter is extracted from government presentations.

The conceptual framework presents a scoring based on several criteria to provide an overall scoring. Policymakers use this scoring during the funding discussions to determine whether the project plans are aligned with what all levels of government agreed on. One has to consider whether this is indeed the best method of testing. It is a rather qualitative method. Literature on urban planning decision-making is often of a quantitative nature. For example, multi-criteria analysis, cost-benefit analyses, and hedonic pricing methods are often used to support location decisions for development projects. However, there is a clear reason that this framework is of a more qualitative nature. It serves as a discussion tool and not as a clear decision-making framework. It has to be used to guide discussion, whereas more sophisticated models might lead to technocratic decision-making. Since these projects are heavily related to political incentives and cover a much broader scope

than just mobility, purely making decisions based on the best quantitative output is likely to overcomplicate an already critical and slow process.

The framework examines the relationship between the value of housing construction, costs, gains, how it adds to the overall housing challenge and the accessibility value of the area. The latter concerns how the project will affect the status quo of mobility and whether the mobility infrastructure related to the project adds to the overall mobility ambitions. The housing construction value considers the project's stance towards the current housing market, the number of housing units within the affordable sector, the relevancy and necessity of the required mobility infrastructure to facilitate the new residences and the reliability of the plans regarding the units to be constructed before 2030. The volume of existing and new houses outside of the project area that benefit from the infrastructure investments is also accounted for.

To complete the symbiotic relationship at the core of the framework, the accessibility value relates to the following:

- The project fosters sustainable mobility through close proximity and negative externalities alleviation;
- The impact on national and regional mobility challenges (analyzed and documented in the integral mobility analyses or IMA);
- How the new infrastructure will add to the regional accessibility and how the existing urban areas will benefit.

These two concepts create a vision, that is best explained as a communal goal to realize as many accessible houses as possible. Quality-, health-, safety- and environmental conditions have to be considered. This included the planned construction's alignment with the governments' perspectives on nitrogen emission, short- and long-term safety and sound. When assessing the infrastructure proposals policymakers consider urban activity, balance of functions, spatial development and environmental quality. The framework guides the coordination between the national and regional government and to communicate to the municipal government how mobility infrastructure investments are provided. The framework has a purely consultative function: it provides guidance to the discussion. It should by no means be deemed omnipotent in decision making, as there are other aspects that have to be taken into account when dealing with politics.

The projects that are discussed using the framework are plans that have been laid out before and are seeking funding. Therefore, the framework does not present any recommendations as to how projects make their mobility approach more sustainable. Even more so, mobility inclusion in the projects is likely to already have an origin that is aligned with governmental plans. The project plans that are discussed with the framework largely stem from these plans and are thus supposedly related to a larger mobility vision. In these urbanization strategies, sustainable mobility plays a role too. So essentially, the conceptual framework does not test for sustainability. It tests if the project plans accurately represent the urbanization strategies and their sustainability potential. Therefore, the framework relates heavily to the NOVI and the urbanization strategies, but also to MIRT-analyses of the regions and future projections of mobility.

In this framework, policymakers test for several criteria. Ideally, a project scores high on all of these. Each of these criteria has several sub-criteria that are scored between 1 (low) and 5 (high). The criteria are as follows, including the sub-criteria for sustainable mobility-related subjects:

- (**housing**) alleviating housing market tension: the higher the number of houses constructed, the better;
- (**housing**) Affordable residences: at least 50% of the projected residences should fall within the affordable category;
- (**housing**/**mobility**) Relevance of the infrastructure developments. The

infrastructure investment should be conditional to the housing construction. The investment should be necessary because of the housing influx, not because there is a lack of accessibility in the area in the first place;

- (**housing**) Realistic prognosis of construction before 2030;
- (**mobility**) Surrounding areas should benefit from the investments in infrastructure;
- (**sustainable mobility**) Sustainable mobility inclusion, including the following: the approach is precise in how it will facilitate multimodal availability (modal split) and means (parking facilities, quality of active mobility media, public transit, proximity of facilities and amenities and a mix in functions). There has to be a large share of sustainable mobility in close proximity (expressed in percentages). Additionally, a substantial increase of sustainable mobility in comparison to the current established share in the NOVEX-region is required. In the framework, the focus is on avoiding longer trips made by car. To score on this criteria, experts assess the balance between available transport modes in total and in relation to the entire NOVEX-region. Expert opinions are based on additional mobility plans originating from the relevant region and the development of urban proximity and mobility in line with the urbanization Dashboard.
- (**mobility**) Impact of mobility measures on IMA-challenges, including sub-criteria:
- The mobility infrastructure development leads supports the IMA-challenges in the region. Some examples that are provided are capacity expansion, alternative routes or fostering the mobility transition to alleviate current pressure;
- The increase in housing alleviates the IMA-challenge, for example through having new households travel in different timeslots and focusing on public transit as opposed to conventional automobilism;
- The share of traffic that uses current IMA-challenge related infrastructure is less than 1%;
- (**sustainable mobility**) Improving regional accessibility. Seeking to improve the regional accessibility through spatial development, modal shift and mobility packages. The connection between the proposed investment and the urbanization strategy is important here. Regional accessibility increase is explained as an increase in the number of accessible residents and places of work by bike, public transit or car. This is deemed sufficient when (based on the distance-decay mode) more than 30.000 additional residents and jobs are within reach by bike. More than 90.000 additional residents and jobs should be within reach by public transit and more than 150.000 additional residents and jobs are accessible by car.

An important segment of the sustainable mobility inclusion (sub-)criteria is related to the urbanization dashboard (Dutch: Dashboard Verstedelijking). It was created in commission of the Board of Government advisors (Dutch: College van Rijksadviseurs) as they required a more sophisticated tool for location research (College van Rijksadviseurs, 2018). Consultants developed the urbanization dashboard as a support tool for determining the added value of a project for potential development locations in De Woningbouwopgave. The Board argues correctly that De Woningbouwopgave is not just a challenge. It also presents opportunities for other socio-economic solutions to be introduced. Arguably, De Woningbouwopgave serves as a facilitator for the energy transition, climate adaptation, sustainable mobility, and livability – a notion that is shared with the author of this thesis. The development locations produce financial vitality, mobility behavior, social interaction, energy-usage and transitions. The urbanization dashboard identifies these externalities regarding spatial development

models. The result of the dashboard is insight in nine different themes or subjects that relate to what is on the mind of society. This includes sustainable energy usage and important sustainable mobility is an important part. Throughout these nine subjects, proximity and the power of urban agglomeration plays a major role. This also goes for sustainable mobility and the mobility behavior that follows from this close proximity. Essentially, the dashboard advises the government. The dashboard identifies the societal externalities that accompany a development location depending on the urban model.

The dashboards provide a method for regional and national government to assess locations. The method is as follows: (1) develop different urban models that represent societal debates and development plans. It is important to note that these models do not function as choices. They serve as different representations of preferences to study the positive and negative effects of externalities. (2) Format these models in geographical information software (GIS) and use calculation and traffic models to filter the scores for each indicator. These indicators are grounded in different literature sources. (3) National and regional government should use the outcome of these model calculations to develop conditions for each project location and secure that these are in line with their own visions of the area.

There are three preset urban models that represent mainstream development principles to be used as molds for other area-dependent models. These models rely on relevant urban planning principles (table 5):

Model 1 (city region)
This model focuses on redeveloping urban areas and building close to existing urban cores as much as possible. Changing functions and reassigning areas to residential is an important approach for this. Therefore, brown- and grey-developments are prior to greenfield. From a mobility point of view, this model increases multimodality and to improve the quality of the required media. It seeks to foster strong connections between city cores to create a cohesive road network. Additionally, this model improves urban accessibility by providing higher PTAL's, higher quality of public transit and safe active mobility facilities.

Model 2 (living landscape)
This model focuses on urban sprawl and facilitates accessibility through extensive car- and public transit networks. This model contains the most greenfield development, but also produces new residential areas through grey-field development and transformations. Mobility-wise, the model focuses on increasing accessibility through further development of the road network to be used by cars and buses. It also increases the current public transit service coverage. The model also provides a place for cycling highways. An important note is that the focus of mobility will still be on car networks to get from core to core.

Model 3 (nodes)
This model is based on increasing the residential density surrounding existing and new PT-hubs. The focus is on using existing public infrastructure. High residential area is concentrated where PTAL's are highest. This leads to lower residential opportunities in areas where public transit accessibility is lower. There is a small focus on providing coherent automobility. Still, most of the attention goes to providing a strong public transit network, joined by a safe cycling and walking environment.
One of the main arguments presented by the dashboard is to focus on construction in close proximity of jobs, schools, healthcare and facilities such as shopping and leisure. This is in line with what is seen as relevant within the literature (table 5). Even more so, the dashboard advises to facilitate active mobility in cooperation with this close proximity to foster sustainable mobility behavior. Depending on the spatial context of the urban area and the facility distribution, this leads to either green-, brown- or grey-field development. It is argued that focusing on compact cities and thus facilitating shorter distances through focusing on brown- and grey-field development has a positive

effect on decreasing the CO_2 emissions as a result of mobility. Additionally, urban development concerns providing alternative fuels. This is shared among all three models. On another note, an increase in mobility is barely calculable when looking at one location or project. This should be done for the entire region or group of municipalities. Therefore, mobility development is necessary on a regional level to futureproof the area.

The dashboard does not promote one of the three models as superior compared to the others. The goal was to show how different preferences and ambitions are represented differently and lead to different outcomes in different contexts. From a mobility point of view, the city region model (model 1), the living landscapes and (model 2) nodes model (model 3) show significant opportunities for sustainability, albeit in different ways. Model 1 shows to follow principles of the multinuclear city and the mobility benefits that come with it. Model 2 focuses heavily on automobilism and highway connections. Still, the focus on public transit to provide mobility between the city cores aligns with literature on polycentricity. The living landscapes model, model 2, focuses on urban sprawl and has the most greenfield development. This brings with it both mobility challenges and opportunities. Similar to model 1, the living landscape model focuses on multinuclearity. However, model 2 practices it at a different scale. This is still in line with literature on polycentric cities, but approaches mobility in a different way. An important difference in comparison to model 1, is that this approach still relies a lot on automobility. Model 3 shows a clear example of Transit Oriented Development. The focus is on the development of residential areas with public transit hubs at the center. These public transit nodes and the essence of active mobility make for sufficient sustainable mobility in this model. The question with model 3 is whether the public transit nodes that is at the core of the residential areas can be realized before 2030. Spatial proximity plays an important role in all three models, but mostly in model 1 and 3. These two models have about 50% more jobs in close proximity than the living landscapes model. When it comes to proximity to public transit, the nodes model scores highest, closely followed by the city regions. The living landscapes model has a rather low score concerning public transit accessibility, with the majority of houses not having direct access to public transit at all. This promoting automobility between city cores. The urbanization dashboard accounts for spatial proximity concerning existing infrastructure and how locations facilitate new residential areas in their vicinity. Therefore, the role of existing infrastructure in mobility is deemed to be important in the decision making process for new infrastructure investments.

Back to the conceptual framework itself. Ultimately, the dashboard has a supportive function to the framework. Studying the project area through different models helps setting and assessing the conditions for projects. Reaching a decision on whether the added mobility value of the project proposal is sufficient is difficult to assess. Different questions towards sustainable mobility need to be considered:

- How does the project affect average proximity values?;
- How does the project affect mobility behavior on long and short distances?;
- How does the project foster a sustainable mobility transition through additional policies?

Essentially, answering these questions is also where the dashboard helps. The criterium that is behind all these questions is: what is the impact of the urbanization as a result of the project on movement patterns in the area? This criterion is to be indicated quantitatively by the increase of long distance trips per residence by car or PT. Preferably, the former increases less than the latter. As explained, there are three sub-indicators that relate to sustainable mobility concerned with this part of accessibility. The dashboard supports in answering these criteria:

- The approach towards sustainable mobility is precise about the target (modal split) and means (parking regulations, parking concepts, quality of active mobility and public transit infrastructure, proximity of facilities and mix of functions);
- Relatively high share of sustainable mobility and close proximity. An indication of this is 'more than X% of mobility in the project area is sustainable';
- The mobility infrastructure investment facilitates a substantial increase to the average sustainable mobility situation in the NOVEX-region.

A second criteria related to sustainable mobility and accessibility concerns the improvement of the regional accessibility. This criterion is measured by several indicators. This includes the increase of accessible workplaces for new citizens (in 30 minutes by car, in 45 minutes by PT) and an increase in the number of new residents that is able to reach that work place within those times. Additionally, there is one indicator that examines the alignment with the urbanization strategies.

The third mobility and accessibility criteria concerns the impact on IMA-challenges. The method to measure this is rather robust. It mainly comes down to expert judgement of the alignment with the identified challenges.

In conclusion, the conceptual model framework of accessibility and housing assesses the project plans for the NOVEX-regions. The national and regional government have created urbanization strategies that discuss goals and visions for sustainable mobility development per region. The projects assessed by the framework have been created some time ago and are in need of additional funding. The framework does not exist to give them any advice on how to implement sustainable mobility. However, policymakers judge the plans on whether their mobility proposals align with the sustainability vision in the urbanization strategies. With respect to mobility and accessibility, the framework generally tests for whether the forecasted infrastructure investments and urbanization will lead to changes in mobility behavior and sustainable mobility adoption, in cooperation with a focus on proximity. Policymakers compare the plans to the urbanization strategies, the challenges leading from the integral mobility analyses and the urbanization dashboard. Since it is a qualitative method rather than quantitative, expert judgement is the main approach here. This judgement is rendered during the MIRT in cooperation with mobility consultants. It is later discussed with representatives from the regional and municipal government.

4.2.2 Interpretation

The conceptual framework was created to assess the mobility infrastructure investments for development projects within the NOVEX-regions. It is used during MIRT consultations to discuss how the majority of the Mobility Fund could be divided. The framework was created with the idea that accessibility and housing construction value are inseparable. they should both be estimated for each of the potential investments. Accessibility value directly relates to the extent that sustainable mobility (bike and public transit accessibility to the area next to automobilism) is promoted by the required infrastructure. It concerns to what extent the new infrastructure will add to the regional accessibility and whether or not it adds positively to the mobility challenges identified during the IMA's. Housing construction value relates to the added value of the newly constructed units to the regional housing deficit and how these new and existing units benefit from new infrastructure. Policymakers ask these questions are asked per infrastructure investment in a development project. These projects have existed for some time and are in need of funding. Developers need to prove what they present is indeed in line with the urbanization strategies for that region and the IMA's. Essentially, the framework does not test whether this is the case, as that should be intrinsic to these existing projects. One could argue that taking a look at the urbanization strategies is a better option. Examining the urbanization strategies will indeed provide more information as to how the region

develops in an ideal situation. These plans are also quite clearly relatable to relevant mobility concepts in table 5. Utrecht (box 1) prefers to develop close to city cores and increase density to shorten trip distance while simultaneously increase the PTAL's around these cores. Q-link in the Region Groningen-Assen (Box 2) provides options for transit-oriented development and promotes multimodality due to its hubs. However, the development plans, more specifically the required infrastructure investments, should materialize these visions. One should have a clear idea of how the region should develop by reading the strategies. Still policymakers assess the project developers and their plans regarding whether they receive funding or not. This is what the framework is for. Therefore, the framework and its considerations have to be examined, not the strategies.

There is one important tool that supports the framework and is directly related as to how accessibility value is estimated: the urbanization dashboard. The dashboard considers how spatial distribution in the city affects mobility behavior. It argues that spatial proximity and network effects in an urban area are of the utmost importance for determining how mobility in the area works. The three aforementioned models are also the most popular ones. These models show knowledge of the implications of the polycentric city, compact cities and transit oriented development on a regional and local level. Additionally, active mobility, cohesive networks (facilitating both automobilism and public transit) and changing functions relate to literature. The frameworks concern for accessibility value relates to this dashboard. As the framework is the guiding support in the field of mobility during the MIRT consultations and accessibility value is discussed, so are the considerations of the dashboard. Despite the fact that these discussion tools are available, the criteria in the framework are what ultimately leads to advice. The first real criterium for accessibility value is related to the impact of urbanization on mobility behavior. The increase of long distance trips per new housing unit (and changed behavior of households in existing units) through car or public transit is relatable to trip decrease or increase and what type of means is chosen. This is the first criterium. Sub-criteria involve the preciseness of the plans regarding the target (modal split) and means (parking regulations and concept, the quality of active mobility and public transit infrastructure, proximity of facilities and mix of functions). Furthermore, relevant sub-criteria relate to the share of sustainable mobility in the project area and the increasing average of sustainable mobility in the entire region.

The second criterium relates to increasing the regional accessibility, measuring the effect of area development, mobility investments and considering the added value to the urbanization strategy. Indicators for this criterium are the increase in jobs, the increase in citizens that are able to reach destinations with a given time, a quantitative analysis (one line of text) on the alignment with the urbanization strategy and how many of the developments are actually going to take place. Additionally, the idea of increasing accessibility is quantified estimating the increase in accessible jobs by bike, public transit, and car.

The third criterium discusses the added value to the challenges posed in the IMA's. The indicator related to this criterium concerns the 'target range' of the mobility investment. The combination of both accessibility value and housing construction value is estimated in cost-effectivity per housing unit. Additionally, any conditions are test qualitatively. This includes environmental impact and safety.

So indeed, all three of the main criteria regarding accessibility value discuss either the urbanization dashboard, strategies or the IMA's. However, the depth to which extent these criteria are seemingly discussed is rather lacking. The indicators consider only minor aspects. This includes alignment with the urbanization strategies. This is tested quantitatively through a short textual explanation. Another aspect is the increase in jobs and the number of citizens that have the ability to get somewhere on time after the required infrastructure

is developed. Arguably, there is more to the urbanization strategies and the development plans that requires testing before investing a part of the Mobility Fund (here with € 6 billion available) that has a lasting effect on the urban area. Another shortcoming of the framework could be the in-depthness of the effect on IMA challenges. The indicator for this criterium is the 'target range' for the challenge. There is no indication as to how this is calculated or estimated. This would have been more problematic when the framework were to be leading in the decision as opposed to a more guiding function. Still, it is difficult to guide a discussion when the indicators are vague. There are, however, the sub-indicators that elaborate on this main criterium of connection to the IMA-challenges in the region:

- The mobility infrastructure development leads to relieved IMA-pressure in the region. Some examples that are provided are capacity expansion, alternative routes or fostering the mobility transition to alleviate current pressure;
- The increase in housing alleviates the IMA-challenge, for example through having new households travel in different timeslots and focusing on public transit as opposed to conventional automobilism;
- The share of traffic that uses current IMA-challenge related infrastructure is less than 1%.

These give little insight towards how this connection should be discussed. However, what target ranges as indicators entail remains unclear.

4.2.3 Literature concepts in the conceptual framework

The conceptual framework uses the urbanization dashboard and the regional urbanization strategies to assess the mobility approach in each project. When filtering the conceptual framework for sustainable mobility concepts, the best approach would be to focus on these two tools. In the urbanization dashboard, the three main models each describe a spatial approach for urban development. These models have concepts of their own that relate to the concepts in table 5. Likewise, there are some main concepts per model that are adverse to sustainable mobility. Table 10 will show both of these types of concepts and denotes whether they are in line with table 5 or not. The way this and the following concept-tables should be interpreted is as follows: between brackets, there is the concept and the keyword that relates to it. If there are more keywords that relate, they are included with a semicolon. If there is another concept that is important here, it is provided after the forwards slash, accompanied by the relevant keyword. For each of the connection, a textual explanation is provided. If there are clear adversities to sustainable mobility, these are also included in the table for reference.

Table 10: Literature concepts in the urbanization dashboard

Urbanization dashboard concepts	**Sustainable mobility concept (table 5)**
Model 1 (city region)	
Strengthening multimodality infrastructure	(Mobility as a Service; multimodality) Multimodality fostered through high connectivity, close to stations and cohesive network coverage
Strong connections between urban areas and a cohesive road network	(The Compact City; design / Polycentric City Design; shorter distances) Cities designed with high connectivity and cohesive road networks between all city cores
Improving public transit connectivity and options	(The Compact City; destination accessibility / Polycentric City Design; public transit) Numerous available transport modes and high PTAL's where population is high to facilitate connections between cores
Improving active mobility infrastructure	(Polycentric City Design; active mobility)

	Active mobility infrastructure, short distances that facilitate active mobility
Focus on automobility between city cores	Adverse to sustainable mobility
Build in or close to developed urban areas	(The Compact City; density / Polycentric City Design; high density) Short and walkable distances because of newly developed urban areas close to existing city cores with infrastructure and facilities
Balance between brown- or greyfield development and green spaces	(Transit Oriented Development; three pillars of sustainability / Environmental policies; landscape & surroundings) Eco-system and environmental protection, construction and zoning consideration and sufficient attention for green and social spaces.
Close to facilities and jobs with lower travel times as a result	(Polycentric City Design; shorter distances / The Compact City; vehicle hours traveled; diversity) Close to existing facilities and jobs, mixed zoning and shorter trip distances
High PTAL's	(Polycentric City Design; public transit / The Compact City; distance to transit) High PTAL's across the urban areas to foster PT use
Model 2 (living landscapes)	
Strengthening multimodality infrastructure	(Mobility as a Service; multimodality) Multimodality fostered through high connectivity, close to stations and cohesive network coverage
Cycling highways	(Transit Oriented Development; active mobility / Environmental policies; cycling highways) Designated and efficient lanes for cyclists to promote fast active mobility
Mediocre improvement of public transit facilities and connectivity	(The Compact City; destination accessibility / Polycentric City Design; public transit) Numerous available transport modes and high PTAL's where population is high to facilitate connections between cores
Strong focus on automobility between city cores	Adverse to sustainable mobility
Greenfield development outside of existing urban areas	Adverse to sustainable mobility as there are no experienced benefits from existing facilities and developments
Balance between greenfield development and green spaces	(Transit Oriented Development; three pillars of sustainability / Environmental policies; landscape & surroundings) Eco-system and environmental protection, construction and zoning consideration and sufficient attention for green and social spaces.
Mediocre to low PTAL's	Adverse to sustainable mobility
Model 3 (nodes)	
Strengthening existing public transit nodes	(Transit Oriented Development; public transit / The Compact City; distance to transit) Increased the quality of connections, infrastructure and service and existing PT nodes to better facilitate PT mobility
Active mobility infrastructure around nodes	(Transit Oriented Development; active mobility) A safe walking or cycling environment and pedestrian zones around nodes will facilitate active mobility towards these nodes
New public transit infrastructure only added if it provides a short link between new residential areas and existing infrastructure	(The Compact City; design / Transit Oriented Development; public transit) Development of new infrastructure creates a cohesive PT network with development focused around nodes that will connect them to said network
Build in or close to developed urban areas with higher density closer to nodes	(Polycentric City Design; high density / Transit Oriented Development; public transit; zoning diversity)

	Development around existing areas to benefit from existing facilities but higher densities always around existing or new PT nodes
Balance between brownfield development and green spaces	(Transit Oriented Development; three pillars of sustainability / Environmental policies; landscape & surroundings) Eco-system and environmental protection, construction and zoning consideration and sufficient attention for green and social spaces.
Development of new nodes	(The Compact City; distance to transit; design / Transit Oriented development; Public transit) New nodes should add to a cohesive PT network and provide new opportunities for urban development
Light focus on automobility (sharing economies)	Adverse to sustainable mobility where sharing economies are not concerned
Close facilities and jobs with lower travel times as a result	(Polycentric City Design; shorter distances / The Compact City; vehicle hours traveled; diversity / Transit Oriented Development; zoning diversity) Close to existing facilities and jobs, mixed zoning and shorter trip distances
High PTAL's	(Transit Oriented Development; public transit / The Compact City; distance to transit) High PTAL's make for better and more frequent use of PT

Where the assessment of these models is concerned, there are numerous direct links to the literature. These models are placed in the context of the development projects at hand and vice versa. So there is indeed an important relationship between the way the urbanization dashboard is used and sustainable mobility concepts in the literature. The dashboard helps the framework to guide the discussion related to a set of questions. These questions show how accessibility value is estimated in the framework. Accessibility value is dissected into three parts. Earlier in the descriptive analysis of the conceptual framework, the following questions concerning sustainable mobility were introduced:

- How does the project affect average proximity values?;
- How does the project affect mobility behavior on long and short distances?;
- How does the project foster a sustainable mobility transition through additional policies?

There is one overarching question as main criterium: what is the impact of the urbanization as a result of the project on the movement patterns? The indicator for this question is estimated quantitatively by the increase of long-distance trips per residence by car or PT. Preferably, the former increases to a less extent than the latter. From the perspective of the framework, this is the sole fruit that bears from the sustainable mobility concepts in the urbanization dashboard. In and on itself, the urbanization dashboard includes numerous of these concepts. The conceptual framework filters these concepts to answer that single question.

However, the sub-criteria related to the main criterium posed earlier discuss sustainable mobility in the plans specifically. These three sub-criteria relate to the literature concepts from table 5. Most of the concepts are only given as examples. Still, it is the most precise and complete resource available.

Table 11: Literature concepts in the conceptual framework urbanization sub-indicators

Conceptual framework urbanization sub-indicator	Sustainable mobility concept
Modal split	(Sustainable Urban Mobility Planning; all transport modes / Mobility as a Service; multimodality) Development of the area has to account for several transport modes and multimodality of trips
Parking regulations	(Ownership; private versus shared ownership / Culture; car-centric) Parking regulations and restrictions change per region and need to be considered in the development plans
Quality of active mobility infrastructure	(Environmental policy; active mobility zones; maintaining and increasing the quality of active mobility infrastructure) To promote active mobility, the present infrastructure has to be of sufficient quality
Quality of PT infrastructure	(Socio-economic policy; transit improvements & public transit / The Compact City; distance to transit) To facilitate and promote traveling by PT, the present infrastructure has to be of sufficient quality
Spatial proximity of facilities	(Polycentric City Design; shorter distances; high density / Transit Oriented Development; zoning diversity) A function mix and high density shorten distances to facilities
Mix of functions	(Transit Oriented Development; zoning diversity) A mix of functions shorten average trip distance
High share of sustainable mobility	(Sustainable Urban Mobility Planning; all transport modes; travel demand management / Culture; car-centric) The area should be developed to have a high share of sustainable mobility and not be car-centric
Spatial proximity of mobility	(Socio-economic policy; equity; transit improvements & public transit / The Compact City; distance to transit / Transit Oriented Development; public transit) PT access points should always be in close proximity to promote use

The second 'tool' that is used to guide the discussion are the urbanization strategies. Two of these strategies have been shortly introduced in box 1 and 2. The projects to be assessed follow from these plans and are thus connected to the concepts therein. The conceptual framework tests for the relationship between the project plans and the urbanization strategies. The most reasonable approach in identifying sustainable mobility concepts would be to assess each of the urbanization strategies. However, these plans are only means to support the tool in guiding the discussion. They are not directly within the scope of the research question. The latter focuses on examining the presence of sustainable mobility in the assessment frameworks responsible for the divide of the funds. Examining the seven urbanization strategies in their full capacity is unlikely to yield the added value compared to the additional labor it requires. Therefore, the most direct approach to identifying these concepts is to focus on how the framework assesses the relationship between the plans and the urbanization strategies.

The link between project plans, the urbanization strategies and sustainable mobility, accessibility and positive externalities is explained by a line of text. Without delving further into the contents of these lines of text, it seems rather impossible to test for sustainable mobility concepts inclusivity in a plan without a more extensive analysis whether the same concepts live in the urbanization strategy.

The second part of accessibility value relates to improving the regional accessibility and externalities for the existing urban areas. The main criterium is how the regional accessibility increases as a result of (1) area development, (2) mobility investments and (3) alignment with the urbanization strategies. There are several indicators related to this criterium. One is the aforementioned text concerning the strategy.

Table 12 links these indicators with sustainable mobility concepts from the literature:

Table 12: Literature concepts in the regional accessibility indicator

Conceptual Framework regional accessibility indicator	**Sustainable mobility concept**
Increase accessible workplaces	(Transit Oriented Development; zoning diversity / Polycentric City Design; shorter distances; high density) Having existing facilities for work, shopping and leisure within short proximity
Increase citizens able to reach locations (incl. jobs) within reasonable travel times	(Transit Oriented Development; zoning diversity / Polycentric City Design; shorter distances; high density / The Compact City; vehicle hours traveled) Having existing facilities for work, shopping and leisure within short proximity. 15-Minute cities facilitate this
Line text explaining relation with urbanization strategies	(Sustainable Urban Mobility Planning; vision and participatory approach; all transport modes; reiterative process; travel demand management) Urban mobility has to be included in the plans from the beginning and form an important center point during the development
Percentage of developments realized before 2035	(Sustainable Urban Mobility Planning; vision and participatory approach) Urban mobility developments should be part of a vision

In a way, the indicators that explain this part of accessibility value are indeed relatable to some of the sustainable mobility concepts. However, the urbanization strategy, an important visionary document concerning how the regions' mobility should develop (relatable to the SUMP concepts) is represented by a line of text. A likely pitfall here is that, even though the strategies might be extensive and are indeed grounded in literature, the framework does not test for them thoroughly.

The third part of accessibility value relates to the impact on the IMA-challenges as presented in the descriptive analysis. The mobility infrastructure investments should not just add to the accessibility of the region, but also add to the overall mobility system and the challenges it faces. The main indicator for this criterium was discussed in the former subchapter. This was the target range of the mobility investment with respect to IMA-challenges. As far as sustainable mobility concepts are concerned, this does indeed show recognition of SUMP practices. Nevertheless, it proves difficult to dive deeper into this criterium concept-wise due to the lack of specifics as to how this target range operates. There are still the sub-criteria related to the IMA-challenges that could be translated to literature concepts. These are visible in table 13 below:

Table 13: Literature concepts in the IMA sub-indicators

Conceptual framework IMA sub-indicator concepts	**Sustainable mobility concept**
Capacity increase	(Socio-economic policy; equity; transit improvements & public transit / Mobility as a Service; public transit) To accommodate for increased use, the providers must have the capacity to carry the increased pressure
Alternative routes	(Intelligent Transport Systems; traffic control; traffic efficiency; driver assistance) Assisting drivers in taking alternate routes allows for dividing the pressure on currently blocked traffic arteries
Mobility transition	(Culture; car-centric; culture-shift) Fostering the mobility transition should ideally play a role in the project development
Alternative timeslots	(Socio-economic policy; e-commerce & teleworking) Allowing for employees to travel to work in different timeslots decreases the pressure on current traffic ecosystems during peak hours
Focus on PT (more than automobilism)	(Culture; car-centric; culture-shift / Mobility as a Service; public transit) There should be a larger role for public transit as opposed to automobilism

From a sustainable mobility perspective, that is the entire analysis of the relationship between the conceptual framework and the literature. The urbanization dashboard strongly represents numerous of the literature concepts, but is somewhat lackluster represented itself in the criteria and indicators in the framework. Still, some of the sub-criteria still represent literature concepts to some extent. It is difficult to assess how these sub-criteria relate to the final indicator of how urbanization is likely to change the movement patterns. This is because there is on elaboration in the framework itself. The urbanization strategies are likely to represent numerous sustainable mobility concepts. However, they are not analyzed further in this thesis because of a trade-off between added value and labor-time. Nevertheless, the way that these urbanization strategies and their potential concepts are represented in the framework is bottled down to a line of text in the project plans. The IMA-challenges relate to sustainable mobility and exist in the framework. However, are only represented by the aforementioned target range. Several sub-criteria concern the same indicator and have a connection with the literature, but again it remains unclear how these concepts are represented in said target range. There are other indicators in the framework that fall in the same range as the three tools presented above. These indicators are somewhat representable of sustainable mobility concepts. All in all, there is more to be done to align the conceptual framework with the literature. A recommendation will be presented after the analyses of the other assessment approaches.

4.3 Assessment of mobility in project acceleration

4.3.1 Explanation

The formerly discussed framework is used to assess the mobility aspects of the projects related to the seven NOVEX-regions. De Woningbouwopgave takes place throughout the entire country, also in areas outside of these regions. Therefore, another framework is necessary for the assessment of development projects that are located outside of the NOVEX-regions. Projects in the NOVEX-regions often need long-term guidance and preparation because of their larger size. Projects outside of these regions require an acceleration in development. An important requirement for these projects, is that they are in need of acceleration through funding for increased accessibility – developers must prove that a lack of mobility infrastructure is the reason that they have not been able to start construction yet. This type of financial support concerns project acceleration, making it an important part of the third line of action in the housing construction program.

In April 2022, the Ministry of Internal Affairs and the Ministry of Infrastructure and Water Management have asked municipalities to submit project proposals that fit that requirement. Based on a set of criteria, the first wave of infrastructure investments was agreed on during the BOL consultations in June 2022. During these consultations, 70 project proposals (outside of the NOVEX-regions) were assessed. 32 Of these proposals scored sufficiently. 38 Projects were kept on hold under the condition of co-financing, as they did not suffice the criteria. After the consultations of October 2022, all 70 projects were deemed to be of sufficient quality – except for one project (Weert, Hoornekwartier). This project was withdrawn by the corresponding municipality. This concluded the first round of infrastructure investments, ending up at an estimated total sum of € 1,2 billion, gathered under the Mobility Fund as a part of the total € 7,5 billion.

The second round of investments -not to be confused with the second half of the first round- is related to 35 new project proposals under the same requirements. These proposals were discussed during the MIRT consultations in November, leading to an official letter to the Chair of the House of Representative. In this letter, Ministers De Jonge (Housing and Spatial Planning) and Minister Harbers (Infrastructure and Water Management) discuss the results of the MIRT consultations. They introduce 35 new investments that sum up to € 300 million. Thus completing the € 1,5 billion allocated

under the Mobility Fund for 105 projects. It is important to consider that during the assessment of these projects, 'mobility' concerns accessibility by car, bike and public transit.

The criteria concerning these investments are documented in De Jonge's housing construction program. As discussed, the most important requirement is a lack of accessibility as major bottleneck for construction. The actual assessment following this selection concerns the following criteria:

- Construction has to start within three to five years after receiving the funding;
- Regional or municipal government have to take their responsibility for safeguarding the funding for the 'last mile' in the development. The national government's sole responsibility fund-wise is ensuring that the required infrastructure investments to *start* the project are there;
- The balance between the size of the required investment and the number of houses that will be constructed. The focus should be on locations that make sense and where additional resources and facilities are already present. This includes a (start of a) cohesive mobility network;
- The existing road network should be affected as least as possible. The future pressure on this system should not be disproportional to the number of houses to be constructed;
- Two-third of the houses should be in the affordable category, preferably;
- The urgency related to the shortage in the region and the regional performance agreements should be reflected in the project proposal;
- There is attention for climate resilience, green, ecosystems, water, an equal balance between work and residences. There should be awareness for air- and sound pollution and health.

More critical questions were asked after all projects finished the first round of assessment. These questions act as filters and are as follows:

- How strong is the relationship between the housing project and the infrastructure investments?;
- How high is the cost-effectiveness of the plan, depicted by the investment size per residence?;
- Is the projected location situated close to an IMA-area and is there any cooperation with other policies to benefit from externalities?;
- How realistic is the projected start of construction within three to five years?;
- To what extent is co-financing present and safeguarded during the project?

The 105 projects that came out of these rounds of assessment will make up for € 1,5 billion in infrastructure investments. They are responsible for an increase of 207.000 housing units throughout the country.

As becomes clear, the focus of these acceleration initiatives is short-term construction. These project plans were largely finished when the applied for funding to dissolve their infrastructure bottleneck. Because of that and the short-term focus, it is not the goal of the national government to nudge the projects towards sustainable mobility. Their main mobility-focus is that existing networks are able to carry the extended traffic load. Project areas should be are accessible by car, bike and public transit. However, the full list of infrastructure investments shows that sustainable mobility incentives are certainly present in the project plans (Ministerie van Infrastructuur en Waterstaat, 2022b):

- project Borger-Odoorn (Drenthe, +280 residences) receives funding for a mobility hub. This hub provides an efficient connection between private and public transit and shared mobility and biking facilities.

- Station Dordrecht (Zuid-Holland, +3.500 residences) required funding for safety and sound barriers to shield residential areas from the neighboring railroads. Additionally, these projects receive funds for a shared mobility hub, biking facilities and an active mobility zone;
- The projects Eemskanaalzone Stadshavens II / EKZ4 / Meerstad (Groningen, +2.250 residences) have been granted funding for infrastructure investments that lead to old industrial zones to become a mixed-function area with work and residential;
- Laakhaven Centraal (Zuid-Holland, +5.500 residences) will receive pedestrian infrastructure, a shared mobility hub and the opportunity to transform an industrial zone to a mixed-function area close to the central train station;
- Spoordok Leeuwarden (Friesland, +2.272 residences) will receive financial support for a mobility hub next to the central train station. The focus of the area will be on active mobility, connection to public transit and sufficient space for mobility incentives that will replace private mobility in the area completely.

These are just some examples of how the € 1,5 billion will be distributed among the projects to facilitate mobility infrastructure. There is a clear split in how these investments aim to increase the accessibility by car, or by public transit and active mobility. When making the distinction between sustainable and conventional mobility, the focus on (shared) mobility hubs strengthens the dominance of sustainable mobility over conventional mobility investments.

4.3.2 Interpretation

One thing has to be made clear before the analysis: these projects are required to start as soon as possible. They have been discussed extensively preliminary to the funding allocation already and are set in their designs. The reason that these projects have not been initiated yet, is a lack of mobility infrastructure. These projects have a short time-frame (construction has to start within 3-5 years of fund allocation). A lack of sustainable mobility will not be a bottleneck as long as the existing networks are deemed to be able to handle the increased use. Additionally, one of the most important mobility criteria is that developers account for IMA-challenges. Where € 1,5 billion and 207.000 new housing units are concerned, one could argue that that is quite a shallow approach. Yes, larger and accelerated construction is required. Not considering the importance of sustainability – at least to a lacking extent – equals wasting a great opportunity to foster the sustainable mobility transition. Nonetheless, there is some acknowledgement of the importance of futureproof mobility design in the indicator of the pressure on the existing systems. Despite that, it begs the question whether this leaves enough room for sustainable mobility and does not facilitate an automobilism lock-in even further.

The situation is not as dire as it seems. The assessment criteria for accelerating 105 development projects show policymakers' top-down view on mobility. However, these 105 projects show great incentives towards sustainable mobility themselves. These projects come forth from cooperation between the municipality and project developers that (aim to) operate within that area. Therefore, there is a clear bottom-up incentive in the scope of the acceleration program. The national government does not test for sustainable mobility in particular. Rather, they test whether the mobility infrastructure investments 'make sense' towards the existing plans. The actual sustainable mobility implementation is already included in cooperation with the project developers. The latter two require these mobility investments to initiate their projects, and they chose to opt for presenting sustainable mobility options during the application process. Naturally, these projects come forth from the urbanization strategies as they are in line with the region's development vision and the interference of the government is clearly visible. Still, the assessment criteria hold haste of construction in higher regard than sustainable mobility. The fact that sustainable mobility is still

represented by the project developers' plans is a great example of a bottom-up approach to the concept. However, it does not show incentivization from top-down.

4.3.3 Literature concepts in the acceleration program

The criteria for the acceleration program are divided into two rounds. The first round concerns the requirements of the projects to be eligible and the second round consists of filter questions. Both rounds include critical questions that relate to mobility. Table 14 shows these criteria and whether they relate to sustainable mobility concepts or not. For the sake of clarity, a distinction is made between criteria in the first and second round.

Table 14: Literature concepts in the acceleration program criteria

Acceleration program criteria	**Sustainable mobility concept**
Round 1	
The balance between the size of the required investment and the number of houses that will be constructed. The focus should be on locations that make sense and where additional resources and facilities are already present. This includes a (start of a) cohesive mobility network	(Polycentric City Design; shorter distances / The Compact City; design / Transit Oriented Development; zoning diversity) The infrastructure investment should support residential locations where facilities are already present and where they add to a cohesive road network
The existing road network should be affected as least as possible. The future pressure on this system should not be disproportional to the number of houses to be constructed	(Sustainable Urban Mobility Planning; all transport modes / Ownership; private; sharing economies / Culture; car-centric) Existing infrastructure (car, active and PT) should be able to handle additional traffic from new households with their own movement patterns
There should be attention for climate resilience, green, ecosystems, water, an equal balance between work and residences and there should be awareness for air- and sound pollution and health	(Environmental policies; air pollution & greenhouse gasses; noise; landscape & surroundings) Required attention for the impact of mobility on the quality of life, existing ecosystems and health
Round 2	
How strong is the relationship between the housing project and the infrastructure investments?	(Sustainable Urban Mobility Planning; vision and participatory approach; travel demand management / Culture; residential self-selection) The projected target group of the housing project, their mobility behavior and the built environment design should correspond to the infrastructure investment
Is the projected location situated close to an IMA-area and is there any cooperation with other policies to benefit from externalities?	(Sustainable Urban Mobility Planning; vision and participatory approach / Environmental, socio-economic and technological policies in general) The project should be in line with corresponding IMA-challenges and the vision they ascertain. Other policies support creating positive externalities

Essentially, the criteria that are closely related to mobility show a connection to concepts from the literature. A large sum of capital investments is at stake and this assessment approach is the main hurdle for the project developers to overcome. A set of questions might not be the most thorough approach to safeguard sustainable mobility. As explained before, however, assessing for sustainable mobility in the plans was never the goal of the acceleration program. Because of the speed-requiring nature of the projects, the mobility infrastructure investments in the plans are not prone to change. The approach itself is not designed for that. Still, some relationships with the literature exist. This is shown in table 14. Together with the bottom-up incentives, strengthening top-down assessments with a literature background ensures that sustainable mobility is represented in the accelerated project developments.

4.4 Assessment of mobility in the Woningbouwimpuls (Wbi)

4.4.1 Explanation

In March 2020, the Parliament agreed on the policy for the Woningbouwimpuls (Wbi). The Wbi is a type of funding for housing development projects to accelerate development and alleviate any barriers to construction. The focus of the Wbi is not on funding the actual construction. It provides investments in public goods that facilitate the projects, including infrastructure and soil remediation. These types of investments often fall outside of the initial development cost, but are required for a project nonetheless. Due to the large size of the sums, investments in infrastructure and soil remediation often lower development profits. This leads to potential stagnation or cancellation of the project. This is where the Wbi steps in (Rijksdienst voor Ondernemend Nederland, 2020).

In the housing construction program, Minister De Jonge announced two more tranches of the Wbi to assist in the third and fourth lines of action. Up until halfway September 2022, municipalities submitted projects that needed additional funding to become profitable. Wbi-eligibility follows these criteria:

- The project is located in a designated area that fits the residential function;
- The project concerns a minimum number of houses (for municipalities with less than 50.000 citizens, 200 new residences is the minimum. For municipalities with a size of over 50.000 citizens, the minimum is 500);
- At least 50% of the new housing units will fall in the affordable category;
- Construction has not started yet, but will start within three years after receiving the subsidy;
- The project contributes to a significant housing deficit in the area;
- The infrastructure that requires the investment is of paramount importance to starting the project;
- A maximum of 50% of the required costs is covered by the Wbi. The other half has to be facilitated by the municipality;
- The project plans have to be complete. This is tested by The Netherlands Enterprise Agency (Dutch: Rijksdienst voor Ondernemen Nederland, RVO).

After the selection procedure, a review committee examines the project proposals with a twofold approach. During the second part of this approach, the committee focuses on mobility. This examination is supported through external expertise. The first examination is that of a business case, conducted by five independent consultant bureaus. These five bureaus all create their own analysis of the business case surrounding the project, before it is reviewed by their peers. The second analysis happens from a mobility perspective. A mobility scan will be conducted by either of two mobility consultant bureaus (Goudappel & Studio Bereikbaar) together with the Ministry of Infrastructure and Water Management. During this mobility scan, the consultant bureau examines whether the project plans are in line with currently present infrastructure. They also check for alignment with potential future infrastructure development plans by the municipality and MIRT.

The actual assessment of these plans comes down to three central questions and is thus of a qualitative nature. The responsible consultant examines the plans in the application by answering these tree questions:

- **Project level:** is the projected mobility behavioral profile of the target group and the project plans in line with the currently present infrastructure that is likely to be used by the new citizens?;
- **Network effects**: relating to the mobility profile of the project and the type of housing units to be built, to what extent is the currently present infrastructure sufficient in bearing the additional load from the new citizens?;

- **Network effects:** to what extent is the project in line with the agreements between the municipality and the MIRT?

These questions are answered through expert judgement and are of a qualitative nature. The consultants can execute the scan within a couple of hours. It is mainly used for a general assessment of what the mobility situation will be like. Therefore, the assessment is not targeted at sustainable mobility specifically. The scan does no concern the details of the plan but rather whether the alignment with surrounding infrastructure and future development plans.

4.4.2 Interpretation

The mobility assessment of the projects that apply for funding through the Woningbouwimpuls occurs through a mobility scan. This mobility scan is conducted by one or two mobility consultants after the developer proved that the mobility investment is required for the project to start. This scan consists of a quick assessment of three questions. The first question discusses the profile of the projected target group and alignment with the current mobility infrastructure (1). The second question concerns the current infrastructure quality and capacity to support the increase in use (2). Question number three focuses on the required infrastructure and alignment with existing agreements (3). This assessment approach has efficiency as its main benefit. The entire assessment is designed to be conducted within four hours. On a first glance, there is not a lot of recognition for sustainable mobility. These questions are not sufficiently inclusive to support that. Developers of a project including sustainable mobility receive funding based on the surrounding infrastructure and if current agreements align with the MIRT. The latter often concerns sustainable mobility already. Both the MIRT and the municipality are included in the cooperated development of the urbanization strategies. These strategies could be viewed as examples of 'current agreements' in question three. If any concepts of sustainable mobility are clearly present in the strategy, the infrastructure development might still align with a sustainable development mindset. The first question, relating to the profile of the target group, could also be beneficial for sustainable mobility when interpreted right. The mobility profile that is discussed here relates to residential self-selection: people choose to live in an area that reflects their preferred behavior. This also considers mobility. When the projected target group has a mobility profile of a sustainable nature, the question changes. The question is now: is current infrastructure supporting sustainable mobility to a sufficient degree so the project development and the accompanying target group (with a sustainable mobility profile) will land correctly? If this would be the case, the investment might not be necessary and sustainable mobility is already facilitated in the area to a certain extent. Would this not be the case, the investment is likely to facilitate sustainable mobility infrastructure to increase the support in the development area. As such, there could be incentives for sustainable mobility bottom-up. Project developers could have target groups with sustainable mobility profiles or ask for sustainable mobility infrastructure investments. Simultaneously, the urbanization strategies and their sustainable mobility prospects influence the top-down decision to let the infrastructure investment develop the area in a certain direction. The plans that apply for the Wbi are already finalized and need additional infrastructure funding to start. In that sense, these plans are developed further than the ones applying for the acceleration program. Another notable difference is the high urgency of development in the acceleration program.

4.4.3 Literature concepts in the Woningbouwimpuls

Sustainable mobility inclusion in the assessment approach of the Wbi is tested for in the second round of the overall assessment. In the first round, the only mobility-related criterium is that the infrastructure investment is paramount to solving a bottleneck to the beginning phase of the project. After policymakers' consideration for the Wbi, the mobility scan and the business case assessment phase starts. During the mobility scan, the

consultant focuses on three main questions to assess whether the project should receive funds from the Wbi. These three questions relate to literature concepts, as shown in table 15:

Table 15: Literature concepts in the Wbi Mobility Scan

Wbi Mobility Scan assessment question	Sustainable mobility concept
Project level: is the projected mobility behavioral profile of the target group and the project plans in line with the currently present infrastructure that is likely to be used by the new citizens?	(Culture; residential self-selection; mindset) the infrastructure investment should reflect the mobility behavior of the target group
Network effects: relating to the mobility profile of the project and the type of housing units to be built, to what extent is the currently present infrastructure sufficient in bearing the additional load from the new citizens?	(Culture; residential self-selection; dissonance / Ownership; private or sharing) the existing infrastructure might or might not be already supporting the projected behavior
Network effects: to what extent is the project in line with the agreements between the municipality and the MIRT?	(Sustainable Urban Mobility Planning; vision and participatory approach) the infrastructure investment in the project should be in line with the mobility vision for the area

The mobility scan indeed relates to concepts from the literature. However, these concepts mainly concern vision, planning and the mindset or mobility behavior of the projected target group. This approach is designed to be executed within four hours and is therefore not designated to delve into the details of how sustainable mobility is represented. The nature of the questions makes one relate to the socio-economic (e.g. behavior and culture) aspect of sustainable mobility. If the projected target group indeed has a sustainable mobility behavior, the assessment would test whether the required infrastructure would support sustainable mobility. Were this not the case, a potentially unsustainable investment is the result. The same goes for the third question. That question concerns the alignment with overarching development plans. Yes, the Wbi mobility scan assesses mobility in a way that is relatable to some of the literature concepts. However, it does not test for sustainable mobility in top-down governance. The relation to sustainable mobility concepts must be included in the project plans, preliminary and bottom-up, for the framework to recognize them and affect the decision.

4.5 Assessment of mobility in the Mobility Transition Menu

4.5.1 Explanation

In the former subchapters, the focus was on frameworks and assessments for projects that required funds. In theory these projects were ready to be realized. What about future plans? How do these plans support the sustainable mobility transition? Even more so: how should governments on all levels assist in the fostering of this transition? The MIRT has created a tool that assists in this where future development projects are concerned. The mobility transition menu assists municipalities in guiding their future development projects in cooperation with project developers. In the ‘menu’, policymakers follow these views on transition:

Goal

What is a transition towards sustainable mobility? It is described as an increase in accessibility for citizens in the same (or even smaller) space and a larger share for active mobility in daily mobility systems. A sustainable mobility transition has a positive effect on real estate and mobility value and is an important step in general development. Some of the leading principles are spatial proximity, 15-minute cities, efficiency of traffic and energy usage and a balanced mixture of active mobility, public transit and sharing economies.

Principles
To what extent do residential projects add to the fundamentals of a mobility transition? Spatial proximity plays a major role here, as the aim is to build where facilities are already available and able to carry an additional load. Each residential construction project should be examined from a mobility point of view. Next to what is described in the requirements and performance agreements, this includes the urban context, existing facilities for work, shopping, leisure and mobility. After this assessment, all three levels of government discuss the appropriate mobility measures to foster sustainable mobility alongside the housing development.

Process
How do the differences between processes and measures affect the mobility transition? The process starts with creating a coherent vision that is shared between all involved parties. During the process, the entire spectrum of possibilities needs to be considered and duly covered where possible. The scale of the project and mobility developments plays a role in this, and provides opportunities for positive externalities. Decisions should be made based on data to predict and assess outcomes. Measures should support this vision. They need to be coherent, preferably covering the entire solution spectrum and have a measurable output;

The section *measures* discussed in the former paragraph deserve some more attention. The menu provides a fivefold set of fields of action where these measures relate to. The first focuses on active hierarchy and discusses the role of cycling and walking and decreasing the dominance of automobility in urban spaces. The second field concerns sharing economies and answers the question on how to decrease space occupation of moving and stationary vehicles. Private or shared vehicle ownership plays a role in this. Thirdly, the focus is on parking solutions. Building on that, the amount of space occupied by moving and stationary vehicles is of major importance here. Parking occupies a significant amount of space in urban areas and is often mandatory in development projects. This field of action also looks at alternative uses that could potentially replace parking spaces. Fourthly, healthy environments are discussed: how can the environment foster a higher quality of life? This concerns sound, emission, safety, and visuals of the urban environment, but also the design for active mobility. The fifth and last field of action focuses on logistics and how a development projects accounts for logistics. It occurs at a larger scale than just the project area, as it concerns the logistics and supply chain of an entire city. Based on the contextual analysis, these fields of action provide accurate measures that fit the mobility requirements of the new project. This allows them to foster the mobility transition align with the regional development vision and the MIRT.

4.5.2 Interpretation
Where the former approaches and frameworks focused on existing projects, the mobility transition menu exists to guide new developments. The title already provides the reader with an idea of the mindset behind the menu. The mobility transition as they define it, better accessibility for more people in the same space and a larger role for active mobility, is at the center. The strong focus on spatial proximity, avoiding long-distance trips and promoting active mobility emanates sustainable mobility. The menu provides five focal points. These points (active hierarchy, sharing economies, parking solutions, healthy living environment and logistics) give municipalities and project developers ideas to support sustainable mobility in projects and general area development. This is clearly a top-down approach the government uses to positively affect the mobility transition and sustainable mobility as a whole.

Due to the novel nature of the menu, it is difficult to assess the effect it has on the sustainability transition. However, it does indicate that the principals and stance of the national government are in favor of sustainable mobility where possible. The MIRT has a major role in communicating this between all levels of government. The mobility

transition menu is a progressive tool for this. As of now, that is what the menu is: a tool to guide a discussion or designs. Since it is not directly linked to a funding structure, the power it has is quite little. However, the mindset that emanates from it is likely to be reflected in future project designs together with the urbanization strategy. Therefore, the funding structures and their assessment approaches that are relevant in the present are likely to experience the effect of the menu in the future.

4.5.3 Literature concepts in the mobility transition menu

The mobility transition menu offers municipalities and project developers handles as to how their projects could foster the sustainable mobility transition. The menu emanates sustainable mobility. Table 16 shows the identifiable sustainable mobility aspects from the menu and how they correspond to concepts from the literature list. The concepts are registered under the main section of the menu they belong to.

Table 16: Literature concepts in the mobility transition menu

Mobility transition menu concepts	**Sustainable mobility concepts**
Goal	
Mobility transition	(Culture; car-centric; culture-shift) fostering the mobility transition and shifting away from a car-centric culture
Build in close proximity of facilities and jobs	(Transit Oriented Development; zoning diversity / The Compact City; density) building in close proximity of developed urban areas provides better use of existing facilities
Accessibility through 15-minute cities	(The Compact City; vehicle hours traveled; density / Polycentric City Design; shorter distances) 15-minute cities and accompanying shorter distances decrease vehicle hours traveled
Equity in mobility	(Social policy; equity) everybody has the right to mobility of the same quality
Principles	
Density-related urban mobility	(The Compact City; density / Polycentric City Design; shorter distances) the density of an urban area affects trip length and mobility behavior
Mobility behavior based on urban structures	(The Compact City; density; design / Polycentric City Design; shorter distances) the design of an urban area affects mobility and creates different movement patterns
Process	
Coherent mobility development vision	(Sustainable Urban Mobility Planning; vision and participatory approach; all transport modes; reiterative process; travel demand management) a shared and coherent mobility development vision is a requirement to intertwine sustainable mobility and urban design
Mobility development on different scales	(Sustainable Urban Mobility Planning; vision and participatory approach; all transport modes; reiterative process; travel demand management) since mobility development occurs on different scales, this should be accounted for during the design phase. All levels should cooperate with each other
Data-driven mobility decision-making	(Sustainable Urban Mobility Planning; travel demand management; Intelligent Transport Systems; traffic control) data is used to argue in favor or against certain mobility development decisions
Measures	
Active hierarchy	
Active mobility	(Environmental policy; active mobility promotion / Polycentric City Design; active mobility / Transit Oriented Development; active mobility) active mobility is seen as intrinsic sustainable mobility due to the lack of fossil fuel use and provides health benefits
Promoting public transit use	(Socio-economic policy; transit improvements & public transit; pricing, taxes & incentives / Polycentric City Design; public transit / The Compact City; distance to transit / Transit Oriented Development; public transit)

	promoting public transit is likely to increase the use and thus foster a sustainable mobility transition
Multimodality & shared mobility	(mobility as a Service; multimodality; sharing economies / Technological policy; shared mobility) multimodality serves as a replacement for automobilism on middle- to long-distance trips. Shared mobility adds to that, but is also used for short distance trips
Private ownership	(Ownership; private or sharing) there are numerous downsides to private ownership of vehicles that are alleviated by introducing shared vehicle economies
Reducing trips by working from home	(Socio-economic policy; e-commerce & teleworking) promoting working from home decreases the number of hours traveled and lowers the need for mobility
Sharing economies	
Multimodality	(Mobility as a Service; multimodality) multimodality serves as a replacement for automobilism on middle- to long-distance trips
Shared mobility	(Mobility as a Service; sharing economies / Ownership; private or shared / Technological policy; shared mobility) promoting shared mobility is likely to lower private mobility and increase mobility opportunities
Smart mobility hubs	(Mobility as a Service; ICT; sharing economies / Technological policy; shared mobility; intelligent transport systems) smart mobility hubs promote traffic efficiency and provide new mobility opportunities in sharing economies
Mobility as a service	(Mobility as a Service; public transit; sharing economies; ICT; multimodality / Technological policy; shared mobility) MaaS is a sustainable form of transport combining sharing economies and public transit and making it available on one platform under one fee
Space used by stationary vehicles	(Culture; car-centric / Ownership; private or sharing) stationary vehicle take up space in the built environment that could be put to other uses
Parking	
Parking regulations	(The Compact City; design / Ownership; private or sharing) parking regulations affect the design of the built environment and either increase or decrease the space occupied by parked cars
Parking costs	(Socio-economic policy; pricing, taxes & incentives) the height of parking costs affects the incentive to park in a certain area
Healthy environment	
Emission & pollution	(Environmental policy; air pollution & greenhouse gasses; eco-driving; noise; landscape & surroundings) mobility affects the environment through emission and pollution. Policies and subsequent effects of these policies on the built environment reduce the negative effects
Charging infrastructure & EV	(Alternative fuels; (PH)-EV; HFC; LFG / Technological policy; fuel alternatives / Culture; residential self-selection) including infrastructure for alternative fuels (e.g. charging stations or EV-lanes) incentivizes or attracts people with sustainable mobility behavior to an urban area
Safety	(Socio-economic policy; safety) safety of all traffic participants should be held in high regard in the built environment
Sound	(Environmental policy; noise; landscape & surroundings) sound pollution as a result of mobility has adverse effects on health and surroundings and should be mitigated where possible
Logistics	
Urban logistics	(The compact city; design) the design of the built environment affects urban supply chains by opening or blocking important traffic arteries
Efficient logistics	(Intelligent Transport Systems; traffic efficiency) informing logistical traffic about their routes directs them through urban areas as efficiently as possible

Clearly, the mobility transition menu offers a plethora of options and handlebars that relate to the current literature base. The options range between all four of the main concepts and provide an all-round view on what the sustainable mobility opportunities in the built environment are. These concepts will be introduced to municipalities and project developers to assist in their urban development. In the case that the concepts are received well and accepted into practice, we are likely to see them implemented in the built environment. The frameworks and assessment approaches above will do so too, just as potential new approaches down the line.

Essentially, there are four main assessment approaches. These include the conceptual framework, the acceleration program criteria, the Wbi criteria (including mobility scan) and the mobility transition menu. Then there is the distinction between NOVEX- and not NOVEX-regions, as well as the idea of existing and upcoming projects. The transition menu concerns the latter. Figure 8 should be able to clarify this funding structure a little better. To read figure 8 correctly, one should start on the left and follow the blue arrows.

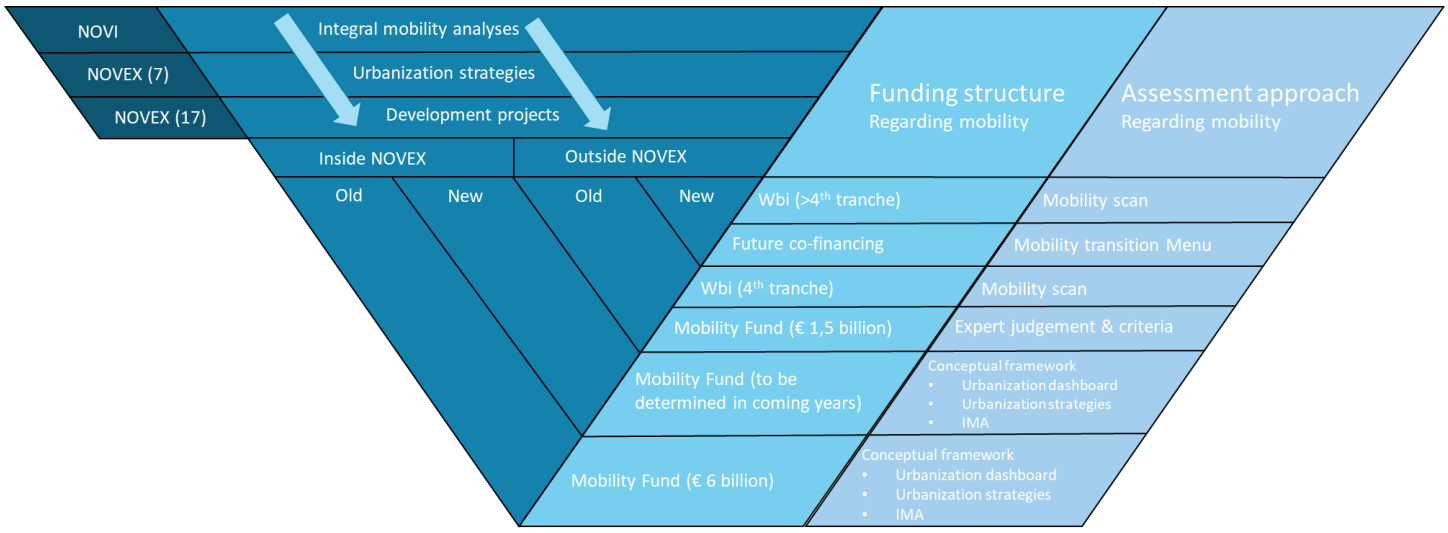


Figure 8: Assessment structure for mobility in De Woningbouwopgave

Both the NOVI and the IMA operate on a national level. NOVEX is one layer below that and operates on a larger regional level, together with the urbanization strategies. Below that are the seventeen NOVEX development regions with the development projects existing both in and outside of those regions. These projects are new, old or existing. This depends on the time of interpretation. Per typology (new versus old and in versus outside of NOVEX) are the funding structures concerning mobility and infrastructure investments as described before. Each of these structures has their own assessment approach for mobility.

4.6 Conclusion on assessment methodologies

The former subchapters discussed the frameworks and approaches, their interpretation and their relation to the literature. The coming paragraphs will provide the conclusion on a main part of the research question as posed in the introduction. This section discusses how the sustainable mobility insights from the literature could be used in the assessment phase of the projects related to De Woningbouwopgave.

Each of the frameworks and assessment approaches have been assessed. The first and probably the most elaborate framework is the conceptual framework related to the large NOVEX-regions. Comparison to the literature has found that the urbanization dashboard, a tool that supports the conclusions of the framework, has the closest connection to the literature. Despite this connection, the framework itself summarizes the support of the dashboard into three questions. These questions have the same focus: how do movement patterns change as a result of urbanization through the urban development? This is indeed a concept or subject discussed in the

literature. However, it nullifies the exactness of the dashboard in its connection to the rest of the literature. The sub-criteria in the elaboration on the framework add some connection to the literature. Still it remains unclear how this is represented in the final indicator related to the main criterium. The second main criterium discusses the connection between the regional urbanization strategies and the project plans. Even though the strategies are likely to have a strong connection to the literature, they are only loosely represented in the framework. Other questions concerning this subject are somewhat related to the literature, but that subject section stands or falls with how the strategies are represented. The third main criterium focuses on the relation between the project plans and the IMA challenges. The latter are represented in the framework by a target range in which the infrastructure developments are placed. This is still rather vague when it comes to how the IMA challenges – explanations on how mobility provides opportunities and problems in the built environment – are represented in the project plans. Again, there are several sub-criteria that relate to the literature, but explanation on how these are represented in the third main criterium is lacking. Therefore, it is difficult to assess to what extent these concepts make it to the final discussion. This is especially the case because, even though they relate to a main criterium, the indicator for this criterium does not discuss the sub-criteria specifically. This vagueness of organization and assessment makes it rather difficult to get a clear idea of how the literature is actually represented.

Not so much as a framework, but more of an assessment approach is set of criteria for the acceleration program. Due to the nature and the need, efficiency is of the essence. The two rounds of the assessment are more or less related to sustainable urban mobility planning and have more of a 'design-process' connection to the literature. Even though this does not particularly prove a strict top-down search for sustainable mobility in the plans, this was never the intention. From a bottom-up perspective, the project plans show great incentives towards sustainable development and are likely to relate closely to the literature. The majority of the infrastructure development investments relate to sustainable mobility rather than promote conventional automobility (Rijksoverheid, 2022). Despite the lack of a top-down pressure from the government, the funds were allocated to sustainable mobility infrastructure developments. This indicates that the sustainable mobility mindset is thoroughly present both top-down (by allocation) and bottom-up (by nature of the infrastructure).

The Woningbouwimpuls (Wbi) is the third assessment approach that was examined. After the initial application procedure, a mobility scan is conducted. During this scan, three questions are answered. These three questions do in turn relate to the literature on sustainable mobility. They mainly concern culture, mindset, mobility behavior and vision and how these relate to the existing and projected built environment infrastructure. Yes, these questions and therefore the approach relate to the literature; no, this does not guarantee that sustainable mobility is fostered by the infrastructure development. This is based on the projected mobility behavior and the nature of the infrastructure development investment required for the project. Again, this indicates that the sustainable mobility incentives lies with the project developer and the municipality: bottom-up rather than top-down.

The fourth and last approach is less of an assessment and more of a guiding approach. The mobility transition menu focuses on delivering the message of sustainable mobility and transition to municipalities and project developers. They are urged to take that information with them for future endeavors. Each segment of the menu is strongly based on the literature. This poses high hopes for these future projects where sustainable mobility is concerned – granted that the message lands correctly. The menu aims to create awareness and a shared vision on how sustainable mobility is implemented to foster the mobility transition. Out of all four approaches (the conceptual framework included), the mobility transition menu relates

closest to the literature on sustainable mobility in the built environment.

Overall, there exists a mindset of sustainable mobility in the assessment approaches for development projects in De Woningbouwopgave. This mindset is mainly shown by the urbanization dashboard, the strategies and the mobility transition menu. Despite the mindset, sustainable mobility in the built environment does not seem to hold steadfast in all of the assessment approaches. This is ascribed to the nature of the funding structure where acceleration of projects is concerned. Considering the Wbi, to the dependence on the target group and nature of the infrastructure. The main bottleneck for sustainable mobility in De Woningbouwopgave lies in the conceptual framework. Even though the urbanization dashboard and the regional strategies relate to the literature, their representation does not accomplish the same goal. Disregarding that the framework is a tool to guide discussion rather than to be a technocratic decision-maker, it remains difficult to guide a discussion with only a part of the relevant information at hand. Some ideas and concepts from the literature are present, but the majority is underrepresented. Since the framework is used to distribute € 6 billion under the Mobility Fund, the mobility transition would profit from coherent and literature-accurate sustainable mobility fostering. This only concerns the current round of investments. In the future, a larger budget is likely to become available. Just as with the tranches in the Wbi.

5. Sustainable mobility concepts in the design phase

This section identifies the suitability of each set of concepts in design scenarios. These scenarios are based on stakeholders and their design criteria following value propositions. Through these criteria, design problems are identified. To solve these design problems, an Analysis of Interconnected Decision Areas (AIDA) approach is applied. Each design problem is given a tailored solution constructed from sustainable mobility concepts. This is where the second section of the bipartite guidance recommendation starts. The chapter starts with a stakeholder analysis, followed by design criteria and an elaboration on the AIDA method, before introducing the results.

5.1 Stakeholder analysis and alignment

This national housing crisis affects every citizen of The Netherlands. Such a vast housing development quest concerns numerous involved parties. These parties have their own value propositions. All involved parties are required to cooperate and potentially partly compromise where the ideal of fulfilling all value propositions is impossible. The following paragraphs will explore who these involved parties are. It discusses their value propositions and how urban planners translate these propositions to criteria for design problems.

To create a cohesive and concise list of involved stakeholders, some perimeters are required to serve as limits to research. Since the housing challenge is of an enormous size, it proves useful to set a scope. Referring to the former chapters, the sustainability concepts will have to be implemented on a project level. Therefore, the stakeholder analysis will focus on all parties and groups of individuals that are affected by urban development projects. This also includes the mobility infrastructure part of the project, as mobility and De Woningbouwopgave are both at the center of this thesis. Therefore, mobility-related stakeholders should be involved. Table 17 shows the stakeholders. Consider that there is a range to what extent stakeholders are involved with both De Woningbouwopgave and mobility. Stakeholders sometimes occupy both and prefer value created from both perspectives. These groups are denominated with an asterisk.

Table 17: List of stakeholders

Stakeholder	Value Proposition
De Woningbouwopgave The following stakeholders are directly related to the housing challenge and the solutions thereof.	
Government (national)*	The national government established that there is a dire need for new housing. Since housing is seen as a primary need for a country's citizens, the national government has a valuable position in providing for their citizens. Therefore, their value proposition is based on solving the Dutch housing crisis. The national government is also responsible for identifying the IMA challenges and has a major role in the MIRT.
Government (provincial)*	The provincial governments aim for a similar goal as the national and municipal government, but on a provincial scale. The provincial governments' value proposition is to solve the housing crisis in their province and to foster the development of the province from a socio-economic perspective. Mobility-wise, the government would like to see regional challenges solved and accessibility increased.
Government (municipal)*	The municipal government also aims to solve the housing crisis. They aim to provide housing for existing citizens, attract new ones, create jobs and bring welfare to their municipality. From a mobility perspective, the municipalities benefit from high accessibility levels and having their challenges resolved.
(Social) housing corporations	(Social housing) corporations aim for accessible, affordable and durable housing and to create stability for the people in financial need.

Real estate developers	Real estate developers in the housing market aim to create new housing projects. By executing their job and delivering on such a housing project, they not only create housing for people in need, but also aim to make a profit and therefore prolong the vitality of their development company.
Construction companies	Construction companies generate value by constructing the (housing) projects that are initiated so solve the housing crisis. Similar to the real estate development company, by executing their jobs, they generate a profit and thus prolong the vitality of their construction company.
Dutch citizens (established)*	The group of Dutch citizens that is already established and has a dwelling that suits their preferences wants to have their QoL remain the same first and foremost, or improve due to surrounding developments.
Dutch citizens (searching)*	The Dutch citizens that require housing have a clear value proposition: to have an accessible, affordable and durable space to live that suits their preferences.
Investors	Investors aim to make a profit by investing in real estate development projects and expecting a return on investment. The projects they invest in have to align with their vision and ambition and have a profitable outlook to interest investors.
Environmental organizations*	Environmental organizations personify the group that aims to preserve the environment and protect it from the effects of new housing development projects. This aim is related to housing construction as well as new mobility developments such as highways and railways.
Land owners	Land owners currently hold the land that is suitable for development. Indeed, governmental institutions can be landowners themselves and thus potentially speeding up the process. Where this is not the case, the landowners will try to optimize their gains from the sale, or decide not to sell at all if it does not suit their preferences
Mobility The scope of this research is sustainable mobility in regards to the Dutch housing challenge. In addition to the groups above, there are some stakeholders that have to be included because they are indirectly related by the Dutch housing challenge and are within the scope of this research.	
Public transit operators (public)	Public transit operators aim to generate a profit to prolong the vitality of the company by providing public means of mobility to its users. Therefore, they generate value by engaging in contracts with different levels of government to allow them to provide this mobility to society.
Public transit operators (private)	Private public transit operators similarly aim to generate profit to again prolong the vitality of the company. They do so by providing mobility according to a more private-based business model.
Shared mobility providers	Shared mobility providers provide shared means of mobility to society. Through this business model, they generate a profit that helps to develop the company and prolong the vitality.
Mobility activists	This group represents the value propositions of a certain mobility mean (e.g. walking or cycling associations). They would like to see their preferred mean to be able to make safe use of the new infrastructure.
*: these groups additionally benefit from a well-developed and sustainable transportation network for different reasons: there are stakeholders that aim to provide mobility infrastructure (government), mobility itself (mobility providers) and those that benefit from it (society, citizens). Therefore, their value propositions extend beyond the limits of purely providing and requiring housing.	

The involved stakeholders described in table 17 have different value propositions, with some overlap here or there. Essentially, they all would like to see the housing crisis solved and for more accessible, affordable and sustainable housing to be created. In doing so, they have different levels of influence and levels of interest. Because of that, there might be conflict between the involved stakeholder groups concerning how their value proposition is safeguarded. Consider the premise that established citizens aim to maintain their QoL or see it improved if possible. Large housing

development projects come with years of preparation and construction, as the developers aim to create housing for the people in need. This might temporarily impact the QoL of the established citizens. Therefore, compromises might have to be made to align value propositions of different stakeholder groups. There are also some differences in where conflict exists. Consider the following example. Even though real estate developers as a group want to create housing projects, developers within the group would like to see their own projects be realized before others. These projects and their overseeing developers have to apply for the same set of subsidies. Even more so, they might want to develop the exact same areas differently. Therefore, this is an example of how conflict does not only exist between groups, but within as well.

A similar situation exists on a municipal scale. Multiple municipalities might want to attract funding for a project development in their own area to further develop the municipality. Another example exists on a more regional scale: when looking at the different NOVEX-regions, they clearly overlap provincial boundaries. Therefore, provinces cooperate to fulfill the required construction quantities per region. Chains of command, geographical development locations and funding allocation lead these consultations.

There is less direct conflict on a higher, overseeing level: all parties want the housing crisis to be resolved as effectively and cost-efficient as possible. However, conflicts start to appear when zooming in on a region- or municipality-level. Take for instance the land allocation for development projects. A real estate developer aims to transform an empty plot of land into a residential area. They create a plan that is aligned with the government vision and want to investigate the location as soon as possible. Included in the matter are also the public transit operators that have region-wide contracts with the government. With an increase in households in the area, new public mobility access points have to be included next to the automobilism. However, the plot of land is located next to an existing residential suburb and currently houses some livestock and has an agricultural function. Even though the plans are aligned with the municipality, there are still other stakeholders that are directly affected by this development. Existing citizens experience tumult from the construction activity for the coming years. This negatively affects their QoL through noise and visual pollution, construction dust and increased mobility in their formerly quiet suburb.

Additionally, environmental organizations prefer the preservation of agricultural land. Not only will the plot of land change in function, development also produces an increasing. This negatively affects the surrounding areas in return for increased accessibility. Related to the latter are also the landowners in the municipality. First of all, the owner of the discussed plot of land, but second of all the owners of the surrounding plots. They will see the value of their plots change and it is unclear whether or not this change will be beneficial to them. One should keep in mind that De Woningbouwopgave is heavily politically influenced. Value propositions as well as decisions may therefore be under the influence of politics as well. This could cause conflicts of both a substantial nature (e.g. in favor or against developments due to their impact on sustainability or the market value of the area) or be more political (e.g. not wanting to cooperate with a party or having political public relations in mind).

Looking at stakeholders on the project level is not conventional. Experience shows that stakeholders are much rather likely to be divided into three different groups: user, society and enterprise (USE). It is useful to study De Woningbouwopgave as a whole from these three different, overarching perspectives.

User

The stakeholder group *user* consists of all the entities that directly benefit from an increase in sustainable urban mobility. This includes the direct users, such as the existing and future citizens of an area. Additionally, this group covers mobility

activists and potential non-governmental organizations that relate close to sustainable urban mobility. This stakeholder group seeks benefit from an increase in sustainable mobility as an accompanying result of residential development They prefer to be able to practice their preferred mobility behavior. With more mode options represented and access points or infrastructure present, the user will be able to go about their tasks the way they want to.

Society
This stakeholder group is on par with the different levels of government, how they govern over the public good and the entities that are directly affected by that. The government makes decides over public good. Considering De Woningbouwopgave, fostering an increase in housing construction units and consequent sustainable mobility improvement would be beneficial. Society benefits from solving the housing crisis. They aim to see people have suitable housing, cities and neighborhoods become well-developed, the housing market to be balanced and their QoL to remain or improve. In a way, the entirety of society is seen as a stakeholder.

Enterprise
Commercial parties make up for the *enterprise* group of stakeholders. This typology does not only include transportation providers, but also the project developers that are responsible for the construction projects. Enterprises benefit from practicing their business proposition. For a mobility provider, this proposition is to generate a profit by providing mobility to people and to maintain and increase their service area, for example. For project developers in De Woningbouwopgave, the main proposition would be to create residential areas and dwellings, preferably in cooperation with the municipality, to generate profit. Inherent to market mechanics, conflicts arise here. This also concerns sustainable mobility. For example: if an area is designed with a focus on public transit, the contracted public transit provider benefits from this development by servicing more customers. However, road construction companies would much rather prefer a focus on automobility and a design including multi-lane streets. Contrarily to the other two groups, stakeholders in the *enterprise* typology are less likely to be aligned directly.

Table 17 shows that the USE-typology is not the categorization of stakeholders that is used. This decision was made for the following reason. The USE-base typology is easily applied to the national scale of De Woningbouwopgave. As described in the former paragraphs, one can indeed identify how the three perspectives view sustainable mobility. However, the goal of the stakeholder analysis is to identify value propositions of specific stakeholders on a project level. This, to translate and use them later in the next sub-chapter that focuses on the design problem. It proves to be difficult to translate the broad (and often internally contradicting) value propositions into design criteria. Yes, it is indeed possible to allocate the chosen stakeholders to either of the three typologies. The former paragraphs are proof of this. However, this does not hold significant value as to how they will be used later. To summarize: discussing De Woningbouwopgave as a whole is useful from the USE-base stakeholder perspectives, but these typologies fall short in the method and scale stakeholders will be used.

Conflict on project-level is more easily identifiable than on a national scale. To solve the housing crises without compromising numerous value propositions, a cohesive mediation and negotiation process is required. Combinations of these value propositions pose design problems for mobility in the built environment. Each of the involved stakeholders potentially views their value propositions as endangered. They could present one or more criteria that the developers should suffice in the design to safeguard the propositions.

These criteria form a design problem with design criteria. The content of these criteria will always be context-dependent, but it is possible to approximate them by looking at the stakeholders' value propositions. Table 18 presents each mobility-

related stakeholder and their potential design criteria considering sustainable mobility in the built environment on a project-level.

Table 18: Stakeholders and design criteria

Stakeholder	**Design criterium** (With respect to sustainable mobility, the project should…)
Government (national)	Add to the IMA challenges and climate goals (reduce CO_2)
Government (provincial)	Increase accessibility of the region and be in line with IMA challenges
Government (municipal)	Increase the accessibility of the region and fit the mobility behavior of the target group that is aligned with municipality
Dutch citizens (established)	Not negatively affect the current way of living, but should provide mobility options and infrastructure that are in line or additional to the preferred mobility behavior
Dutch citizens (searching)	Mobility infrastructure and services that fit the preferred mobility behavior
Environmental organizations	Not have a negative impact on the environment and project area surroundings
Public transit operators (public)	Introduce or improve public transit opportunities and infrastructure and make sure that the services are available to the new citizens
Public transit operators (private)	Facilitate private public transit infrastructure and make sure that the services are available to the new citizens
Shared mobility providers	Introduce or improve shared mobility opportunities and infrastructure
Mobility activists	Represent their preferred type of mobility and provide safe infrastructure

The design criteria in the table above are quite generic. When working in project development, these criteria have to be filled in according to the best of one's knowledge and through interviews and consultations with the stakeholders. If done correctly, the project developer and the municipality acquire a list of design criteria. In turn, these criteria suffice the stakeholders' value propositions. Thus, the design problem is identified.

5.2 The Analysis of Interconnected Decision Areas (AIDA)

5.2.1 AIDA: theory

The design criteria that follow from the stakeholder analysis are only the first half of the story. These

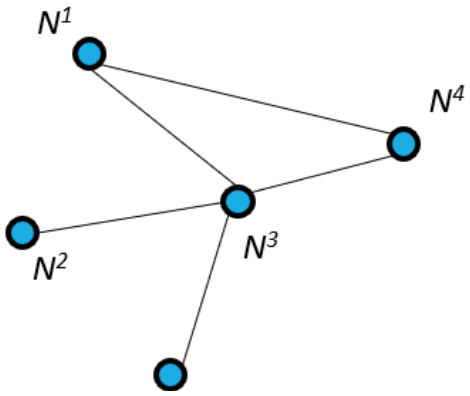


Figure 9: Strategy graph with five decision areas

design criteria describe the design problem that is at hand. Now it is time to find a solution to this problem. Or rather, several sets of solutions. To do so, the method that is proposed here is called the analysis of interconnected design areas, or AIDA. This method was shortly introduced by Harary et al. (1965) and later expanded upon in Luckman (1967). Basically, Harary et al. (1965) describes the principles behind the method as follows: design in project development often comes down to making many decisions between varieties of options. When these options are alternatives to each other, they fall within the same decision area. Even though these options and decision areas might be technically independent, each option chosen per decision area might affect the outcome of options within other areas. In a way, you are dealing with a mathematical problem where numerous outcomes are possible. Because of the nature of the decision problem, Harary et al. developed an algorithm that is able to support project developers in their design phases. In the development of a project, design considerations have to be accounted for to fulfil the requirements of the project. Here, the project requirements take the form of the design criteria that resulted from the stakeholder analysis. When

making these design decisions along a stepwise and linear path, it often leads to backtracking where design conflicts arise. The proposed algorithm is a more systematic approach. Since its introduction in 1964, the AIDA approach has been used extensively in urban planning.

The analysis of interconnected decision areas starts with a strategy graph. This graph consists of *N* number of nodes. These nodes represent the decision areas. As of now, these decision areas do not have their internal options specified. From a design perspective, the strategy graph shows how each decision area is connected to each other and thus has an influence on each outcome per area. Hence the name: interconnected decision areas. An example based on the information of Harary et al. is as follows:

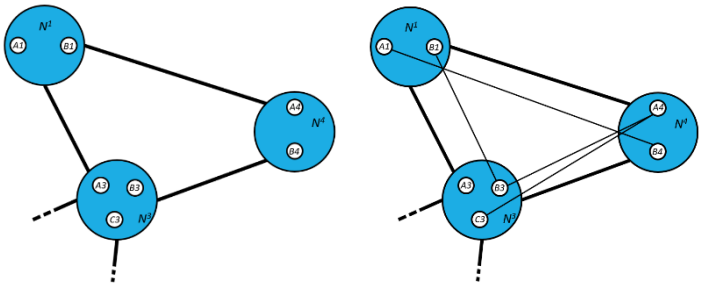


Figure 10: Decision areas in a strategy graph (cut-out)

Figure 9 shows node N^3 connected to all other nodes and as part of a triangular connection with nodes N^1 and N^4. This indicates that the decision made in N^1 affects and is affected by the options chosen in the other two. Essentially, the rule of thumb here is that when nodes are connected, the decisions made in the decision areas influence each other. If there is no connection, the options made per decision area still exist in the same project, but are of no importance to each other. Each decision area consists of a set of options. These options act as alternatives to each other, since only one of the options is chosen per decision area in this iteration. An exaggerated version of the triangular connection is shown in figure 10, now including the options per decision area. The figure on the left depicts the decision areas with connections in between. However, nothing is yet done with the options *within* these decision areas. These are depicted by the white circles and denoted with a letter and a number corresponding to the node they are in. After creating the strategy graph, the next step is to connect the design options to indicate whether they are compatible in the design or not. To clarify: when two options between decision areas are connected, they are deemed to be incompatible in a design. When two decision areas *themselves* are connected, they influence each other in the design. This situation is shown in figure 10 on the left side.

On the right in figure 10 is depicted whether or not options are compatible in the design. As is shown, option *A1* and *B4* are connected, indicating that they are not compatible and that any design solution with this combination will not be feasible. In AIDA, the compatibility of options is based on literature foundations. The same goes for incompatible alternatives. The next step is to search for all the feasible combinations. Looking at the exaggerated triangular version, one of the feasible solutions would be *A1-A3-A4* as none of them are connected. In the complete graph, the feasible solution consist of five chosen options. Since the decision areas of N^2 and N^5 are not connected to N^1 and N^4, incompatibilities cannot exist. However, they are connected to the middle node, N^3. Since they are connected, any feasible solution will not have combinations of options that strike between these nodes. In the example of Haray et al. (1965) and the elaboration in Luckman (1967), each of the options is assigned a cost as an additional requirement for making the decision. Each feasible solution therefore has a combined cost. This cost could be indicative for the final chosen solution based on the fulfilled requirements. Basically, this is where the AIDA is finalized. From here on, the results of the AIDA will be combined with the results from the stakeholder analysis.

5.2.2 AIDA: application

This part of the research focuses on answering the question: how could the sustainable urban mobility concepts from the literature be used to solve the urban design problem? Where identifying the design problem along the stakeholders' value propositions and design criteria provides the design

problem, AIDA presents the sets of feasible solutions. Some solutions may not be viable at all. This shows the importance of context that surrounds the urban design phase. During the analysis, the context and the scope of the decision areas is of the utmost important. The design problem and the criteria relate to urban mobility in the built environment. To relate this to the sustainable urban mobility concepts from the literature, the following decision areas and accompanying options are identified (table 19). The 25 concepts in table 19 represent design options that fall in each of the decision areas. As opposed to including all of the identified concepts from table 5 in the AIDA, these representations were chosen because of their cohesiveness. Including all relevant concepts would yield an unusable quantity of results. Table 5 show 12 concept typologies that each include several key-concepts. These represent solutions towards sustainable mobility. Including all of these key-concepts would yield too many results and would give too much overlap between the decision areas. To clarify: table 19 presents rewritten versions of the concept typologies and several of the key-concepts from the literature in table 5. These are more easily separable and can be categorized in the different decision areas for AIDA application.

Table 19: Motivation for decision areas and option alternatives

Decision area	**Motivation**	**Option alternatives**	**Motivation**
Design ideology	The ideology behind how the area should be designed is paramount for further decisions made during the design and development phase.	Polycentric city design	One of the main urban designs for sustainable mobility.
		The compact city	One of the main urban designs for sustainable mobility.
		TOD	One of the main urban designs for sustainable mobility.
		(Horizontal) urban sprawl	A viable and popular option for urban design.
Role of motorized traffic	The role motorized traffic will play in the design is indicative for other design choices and behavior of the area.	Superblocks (no through traffic)	No motorized (through) traffic is allowed here.
		(Focus on) high PTAL's	Motorized traffic is allowed, but the focus is on PT.
		(Focus on) automobility	Motorized traffic is allowed, but the focus is on automobility.
Road design	Road design facilitates and promotes certain types of mobility.	EV-lanes	Roads with EV-lanes favor EV-driven vehicles.
		Cycling highways	Cycling highways promote the use of active mobility.
		Focus on PT	PT-lanes and roadside stations facilitate the use of PT.
		Focus on automobility	Road design could favor efficient automobility.
Use of space	How space in the built environment is used influences the QoL of an area and promote certain types of mobility.	Private parking (roadside)	Roadside parking for private vehicles (with permit) takes up space in urban design.
		Private parking (driveway)	Driveways for private vehicles take up space in urban design.
		Public parking fields	Public parking fields or plots take up space in the built environment.
		Green / social	Green or social areas take up space in the built environment.
Mobility incentivization	The design of the built environment influences the appeal of a certain mobility mode choice. Because of this, the built	Safe walking infrastructure	A safe walking infrastructure favors pedestrianism.
		Safe cycling infrastructure	A safe cycling infrastructure favors cyclists.

	environment incentivizes the new citizens to show certain mobility behavior.	Car infrastructure	Car infrastructure incentives people to opt for the car.
		Charging infrastructure	Charing infrastructure (e.g. stations) promote the use of EV-driven vehicles.
		High PTAL's and PT safety	High PTAL's and PT safety promote the use of PT.
Ownership	An area should be designed with mobility and vehicle ownership in mind.	Shared	When designing an area, one could have sharing economies of mobility (incl. MaaS) in mind.
		Private	When designing an area, private ownership of mobility could be leading.
Zoning	The zoning distribution of functions affects mobility mode choices through the influence of trip distance.	Mixed	Mixed distributions of functions lead to shorter trip distances.
		Strategic	Strategic zoning is concerned with the context and allocates zoning according to possible externalities.
		District	District zoning focuses on blocks of functions.

Some of the concepts in the table are not indicative of sustainable mobility in the built environment, but are rather related to conventional and unsustainable mobility. Some examples of this are the horizontal urban sprawl in design ideology or the roadside and driveway parking of private vehicles. These concepts still hold a strong position in the field of urban spatial planning and have therefore been added as reference material for the more sustainable concepts.

As explained in Harary et al. (1965), the first step to identify the feasible solutions is to create a strategy graph of the interconnected decision areas. The areas identified in table 19 show the following connections, based on the writer's own experience:

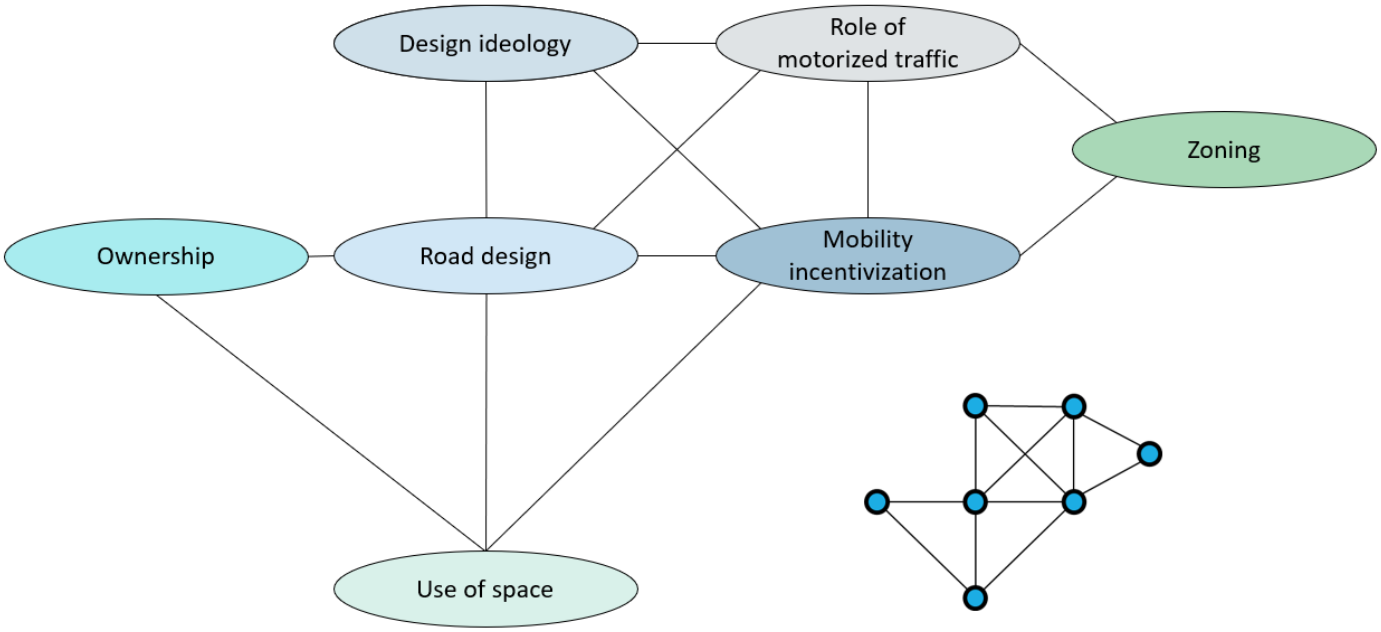


Figure 10: Strategy graph showing connected decision areas

Figure 11 also shows a the strategy graph in the same format as presented earlier for clarification, but smaller. The connections between the decision areas, as well as some of the lacking ones, require some explanations. Table 20 provides these explanations per connection.

Table 20: Elaboration on the connections in the strategy graph

Connection		**Explanation**
Zoning	Role of motorized traffic	The zoning and distribution of functions affect the trip distance and thus how they are available. Motorized traffic plays a role in traversing middle to long distances to reach facilities.
Zoning	Mobility incentivization	The zoning and distribution of functions affect the trip distance and thus how they are available. An increased or decreased average trip distance to functions incentivizes citizens to opt for a corresponding type of daily mobility preferences.
Mobility incentivization	Role of motorized traffic	The built environment incentivizes a type of mobility by the infrastructure it provides. This type of infrastructure has to fit the role of motorized traffic that was envisioned for this urban area.
Mobility incentivization	Design ideology	The built environment incentivizes a certain type of mobility by the infrastructure it provides. This area has to be designed along a certain ideology to provide the correct type of incentivization that is in line with the envisioned mobility behavior.
Mobility incentivization	Road design	The built environment incentivizes a type of mobility by the infrastructure it provides. The road design is part of this infrastructure and facilitates a type of mobility.
Mobility incentivization	Use of space	The built environment incentivizes a type of mobility by the infrastructure it provides. The way that space in the urban environment is used supports mobility incentivization.
Role of motorized traffic	Design ideology	The design ideology that is leading for the urban area has a large impact on the role that motorized traffic will play.
Role of motorized traffic	Road design	The way that the road is designed facilitates a type of mobility. Because of that, the road dictates the role of motorized traffic in the urban environment.
Road design	Design ideology	The design ideology has a large impact on how the mobility in the urban area will behave. The way the road is designed is the result of this.
Road design	Ownership	Road design focused on public transit or active modes (e.g. more bus-lanes or cycling highways than regular car-lanes) disincentivizes private automobility in the area.
Road design	Use of space	Use of space (e.g. roadside or driveway parking) affects the way that roads are designed, since they will have to accommodate for this.
Ownership	Use of space	Private vehicles have to be stored when stationary. This consumes unnecessary space in the built environment.

Arguably, some connections lack in the strategy graph. There are some connections that seem logical at first, and they are, but the essence of that proposed connection is already captured in another connection. One example is the lacking direct connection between design ideology and use of space. Indeed, following an ideology in the design of open spaces is important. However, from a mobility perspective, the use of space is related to mobility incentivization. This is a connection that exists already and the essence is therefore captured. After designing the strategy graph, each of the decision areas will have their option alternatives included as well. This is depicted in figure 13, without connections of incompatibility, yet:

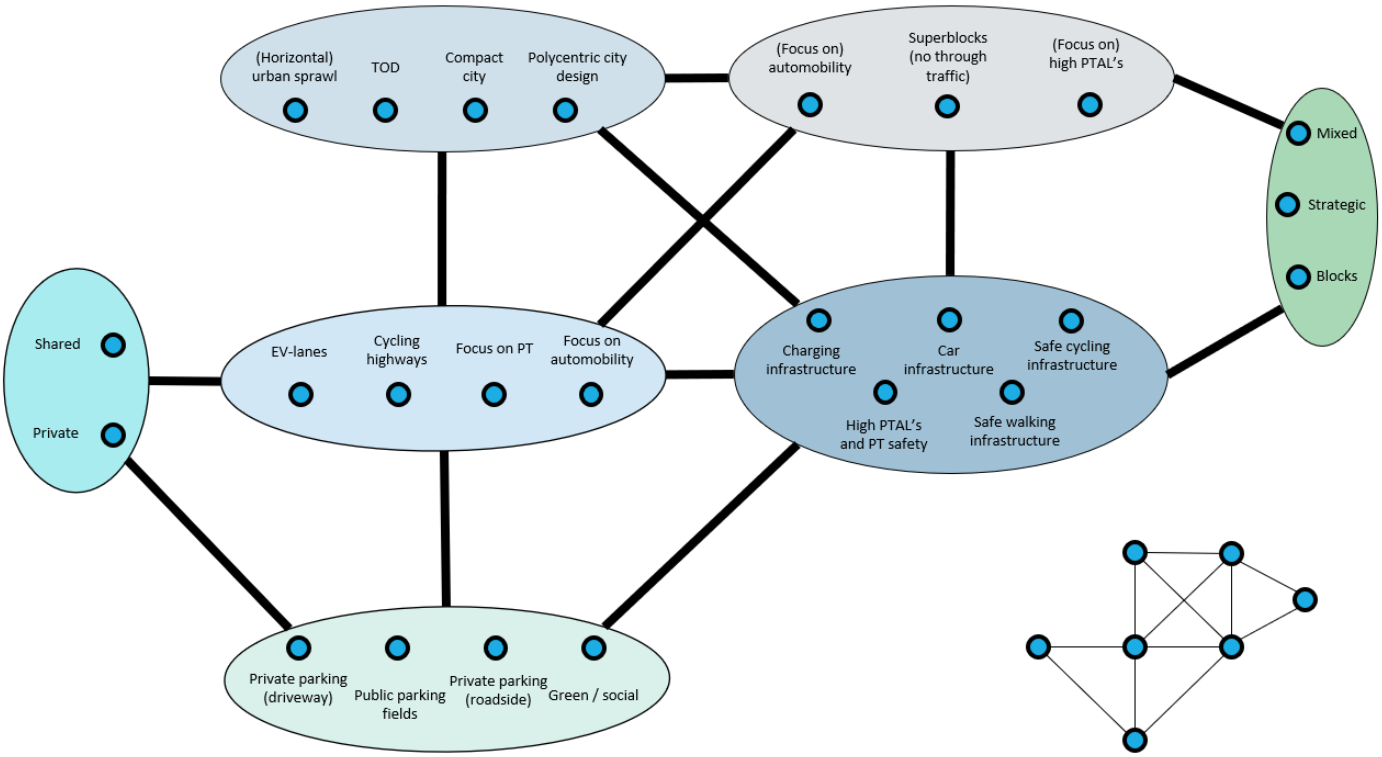


Figure 11: Strategy graph including option alternatives

To identify incompatible options in the design, literature study and the nature of the concepts is important. Placing these concepts in an option matrix allows for a schematic representation these concepts. The matrix for these concepts is found in appendix A.

Each of the options is assessed in compatibility to the other options and denoted either a 1 or 0, with 1 symbolizing a connection and thus incompatibility. An example of this is visible in figure 14. When the cell shows a light blue color, this indicates the matrix-connection between the same fields and is thus inherently similar. The dark blue color with the small 'x' denotes that there is no connection between the decision areas following the strategy graph.

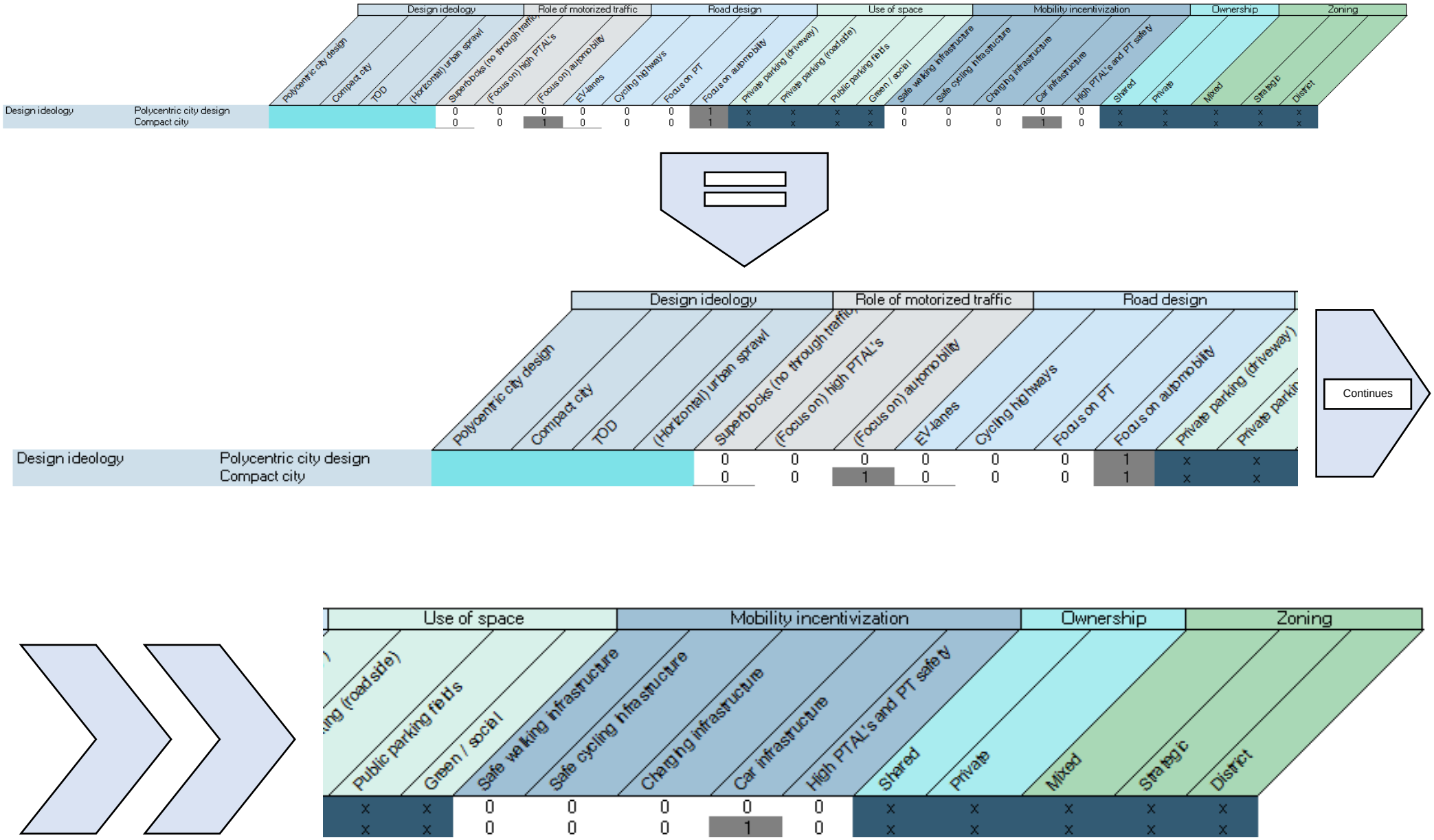


Figure 12: Matrix excerpt

In total, 37 combinations have been deemed to be impossible to unify in one single design. The number of total combinations (unbothered by any incompatibilities) and thus design solutions is calculated by multiplying each of the options per field:

$$4\ (design\ ideology) * 3\ (role\ of\ motorized\ traffic) * 4\ (road\ design) * 4\ (use\ of\ space) * 5\ (Mobility\ incentivization) * 2\ (ownership) * 3\ (zoning) = 5.760\ multiple\ combinations$$

As discussed before, this is the calculation including 25 different concepts. Having all of the literature concepts included would yield an enormous amount of combinations. Figure 14 shows the strategy graph including the options and the connections. To make it more visually appealing and the connections easier to follow, the visual structure has changed (figure 15). However, the figure still adheres to the strategy graph structure in figure 12:

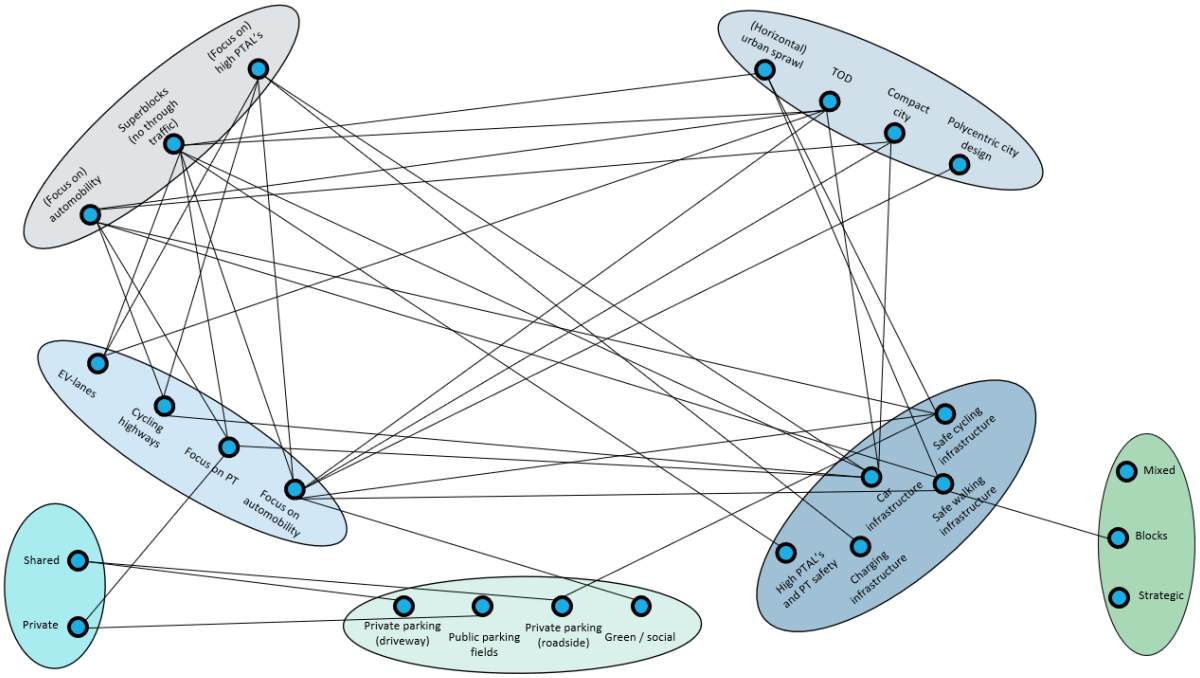


Figure 13: Strategy graph showing incompatibilities between option alternatives

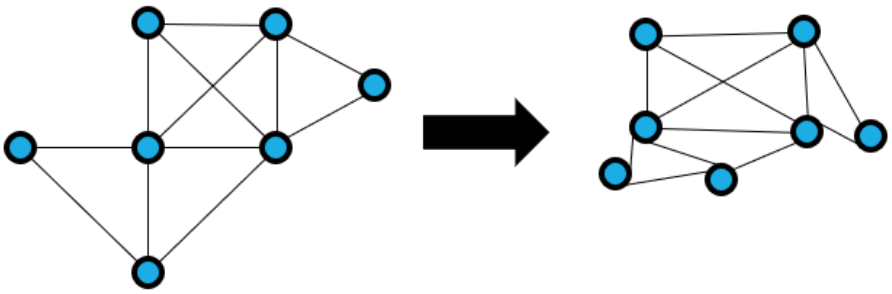
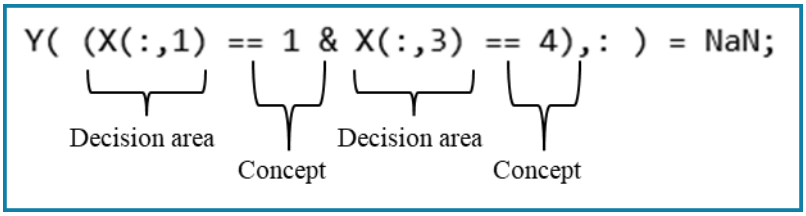


Figure 14: Format of the strategy graph

With the connections and incompatibilities identified, the time is right to identify the combinations of design options that are indeed viable. This set of solutions presents the complete array of design solutions based on literature concepts for sustainable mobility in the built environment.

There are several approaches to identify this set of design solutions. Figuring out each of the combinations manually is indeed an option, but this is rather inefficient and sensitive to errors. Instead the option matrix was plotted in Matlab. Each of the decision areas was numbered 1 through 7. Each of the options was treated similarly, for example: design ideology is now 1, and the four concepts were denoted as 1 through 4. This was repeated for each of the decision areas. After the plot, the 'rules' have to be clarified. An example of these rules is basically 'when the number in column 1 (design ideology) is 1 (polycentric city design), every line in the matrix where 3 (road design) has value 4 (focus on automobility) has to be filtered out'. In programming, this rule translates to:



This was repeated for each of the 37 incompatible combinations. After the final plot and the eliminating all the lines in the matrix with incompatible combinations, the total number of design solutions is visible in a separate table. The result from this Matlab exercise is a set of 317 rows with numbers. The next step is to re-translate the numbers in each line to the corresponding sustainable mobility concept from the original option matrix. Seven concepts on the same line represents one design solution.

5.2.3 AIDA: results

The final output is a table with seven columns, each representing one of the decision areas. Appendix B shows the full table, including all the 317 design solutions. An excerpt of the final set of solutions is as follows:

Table 21: Design solutions 224 and 225

Design nr.	Design ideology	Role motorized traffic	Road design	Use of space	Mobility incentivization	Ownership	Zoning
224	TOD	high PTAL's	PT focus	Pub. parking fields	Walking infrastructure	Shared	Mixed
225	TOD	high PTAL's	PT focus	Pub. parking fields	Walking infrastructure	Shared	Strategic

The design solutions presented here (numbers 224 and 225) show only a part of the possible solutions. Where the first solution (starting with 'compact city') advises to implement high PTAL's and PT safety to an end of mobility incentivization where the rest of the concepts seem to focus on automobility, other options for incentivization are possible as well. This is where the link to the stakeholder analysis and the identified design criteria is made. These design solutions are versatile and numerous enough to be adapted. They fit into the full set of design criteria that are in turn dependent on the context and the debate surrounding the project development.

The next step in answering the question "How can these stakeholders be aligned through design decisions to create an optimal sustainable mobility approach related to De Woningbouwopgave?" is to compare the set of possible design criteria to the full set of design solutions that come from the AIDA. As explained earlier in relation to table 18, stakeholders' design criteria will be context-dependent. Examples of this dependence include their preferred mobility behavior, a mobility providers' business model or ambition to expand

their services or the region-based IMA as discussed by the government.

Arguably, the nature of the design criteria is regardless of De Woninbouwopgave. However, project developers and the municipality have to balance and juggle the stakeholders' design criteria and the requirements for project funding under the Mobility Fund. The following chapter provides conclusions towards how development projects in De Woningbouwopgave are intertwined with stakeholder alignment.

5.3 Conclusion on AIDA & stakeholder alignment

Chapter 5 concluded with a recommendation towards how the literature concepts on sustainable urban mobility could be used in the frameworks and assessment approaches regarding projects in De Woningbouwopgave. This chapter discussed how these concepts could be implemented in the built environment as sets of design solutions per design problem originating from stakeholders' criteria. The AIDA method shows how 25 literature concepts can be combined (or not) to create design solutions for the built environment.

Due to the context-dependency of residential development projects, stakeholders and their design criteria often differ. Considering mobility in the new residential area, the project developers are not only responsible for new households moving into the area. They also oversee the impact that their development will have on the existing area and current mobility.
The research literature base has been expanding for decades and is likely to have numerous solutions to offer for similar situations in one way or another. Working with this knowledge and having design solutions backed by conducted research is therefore a viable approach to solving a design problem.

The results of the AIDA present 317 design solutions with corresponding concepts. These solutions apply to ease the process of stakeholder alignment. They ensure that all the value propositions are safeguarded in the project where and when sustainable mobility is concerned. Project developers should gather the involved stakeholders and discuss their design criteria with them. These design criteria should follow from the value proposition they hold dear. By gathering these mobility-related design criteria, the project developer should be able to compare them to the list of design solutions from the AIDA. Due to the largely sustainable nature of the results (including all the conventional options), sustainable mobility is likely to find a place in the new area while sufficing all of the design criteria.

These 317 solutions result from the AIDA and serve as a set of tools to align stakeholders. Each urban development exists within a different context and is thus prone to different design criteria each time. Therefore, there is no 'best' solution or applicable ranking between the 317. Each of the solutions can be a best fit, depending on the context. The aim of this thesis was to use literature concepts in combination with AIDA to align stakeholders. In order to elaborate on the results and find a potential ranking or best fit, one could apply the method to an actual case study – including context-dependent design criteria.

Conclusion & discussion

This chapter provides the central conclusion of the thesis. It explains the bipartite recommendation. After doing so, there is an elaborate discussion of the information, method and result of this thesis.

Governance: Top-down

The former chapters provided a bipartite guidance. The first section aimed at examining the current governance approach towards fostering the sustainable mobility transition through De Woningbouwopgave. The chapter introduced the context of De Woningbouwopgave, the funding structures and their accompanying assessment methods (one framework, two sets of criteria and an informative menu). These were followed by interpretations and examinations of their connection with the literature base.

The following paragraphs present a recommendation towards improved including sustainable mobility in the fund allocation for De Woningbouwopgave. The recommendation builds on the current framework and assessment approaches. It provides additional handlebars for the national, regional and municipal government. These handlebars support the Dutch transition towards sustainable mobility through sustainable mobility in De Woningbouwopgave. To structure the recommendation, let us first focus on the strengths and shortcomings of the current sustainable mobility inclusion.

As discussed in the conclusive section on each framework and assessment approach, there indeed exists a mindset concerning the sustainable mobility transition. The first approach, the conceptual framework, is supported by tools that are closely related to concepts from the literature. These tools are then represented by a set of questions that somewhat nullify the extensiveness of said tools. These tools have a prominent role in the funding discussion. Their shown results towards the projects' infrastructure developments indicates some alignment with the literature. However, the main conclusion is based on sets of questions. The acceleration criteria focus on the nature of the investment, the context and how urgent the required infrastructure is to the project. The literature has some connection to this process, in the sense that the approach focuses loosely on the design phase and how the project will land. SUMP is therefore included in the assessment. Nevertheless, other concepts fail to be represented. The assessment approach for the Wbi focuses on the mobility behavior of the projected target group and is in line with the culture and mobility mindset related concepts. Again, other concepts fail to be represented to their full extent. The mobility transition menu is a rather strong method of representation for each of the concepts. It discusses city planning, policy, mobility behavior and technology. Out of the four assessment types (thus including the framework), the menu provides the best literature representation.

There is room for improvement in all four approaches; although some require more adaptation than others. Starting with the approach that would benefit the most, the conceptual framework receives its recommendations first. The conceptual framework partly leads the discussion on how € 6 billion from the Mobility Fund will be distributed among NOVEX-based infrastructure investments. It is thus of great influence on the total governance within De Woningbouwopgave. It is easy to comprehend that it is unfavorable to have a full technocratic approach due to the political side of the discussion. However, the three tools (the urbanization dashboard, the urbanization strategies and the IMA challenges) that support the framework have to be represented better. These three tools are in line with the literature and show acknowledgement of the relevancy of sustainable urban mobility concepts. Where the urbanization dashboard is concerned, the framework should look further than the impact of changes in the built environment on the mobility behavior. The dashboard itself provides a conceptual explanation on how this change occurs based on the urban model. It provides corresponding infrastructure measures and how they will adapt the region on all

types of fronts. Since a strong connection to the literature already exists and the dashboard expands further than just mobility, it has to be represented to a better extent. To let the literature concepts and their impact matter in the discussion, more questions have to be included. As of now, the central criteria is the impact of the urbanization on urban movement patterns. this is measured as the increase in long distance trips per new housing unit by car and public transit. Keep in mind that several urban models are tested and that the scale is larger than a regular project, as the framework concerns large NOVEX-regions. Additional literature representation in the framework should discuss the concepts to a much larger extent than simply long distance trips, for example:

- How does urbanization as a result of the project affect trip distance due to mixed functions and active mobility incentivization? This is discussed in the urbanization dashboard, but is underrepresented in the framework. As of now, the framework focuses on long distance movement by car or public transit;
- To what extent is greenfield development influential of mobility in the context of the area compared to brown- or greyfield development? The difference between these three is made clear in urbanization models and shows different effects on movement patterns;
- To what extent does the proposed infrastructure investment foster a mobility transition through urban expansion that favors sustainable mobility over conventional automobilism?

The urbanization dashboard discusses different models of urbanization, the role (sustainable) mobility plays and its effect on movement patterns in the area. These are all indicative of literature concepts. The questions above are only some examples on how to better represent these concepts. In doing so, the leading consensus is led by more than just the increase in long distance trips and there is a broader knowledge base to be discussed. In turn, this would lead to a better informed discussion with literature to back up arguments. This is contradictory to the opposed numerical but rather shallow conclusion on an otherwise extensive tool.

The second tool supporting the framework is the set of urbanization strategies. They suffer from the same problem as the dashboard: correct and close to the literature in nature, but badly represented in the framework. As discussed, the framework asks for assessment of improvement of the regional accessibility. To do so, several numerical improvements are investigated, but alignment with the urbanization strategies (i.e. the leading document on how to develop the region) is assessed by a short textual explanation. Policymakers should include the urbanization strategy and accompanying literature concepts as follows:

- Question the influence of public transit infrastructure investments in the context of the area: what infrastructure is present and how can this dictate the spatial development and urbanization of the area to promote sustainable travel over automobilism?;
- What role does the connection between distance and function allocation play and how is this relationship present in the future development of the area? Looking at the urbanization strategy for Utrecht in box 1, spatial proximity plays an important role;
- How does the proposed infrastructure development correspond with the urbanization strategy in relation to how it aims to cooperate with local and regional mobility providers? Because of the regional nature of the strategy, different parties could be involved. In the strategy for Groningen-Assen (box 2), an important role is allocated to the Qlink public transit system. It is important to acknowledge such a cooperation in the framework.

The urbanization strategies considers the regional context. This includes all the parties and agreements for future developments at stake. Policymakers should consider the regional nature when examining the region and the impact of the infrastructure investment on the mobility patterns in the area. A short textual explanation simply does not suffice. The discussion would benefit greatly from a better shared knowledge base regarding the relationship between the infrastructure investment and the strategies. The framework facilitates this through better strategy representation.

The integral mobility analyses and the accompanying challenges discuss the present and upcoming mobility developments in The Netherlands. In this section of the three-part value examination, policymakers assess the relationship between the proposed infrastructure investment and relevant IMA-challenges. The framework presents the main indicator for this relationship to be a 'target range' of the infrastructure investment. This is too vague. However, literature concepts clarify the contents of this relationship. After identifying the IMA-challenges that the NOVEX-region is concerned with, one could take a closer look at the nature of the proposed infrastructure. Highly urbanized areas in urban agglomerations are set to expand, with an increase in facilities and jobs as a result as well. This is a good example of a potential challenge in urban agglomeration. These jobs and facilities will also see an increase in accessibility due to mobility development externalities. Due to this higher accessibility, public transit is likely to experience shortcomings in their service capacity, leading to discomfort and overly full busses and trains. When a proposed infrastructure development concerns bus rapid transit system expansion, the question should be whether or not this new infrastructure has the potential to alleviate the existing pressure on the regional public transit system. This is something that should be calculable and has to be proven in the project application. Literature supports the conceptual value of high PTAL's and the potential of TOD and incentivizing public transit through policies. Clearly, a cohesive approach towards an IMA-challenges extends beyond physical infrastructure developments. The project's developers should acknowledge this and provide different explanations on how their initiative might support the government in their approach of the IMA-challenge from several fronts based on literature concepts – not just by the physical infrastructure development. Examining the 'target range'

Some sub-criteria relate to the literature and they receive a score. However, it remains unclear as to how they are represented in the final indicator in the framework. Even though there might be a connection between these sub-criteria and their role in the discussion led by the indicators, it is uncertain whether or not this is actually the case.

The nature of the acceleration framework makes it difficult to implement changes to the project plans. Therefore, it is reasonable to check the sensibility to invest in infrastructure regarding urgency and IMA-challenges. Yes, the assessment of the plans could and should ideally include a closer connection to the literature. What the assessment does well, is checking the impact the project and infrastructure investment have on the surrounding area and infrastructure. Discussing the connection between projects, the urbanization strategy and the municipality's vision would strengthen the connection to the literature. This does not have to be done through an assessment or checklist, but rather in a discussion or brainstorm format. First, the municipal and regional government extract a list from the urbanization strategies and municipality development vision containing sustainable mobility concepts they want to focus on. Then, the project developers have to come up with an explanation on how their proposed infrastructure investments is aligned with these concepts. They have to explain how it enriches the area in line with a shared vision. This shared vision will consist of the middle ground of top-down concepts and a bottom-up explanation where sustainable mobility concepts are concerned. Together with the assessment of the IMA-challenges, the literature nature of the urbanization

strategies ensures that sustainable urban mobility concepts make it to the discussion without slowing down an assessment process with an urgent nature. Each existing document in these discussions must be assessable and should provide a list of concepts from the literature.

The assessment of sustainable mobility in the Wbi relates to SUMP-concepts and deals with the mindset of the new households and the units to be built. Therefore, this approach already relates to the literature to some extent. There is less urgency with the Wbi projects than with the ones applying for the acceleration program. Because of that, there is more space and time available for these plans to adapt and include sustainable mobility. However, the plans that make it through the first assessment round and end up in the phase of the mobility scan are already tested for their alignment with existing plans. These development plans were created by the regional and municipal government. Depending on their nature of the plans, this defines a sense of alignment with the existing strategies. Similarly to the proposed approach for the acceleration program, a shared vision created from top-down concepts (originating from the existing development plans) and a bottom-up explanation (the assessment) allows for discussing the literature concepts. However, the mobility scan is designed to be executable within four hours by one mobility consultant. Where urgency is of the essence within the acceleration program, this is not the case for the Wbi. There is time for more elaborate discussion where the literature concepts are investigated. Another potential improvement to the assessment method for the Wbi concerns the carbon footprints of the projected target group. The approach has connections to the culture and mindset categories in the literature. With enough information about the target group's mobility behavior - indicative for passing the mobility scan – one should be able to estimate this footprint. If knowledge about the sustainability of this footprint is tested for, the municipality and project developer could investigate decreasing this footprint in cases that evidently lack in sustainability. Possible solutions are then found in the literature concepts and by using the proposed AIDA method. A practical example would be to replace the 'cost' influence as proposed by (Luckman, 1967a) with environmental impact.

The mobility transition menu correctly represents literature concepts. It acknowledges the importance of a transition. The five main concepts in their diversity show this clearly. The challenge is to communicate this information to the different levels of government and the developers of future projects. One way to check and assess the future impact of the menu, is to implement an additional indicator in all future assessments. This indicator should ask developers to explain how the plans relate to the concepts from the menu. This is similar to the proposed approaches for the acceleration program and the Wbi. Although, the menu itself represents the literature. In the future, there has to be a clear synergy between what is preached by the menu and the assessment methods that guide the discussion. The information in the menu has to be presented now, to make projects more viable to be deemed eligible for funding according to the new, reworked and sustainable mobility fostering assessment methods.

To summarize: the mindset for sustainable mobility exists, but it earlier findings are underrepresented. Two of the assessments depend on the mobility behavior of the target group and the present infrastructure. This leaves room for unsustainable mobility, as long as it aligns with these two criteria. There are certain tools that focus on sustainable mobility in the built environment. The way these tools are in turn represented in the framework is lacking. Since policymakers use this framework in enormous budget discussions, the framework's contents could be considered the main bottleneck in the assessment and funding procedure.

The question at hand is: why is including findings from the literature important for fostering sustainable mobility in the built environment through governance? To answer that question, it is useful to look at the total picture. There is a housing crisis in The Netherlands and 900.000 houses are

planned for construction before the end of 2030. These housing units are going to house an estimated 850.000 new households in newly developed urban areas. With these new households, the pressure on existing urban mobility ecosystems is going to increase. Because of that, cohesive urban mobility planning and infrastructure is required for each development project. For this mobility infrastructure development, the national government has allocated € 7.5 billion through the Mobility Fund. Project developers apply for this fund through several programs and are assessed according to the corresponding frameworks and assessment approaches – the ones discussed in this chapter. This budget allocation has a significant impact on the mobility status quo in the country. The housing challenge is not the only crisis that relates to the built environment. Another significant challenge is that of the unsustainability of mobility and the urge for a mobility transition. Through this budget and the infrastructure investments, the government is able to steer the mobility transition. This way, the project developments in De Woningbouwopgave provide opportunities for more sustainable mobility in urban environments. Why is literature so important in this steering process. Well, to foster sustainable mobility in the built environment, the government does not have to reinvent the wheel. There is a vast literature base on sustainable mobility in the built environment that includes former research and case studies, presenting the effect of interventions. Using these insights in the distribution frameworks and assessment approaches will therefore represent former knowledge and findings in the foundation for new developments – without the assessors having to rely solely on assumptions and own experience.

Design: Bottom-up

The former chapter discussed applying the AIDA-method as proposed by Harary et al. (1965). This application in combination with the stakeholder analysis shows literature concepts could be combined for the sake of stakeholder alignment in the design phase. The following paragraphs provide a recommendation towards how this procedure would be.

The procedure could be as follows. A project developer has come to an agreement with the municipality about where a new urban residential area will be constructed. To make a cohesive design and to minimize roadblocks and criticism along the way, the project developer assigns a mediator that gathers the relevant stakeholders. For this example and the AIDA application, only mobility-related stakeholders are required. The stakeholders that are approached by the mediator explain their concerns and indicate how their value proposition has to be represented in the project. This is where the design criteria are exclaimed and noted. Examples of these criteria could be ‘stakeholder A wants to be able to walk or cycle to work, ‘stakeholder B wants a driveway to park their car’ and ‘stakeholder C would rather not see too many through traffic and prefers peace and silence’. The mediator takes these criteria to an expert in urban planning. The urban planner assesses the criteria and compares it to the list of design solutions that is presented here. An example of a fitting solutions is solution *108*. Stakeholder A’s criterium is satisfied by a compact city design with mixed functions, as well as safe walking and cycling infrastructure. Stakeholder B is satisfied because of the driveways in the design. Stakeholder C will be glad to live in a superblock area without through traffic. This set of design solutions is then communicated to both the stakeholder group and the municipality by the mediator. The stakeholder group has to conclude whether or not their design criteria are fulfilled. Is this not the case, then the mediator will return to the urban planner. The urban planner then presents a new solution that is akin to the former one, but might fit each design in a different way. There are numerous sets of solutions that are so close in similarity but differ one possible concept, that the model has a high versatility. This process repeats until the stakeholder group agrees with the proposition. The municipality will assess the proposed set of solutions in their regional development plans. The project development has to be in line with the

vision for the area. If this is the case, both parties agree and the AIDA has served its purpose. On to the funding phase – *with* the backing of literature on sustainable mobility in the urban environment.

To connect this conclusion on design and the recommendation in the former chapter, one could align the results from the AIDA with the mobility transition menu. The transition menu informs project developers and municipalities about sustainable mobility options for future projects. In turn, these two parties are able to extract concepts to their liking and relate them to the concepts in the AIDA. They could also place them in a new AIDA format, following the proposed methodology. Concepts that fit their preferences could be aligned with the regional development vision or the urbanization strategies on a higher level. When zooming in on a project level, the chosen concepts are still of importance. They will have to be tailored to fit the spatial and socio-technical context of the area. This includes the stakeholders and their design criteria, thus heralding the use of AIDA. Where future projects are concerned, the mobility transition menu should be leading in communication between the three levels of government and the project developers. In turn, the AIDA should be used to further communicate the results from that former consultation to the stakeholders on the project level.

Questions answered

During the introduction to this thesis, a central research question was presented. This research question is supported by several sub-questions. These sub-questions discussed separate parts of the research. The second and third chapter of this thesis presented the answer to the first question – to research the current literature insights towards sustainable mobility in the built environment. This resulted in a historical study of the subject and its role in research literature, but also the list of concepts used throughout the research. The fourth chapter discussed the structure of De Woningbouwopgave, followed by chapter five with introductions and analyses of all the relevant assessment approaches. Literature was deemed to be underrepresented in these approaches – a notion of need for sustainable mobility was recognized. Chapter 6 presented which stakeholders are involved with sustainable mobility in the built environment on a project level. An execution of the AIDA-method was presented. Through this method, literature concepts can be used to align stakeholders and foster the implementation of sustainable mobility in the built environment. This chapter provided central conclusions in the form of a two-part guidance recommendation. The first part discusses how literature can be used to include sustainable mobility in top-down project assessment for De Woningbouwopgave. The second part concerns bottom-up inclusion through design and stakeholder alignment.

With that, all five sub-questions have been answered accordingly. But what about the overarching research question? The bipartite guidance recommendation in this thesis provides the answer to that question. Even though the tools used in the framework and assessment approaches relate to sustainable mobility in one way or another, they are not well-represented in the assessments themselves. A better representation of these tools will consequently better represent the literature that supports them. This enables policymakers to better assess sustainable mobility in the plans according to the literature. Additional tooling is required to further the inclusion of literature where desired. The second part of the guidance recommendation is a procedure based on AIDA. This procedure unites stakeholders through design solutions based on literature that fit their design criteria and value propositions. This creates bottom-up inclusion of literature concepts and fosters their implementation in design.

Then there is still the overarching question: how could sustainable mobility insights and findings related to the built environment be used in the assessment of current development plans and in the design phase of future residential development projects as part of De Woningbouwopgave? To summarize: this these presents a two-pronged

approach. The first part concerns governance (top-down). Assessment methods should include indicators and criteria that better represent the tools that support them. Additional support tools are also required. This is where the second part comes in, concerning design (bottom-up). Urban planners should use the presented AIDA-method to design projects and align stakeholders through literature concepts. These concepts should concern literature on sustainable mobility to represent existing knowledge. After this stakeholder alignment through AIDA, projects that follow these sustainable insights eventually meet assessment methodologies following the same concepts. Through this bipartite approach, De Woningbouwopgave facilitates the sustainable mobility transition in The Netherlands. This transition is a journey that takes time and effort. The details are up to the government, project developers, stakeholders and society in general. But by harnessing the wealth of knowledge in literature, we can drive a more effective and inspiring sustainable mobility transition, bringing us closer to a cleaner, greener future for all.

Discussion

In each research project, limitations and alternative options play a role. Because of the choices in the methodology or the rate of availability of information, concessions have to be made. This does not necessarily lower the integrity of the method, results or the conclusion. Rather, it indicates that there are still possible improvements and further research could be conducted. The following chapter will elaborate on how this research would benefit from improvement and where limitations were encountered.

Literature on sustainable mobility exists in vast quantities. Not all of that is related to mobility in the built environment. The literature review focused on four main sustainable mobility categories. These categories included policies, urban planning, technology and culture, mindset and behavior. Policies was chosen as the first main category, because environmental, socio-economic and technical policies support innovation and development. Not all the mobility-related policies that fall within these three categories are all directly related to the built environment, an sich. However, they all have the potential to support sustainable innovation within the urban mobility sector through development of the built environment. Therefore, policies are still included as one of the main categories.

The second group concerned urban planning. Literature has shown that urban planning indeed has significant effects on mobility behavior, adoption and distribution, among others. For this research, focusing on urban planning in relation to mobility is done from a literature perspective. However, there are several modeling and algorithmic approaches that provide additional insights towards how urban planning models affect mobility. Arguably, looking at urban planning models from a literature perspective leaves out some of the more analytical differences between the models. The goal to discuss these categories and create the list of concepts was to identify if and how the national government assesses mobility in De Woningbouwopgave. Discussing the analytical differences between concepts was excluded in the scope and is therefore not elaborated on. Furthermore, to accurately discuss differences between urban models, one would need a case study to project these models on. An example is the iteration of the urbanization dashboard with the Randstad region (focusing on Amsterdam). Three different models are analyzed. However, projecting literature concepts on specific case studies to examine their effects on the area was also not within the scope of this research. It has to be stressed that grouping the urban planning approaches and discussing them at length, solely purposed the goal of summarizing concepts to compare with the government's approaches. Continuing with the urban planning categorization: arguably, including SUMP is rather strange and overlaps with policies rather than with urban planning. Indeed, SUMP is more of a planning practice rather than an actual urban planning model. However, just as with the policy

categorization, SUMP supports urban planning models in concerning sustainable urban mobility in the development plans. SUMP works on a different level than regular policies. It concerns the actual inclusion and execution of mobility designs in urban areas, rather than try to affect them indirectly. Therefore, it is justified to include this concept within the urban planning categorization.

The third and fourth categories that are represented here are related to technology or systems, culture and behavior and how they affect the built environment and vice versa. At a first glance, these two categories might not be as applicable or relatable to the built environment. However, the introduced literature concepts indicate that there is an effective relationship between the built environment and the two categories in different ways. This does spark a point of discussion: if you search far and wide, more than just these four categories could be connected to the built environment. Arguably, the list of concepts and categories is thus incomplete. There should always be an incentive for further research, but these four concepts were decided to be in the scope of the research. This decision has led from both time- and resource-based limitations. Following the ideology behind this discussion point, other fields of expertise or categories relating mobility to the built environment would be able increase the integrity of the list. However, due to the overarching nature of the literature categories that were used, most of the possibilities seem to be a sub-category. Indeed, working with sub-categories would potentially increase the user-friendliness of the list and would allow for better categorization. This could be a manner of improvement for research that builds on this one. Building on the former, there is something to be said about the overall integrity of the concept list. Not only are other (sub-)categories possible additions, interpreting existing literature and categories could be improved as well. The list is based on a large literature base interpretation and is therefore subjective as to how the articles are interpreted and are translated into concepts. These concepts represent the articles and the underlying theories and claims in a way that they are relatable to the writer of this thesis. The concepts consist of a few keywords and explanations. They might therefore be an incomplete representation to one person, where they are interesting and descriptive enough to the other.

There is a comment to make about the way that the concepts in the final literature concepts list are phrased. Each of the categories and the subsequent concepts were phrased according to how they are represented in the literature. Because of the focus of category, it is not unreasonable that several concepts are represented often. Examples are high PTAL's and spatial proximity. High PTAL's or the effect of the built environment on distance and accompanying transport modes are represented in the list in different ways and numerous times. Arguably, including the same concept multiple times or in different ways gives a skewed image of how many concepts are related to sustainable mobility in the built environment. There are two counterarguments to this. Firstly, if a concept is represented in the literature more often, it is highly likely that it has a significant impact on the issue at hand. High public transit accessibility is often mentioned in the literature and is indeed deemed to have such a significant impact. Therefore, including it in the concept list more than once shows that it has a multidisciplinary impact or that that same impact has a quasi-linear relationship with the number of mentions. In a way, the number of mentions here works similar to the number of citations in research articles: more citations are likely to indicate a higher impact of the article. The second argument builds on the multidisciplinary aspect of concepts. Sometimes, a concept is named more often because it is a core concept of several categories and thus affects sustainable mobility in the built environment in different ways. Two examples of this are PTAL's in urban planning, policies and culture, as well as (promoting) active mobility in different categories. Because of the impact and the multidisciplinary aspect of several concepts, naming them several times in different contexts is justifiable.

To conclude the discussion on the literature review: The concept list is the author's interpretation of literature on sustainable mobility in the built environment. Any other person is likely of the opinion that similar categories need to be included (potentially among others of their liking). However, these concepts could be interpreted and worded differently. This may lead to other, just as useful, insights towards sustainable mobility in the built environment.

Solving De Woningbouwopgave is an ongoing process. The examination and elaboration provided in the related chapters is based on earlier publications and is adapted through timely updates when new information was released. However, due to the ongoing nature of the political process, new information will keep coming over the coming years. This shows that the government is indeed trying to solve the crisis and communicate their actions. It also means that this thesis and the explanation of De Woningbouwopgave will outdate. However, the list of literature concepts and the AIDA approach will not change drastically. Therefore, the seasonable explanation of De Woningbouwopgave does not deteriorate the integrity of the research. Instead, it is a zero measurement of this period to study direction the governance process moves from here.

The chapter that introduces De Woningbouwopgave mainly focuses on the housing construction program. As explained, the housing construction program is a part of a set of plans. This also includes plans related to affordable housing, housing for the elderly and making construction more sustainable. Mobility plays a role in these plans too. Even though it is not always directly related to the built environment, the plans do concern mobility and could potentially benefit from a sustainability point of view. Further research should look into the interactions between these plans. It should investigate how they share sustainability mobility synergies, as they are all connected to living in the built environment and aim to solve De Woningbouwopgave.

When assessing the funding structure, a major limitation was encountered: since the funding decisions concern politically sensitive information, not all sources are open. Because of that, the chapter discusses the funding structure including the frameworks and assessment approaches as best as possible. MIRT consultations are generally closed of to the public, until the point that the decisions are published. Therefore, it is not within the realm of possibilities to assess how these consultations – and thus the direct impact of the frameworks and assessment approaches – were conducted per project.

The section regarding the funding structure within De Woningbouwopgave ends with a recommendation towards why including sustainable mobility concepts is important. It touches on how this could be done per assessment approach. However, this recommendation could be expanded by proposing a newly created assessment approach (potentially following the NOVEX / not-NOVEX or new versus old projects typologies). Due to time- and resource-related causes, a complete new approach that revolves around literature concept to form an ideal framework has not been possible. Furthermore, creating a framework such as this has never been the scope of the research. The goal was to assess the current assessment approaches the government follows and to provide a recommendation as to why and how literature on sustainable mobility should be followed.

Chapter 6 discusses the stakeholder analysis and how the identified value propositions form the foundation for the design criteria. Even though the list of stakeholders is deemed to be conclusive, residential development is always context-dependent and therefore prone to difference in affected stakeholder groups. This also concerns the value propositions to some extent, but even more so the design criteria. These could be related to mobility or another aspect of the built environment. Even though this is indeed the case, the set of design solutions that follows from the AIDA accounts for this context-dependency with its large

number of possible solutions. Still, it might prove useful to apply the method – including both the stakeholder analysis and the design criteria– to a case study on a project level. The challenge posed by De Woningbouwopgave is not new. Older cases considering residential development that already have their design solutions tried and tested serve as potent study material. Traditionally, the AIDA method ends with an analysis of the costs per design solution to add an extra dimension to the method (Harary et al., 1965; Luckman, 1967b). Where the current AIDA and the built environment are concerned, the cost per design solution would be even more context-dependent. However, one would be able to apply the aspect of cost to an earlier case and compare the outcome to the alternatives to see if total costs would have changed the outcome. Whereas costs provides one extra dimension, there are other possible characteristics of design choices that could have different impacts or relations with externalities. Future research could concern design differences in ecological sustainability and express the impact of each solution in the estimated emission reduction. An alternative would focus on direct connection and fit with surrounding urban areas. This might be more difficult to quantify and would therefore result in a qualitative comparison.

The AIDA method has existed since it was introduced by Harary et al in 1965. It has been used in urban planning, but it has not been extensively discussed in the literature. This begs the question whether there are other design methodologies that are founded on completely different characteristics that seem to be a better fit. Concerning design criteria and preferences, methods for future research could include the interaction between supply and demand (Zhang & Tan, 2023) and how demand dictates the type of amenity or mobility that is provided per urban area. Following a supply and demand-based approach is likely only applicable to a case study. One would need to estimate supply in surrounding urban areas to identify the demand in the project area. Based on that surrounding supply, amenities would be in higher demand. From a mobility perspective, an example would providing public transit access points around the project area. If there are few bus stations surrounding the project area, a design decision would be to work with public transit providers to facilitate additional bus services in the project area. This approach takes context into account to an extent that is difficult with AIDA – especially without an application to a specific case study. However, the goal was to use AIDA to provide a design solutions where literature would be leading in aligning stakeholders with different criteria. This is where the AIDA method succeeds due to its versatility in available sets of design solutions.

With 317 possible solutions, it is likely that one combination is better than another. There are some combinations or compatibilities between concepts that could use more explanation. Because of rather vague connections, some sets of design solutions seem ambiguous. An example of this is combination 115, where the concept ‘public parking fields’ seemingly contradicts superblocks in a compact city with active mobility infrastructure. Naturally, using that space for a green or social function would be a better fit than allocating it to public parking fields. However, the model is not fitting for specific spatial allocation and thus does not indicate where the public parking fields would have to located in the urban design. Even more so, this connection and more alike are explained by literature surrounding the concepts. To clarify this example: superblocks do not allow for motorized traffic to travel through the block. However, when someone is not living in such a block (whereas people that do are likely to have private parking underground) but has to be somewhere in that location, public parking fields on the outsides of the superblock would pose a solution for parking. Despite seemingly possible ambiguous combinations, this indicates that the connections between concepts that fit or do not fit are made with literature explanations.

One could argue that it is useful to ‘rank’ the 317 design solutions according to how fitting they are for given design criteria. An argument in favor of

this, is that it would give a more practical proof of concept. Having 317 possible solutions is arguably still a set too large to apply. However, this thesis argues that the applicability lies in its large number of solutions. When working with urban planning, context will heavily influence the design problem at hand. Stakeholders are likely to have different design criteria based on the urban environment. When discussing one or two case studies, one might indeed be able to rank the 317 solutions according to the design criteria. However, one would render the results inconclusive with respect to the idea that such a design problem is heavily context dependent. Due to the difference in case studies, ranking the solutions is inefficient and unnecessary within the scope of this thesis. Providing 317 solutions for design principles accounts for that context-dependency and provides an elaborate toolbox for urban planners and mediators. To relate to the research question posed in the introduction: the goal of this thesis was to research how literature concepts could be used in the design phase to foster the role of sustainable mobility in the built environment. Applying the AIDA-method in combination with literature knowledge facilitates this.

References

Abnett Kate. (2022). *EU approves effective ban on new fossil fuel cars from 2035 | Reuters*. Reuters. https://www.reuters.com/markets/europe/eu-approves-effective-ban-new-fossil-fuel-cars-2035-2022-10-27/

Acheampong, R. A., & Siiba, A. (2020a). Modelling the determinants of car-sharing adoption intentions among young adults: the role of attitude, perceived benefits, travel expectations and socio-demographic factors. *Transportation*, *47*(5), 2557–2580. https://doi.org/10.1007/s11116-019-10029-3

Acheampong, R. A., & Siiba, A. (2020b). Modelling the determinants of car-sharing adoption intentions among young adults: the role of attitude, perceived benefits, travel expectations and socio-demographic factors. *Transportation*, *47*(5), 2557–2580. https://doi.org/10.1007/s11116-019-10029-3

Adelfio, M., Navarro Aguiar, U., Fertner, C., & Brandão, E. da C. (2022). Translating 'New Compactism', circulation of knowledge and local mutations: Copenhagen's Sydhavn as a case study. *International Planning Studies*, *27*(2), 173–195. https://doi.org/10.1080/13563475.2021.1979943

Aguilera-García, Á., Gomez, J., Antoniou, C., & Vassallo, J. M. (2022). Behavioral factors impacting adoption and frequency of use of carsharing: A tale of two European cities. *Transport Policy*, *123*, 55–72. https://doi.org/10.1016/j.tranpol.2022.04.007

Allam, Z., Bibri, S. E., Chabaud, D., & Moreno, C. (2022). The '15-Minute City' concept can shape a net-zero urban future. In *Humanities and Social Sciences Communications* (Vol. 9, Issue 1, pp. 1–5). Palgrave. https://doi.org/10.1057/s41599-022-01145-0

Amsterdam, M. (2022). *MRA in brief aan ministers: 'Versnelling woningbouw vraagt meer samenhang met mobiliteit, energie, klimaat en landschap' - metropoolregioamsterdam*. https://www.metropoolregioamsterdam.nl/mra-in-brief-aan-ministers-versnelling-woningbouw-vraagt-meer-samenhang-met-mobiliteit-energie-klimaat-en-landschap/

Anastasiadou, K., Le Pira, M., & Giuffrida, N. (2021). Sustainable Mobility Driven Prioritization of New Vehicle Technologies, Based on a New Decision-Aiding Methodology. *Sustainability 2021*, *Vol. 13*, *Page 4760*, *13*(9), 4760. https://doi.org/10.3390/SU13094760

Andersen, J., & Sutcliffe, S. (2000). Intelligent Transport Systems (ITS) - An Overview. *IFAC Proceedings Volumes*, *33*(18), 99–106. https://doi.org/10.1016/s1474-6670(17)37129-x

Anjos, M. F., Gendron, B., & Joyce-Moniz, M. (2020). Increasing electric vehicle adoption through the optimal deployment of fast-charging stations for local and long-distance travel. *European Journal of Operational Research*, *285*(1), 263–278. https://doi.org/10.1016/j.ejor.2020.01.055

Anowar, S., Eluru, N., & Miranda-Moreno, L. F. (2014). Alternative Modeling Approaches Used for Examining Automobile Ownership: A Comprehensive Review. *Transport Reviews*, *34*(4), 441–473. https://doi.org/10.1080/01441647.2014.915440

Banister, D., & Hickman, R. (2006). How to design a more sustainable and fairer built environment: Transport and communications. *IEE Proceedings: Intelligent Transport Systems*, *153*(4). https://doi.org/10.1049/ip-its:20060009

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

Basiago, A. D. (1996). The search for the sustainable city in 20th century urban planning. In *Environmentalist* (Vol. 16, Issue 2, pp. 135–155). Springer. https://doi.org/10.1007/BF01325104

Bebber, S., Libardi, B., De Atayde Moschen, S., Correa da Silva, M. B., Cristina Fachinelli, A., & Nogueira, M. L. (2021). Sustainable mobility scale: A contribution for sustainability assessment systems in urban mobility. *Cleaner Engineering and Technology*, *5*. https://doi.org/10.1016/j.clet.2021.100271

Berkowsky, R. W., Sharit, J., & Czaja, S. J. (2017). Factors Predicting Decisions about Technology Adoption among Older Adults. *Innovation in Aging*, *2*(1). https://doi.org/10.1093/geroni/igy002

Berman, W., & Radow, L. (1997). Travel demand management in the USA: context, lessons learned and future directions. *Energy Policy*, *25*(14–15), 1213–1215. https://doi.org/10.1016/s0301-4215(97)00119-5

Bertolini, L. (1999a). Spatial development patterns and public transit: The application of an analytical model in the Netherlands. *Planning Practice and Research*, *14*(2), 199–210. https://doi.org/10.1080/02697459915724

Bertolini, L. (1999b). Spatial development patterns and public transit: The application of an analytical model in the Netherlands. *Planning Practice and Research*, *14*(2), 199–210. https://doi.org/10.1080/02697459915724

Bielińska-Dusza, E., Hamerska, M., & Żak, A. (2021). Sustainable mobility and the smart city: A vision of the city of the future. the case study of Cracow (Poland). *Energies*, *14*(23), 7936. https://doi.org/10.3390/en14237936

Boelhouwer, P., & van der Heijden, H. (2022). De woningcrisis in Nederland vanuit een bestuurlijk perspectief: achtergronden en oplossingen. *Bestuurskunde*, *31*(1), 19–33. https://doi.org/10.5553/bk/092733872022031001002

Bonnici, D. (2022). *How many cars in the world?* WhichCar. https://www.pd.com.au/blogs/how-many-cars-in-the-world/

Breheny, M. (1993). Planning the sustainable city region. *Town & Country Planning*, *62*(4), 71–75. https://doi.org/10.4324/9781315070315-15

Brundtland, G. H. (1987). Our Common Future: Report of the World Commission on Environment and Development. In *United Nations Commission* (Vol. 4, Issue 1). https://doi.org/10.1080/07488008808408783

Cao, X., Mokhtarian, P. L., & Handy, S. L. (2009). Examining the impacts of residential self-selection on travel behaviour: A focus on empirical findings. In *Transport Reviews* (Vol. 29, Issue 3, pp. 359–395). Routledge. https://doi.org/10.1080/01441640802539195

Castellanos, S., Grant-Muller, S., & Wright, K. (2022). Technology, transport, and the sharing economy: towards a working taxonomy for shared mobility. *Transport Reviews*, *42*(3), 318–336. https://doi.org/10.1080/01441647.2021.1968976

CBS. (2022a). *3. Demografische ontwikkelingen en de woningvoorraad*. https://www.cbs.nl/nl-nl/longread/de-nederlandse-economie/2022/achtergrond-bij-de-huizenprijsstijgingen-vanaf-2013/3-demografische-ontwikkelingen-en-de-woningvoorraad

CBS. (2022b). *Bevolkingsteller*. https://www.cbs.nl/nl-nl/visualisaties/dashboard-bevolking/bevolkingsteller

CBS. (2022c). *Hoeveel mensen komen om in het verkeer?* https://www.cbs.nl/nl-nl/visualisaties/verkeer-en-vervoer/verkeer/hoeveel-mensen-komen-om-in-het-verkeer-

Centraal Bureau voor de Statistiek. (2020). *ICT'ers werken vaakst vanuit huis tijdens coronacrisis*. https://www.cbs.nl/nl-nl/nieuws/2020/33/ict-ers-werken-vaakst-vanuit-huis-tijdens-coronacrisis

Centraal Bureau voor Statistiek. (2022). *3. Demografische ontwikkelingen en de woningvoorraad*. https://www.cbs.nl/nl-nl/longread/de-nederlandse-economie/2022/achtergrond-bij-de-huizenprijsstijgingen-vanaf-2013/3-demografische-ontwikkelingen-en-de-woningvoorraad

Cervero, R., & Kockelman, K. (1997). Travel demand and the 3Ds: Density, diversity, and design. *Transportation Research Part D: Transport and Environment*, *2*(3), 199–219. https://doi.org/10.1016/S1361-9209(97)00009-6

Cohen, B., & Kietzmann, J. (2014). Ride On! Mobility Business Models for the Sharing Economy. *Organization and Environment*, *27*(3), 279–296. https://doi.org/10.1177/1086026614546199

College van Rijksadviseurs. (2018). *Dashboard Verstedelijking | Rapport | College van Rijksadviseurs*. https://www.collegevanrijksadviseurs.nl/projecten/Adviezen-publicaties/publicatie/2018/10/16/dashboard-verstedelijking

Commission, E. (2009). *Action plan on urban mobility [COM(2009)490]*. https://www.eumonitor.eu/9353000/1/j9vvik7m1c3gyxp/vikqhnuvfxzb

Commission of the European Communities. (1990). *Green Paper "on the urban environement" Communication from the Commission to the Council and Parlament COM (90) 218 final*. https://op.europa.eu/nl/publication-detail/-/publication/0e4b169c-91b8-4de0-9fed-ead286a4efb7/language-en

Curtis, C., Renne, J. L., & Bertolini, L. (2009). Transit oriented development: Making it Happen. In *Transit Oriented Development: Making it Happen*. Ashgate.

D'Orey, P. M., & Ferreira, M. (2014). ITS for sustainable mobility: A survey on applications and impact assessment tools. *IEEE Transactions on Intelligent Transportation Systems*, *15*(2), 477–493. https://doi.org/10.1109/TITS.2013.2287257

Dash, S. K., Chakraborty, S., Roccotelli, M., & Sahu, U. K. (2022). Hydrogen Fuel for Future Mobility: Challenges and Future Aspects. In *Sustainability (Switzerland)* (Vol. 14, Issue 14, p. 8285). Multidisciplinary Digital Publishing Institute. https://doi.org/10.3390/su14148285

Davoudi, S. (2003). Polycentricity in European spatial planning: From an analytical tool to a normative agenda. *European Planning Studies*, *11*(8), 979–999. https://doi.org/10.1080/0965431032000146169

De Jong, A., Huisman, C., & Stoeldraijer, L. (2019). *Prognose 2019-2050: woningbouwveronderstellingen*. https://www.cbs.nl/nl-nl/longread/statistische-trends/2019/prognose-2019-2050-woningbouwveronderstellingen?onepage=true

Di Blasio, G., Agarwal, A. K., Belgiorno, G., & Shukla, P. C. (2022). Introduction to Application of Clean Fuels in Combustion Engines. In *Energy, Environment, and Sustainability* (pp. 3–6). Springer Nature. https://doi.org/10.1007/978-981-16-8751-8_1

Emadi, A., Lee, Y. J., & Rajashekara, K. (2008). Power electronics and motor drives in electric, hybrid electric, and plug-in hybrid electric vehicles. In *IEEE Transactions on Industrial Electronics* (Vol. 55, Issue 6, pp. 2237–2245). https://doi.org/10.1109/TIE.2008.922768

European Commision. (2015). *Smart Cities / European Commission*. Digital Agenda for Europe. https://ec.europa.eu/info/eu-regional-and-urban-development/topics/cities-and-urban-development/city-initiatives/smart-cities_en

European Commission. (1992). Green Paper on the Impact of Transport on the Environment, COM (92) 46 Final. In *Commission of the European Communities*. https://op.europa.eu/nl/publication-detail/-/publication/98dc7e2c-6a66-483a-875e-87648c1d75c8/language-en

European Commission. (2011). *Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport system (Commission staff working document accompanying the White Paper)*.

European Commission. (2013). A Concept for Sustainable Urban Mobility Plans. *European Union*, 1–5. https://ec.europa.eu/transport/sites/transport/files/themes/urban/doc/ump/com%282013%29913-annex_en.pdf

European Commission. (2016). *A European Strategy for Low-Emission Mobility — European Environment Agency*.

https://www.eea.europa.eu/policy-documents/a-european-strategy-for-low

Ewing, R., & Cervero, R. (2010). Travel and the built environment. *Journal of the American Planning Association*, *76*(3), 265–294. https://doi.org/10.1080/01944361003766766

Fistola, R., Gallo, M., Rocca, R. A. La, & Russo, F. (2020). The effectiveness of urban cycle lanes: From dyscrasias to potential solutions. *Sustainability (Switzerland)*, *12*(6). https://doi.org/10.3390/su12062321

Fitt, H. (2021). The status of being or the achievement of becoming? Towards better understandings of cars as status symbols. *Social and Cultural Geography*. https://doi.org/10.1080/14649365.2021.2000014

Fonseca, F., Ribeiro, P. J. G., Conticelli, E., Jabbari, M., Papageorgiou, G., Tondelli, S., & Ramos, R. A. R. (2022). Built environment attributes and their influence on walkability. In *International Journal of Sustainable Transportation* (Vol. 16, Issue 7, pp. 660–679). Taylor & Francis. https://doi.org/10.1080/15568318.2021.1914793

Gallo, M., & Marinelli, M. (2020). Sustainable mobility: A review of possible actions and policies. In *Sustainability (Switzerland)* (Vol. 12, Issue 18, p. 7499). Multidisciplinary Digital Publishing Institute. https://doi.org/10.3390/su12187499

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research Policy*, *31*(8–9), 1257–1274. https://doi.org/10.1016/S0048-7333(02)00062-8

Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy*, *36*(3), 399–417. https://doi.org/10.1016/J.RESPOL.2007.01.003

Grant, J. (2003). Exploring the influence of new urbanism in community planning practice. *Journal of Architectural and Planning Research*, *20*(3), 234–253.

Gudmundsson, H. (2003). Making concepts matter: Sustainable mobility and indicator systems in transport policy. *International Social Science Journal*, *55*(176), 199–217. https://doi.org/10.1111/j.1468-2451.2003.05502003.x

Harary, F., Jessop, N., Luckman, J., & Stringer, J. (1965). Analysis of interconnected decision areas : An algorithm for project development [43]. In *Nature* (Vol. 206, Issue 4979, p. 118). Nature Publishing Group. https://doi.org/10.1038/206118a0

He, M., He, C., Shi, Z., & He, M. (2022). Spatiotemporal heterogeneous effects of socio-demographic and built environment on private car usage: An empirical study of Kunming, China. *Journal of Transport Geography*, *101*, 103353. https://doi.org/10.1016/j.jtrangeo.2022.103353

Hensher, D. A., Ho, C. Q., Mulley, C., Nelson, J. D., Smith, G., & Wong, Y. Z. (2020a). *Understanding Mobility as a Service (MaaS): Past, Present and Future*.

Hensher, D. A., Ho, C. Q., Mulley, C., Nelson, J. D., Smith, G., & Wong, Y. Z. (2020b). *Understanding Mobility as a Service (MaaS): Past, Present and Future*.

Hietanen, S. (2016). *Mobility as a Service Can it be even better than owning a car?* https://www.itscanada.ca/files/MaaS Canada by Sampo Hietanen and Sami Sahala.pdf

Holden, E., Banister, D., Gössling, S., Gilpin, G., & Linnerud, K. (2020). Grand Narratives for sustainable mobility: A conceptual review. In *Energy Research and Social Science* (Vol. 65, p. 101454). Elsevier. https://doi.org/10.1016/j.erss.2020.101454

Holden, E., Gilpin, G., & Banister, D. (2019). Sustainable mobility at thirty. *Sustainability (Switzerland)*, *11*(7), 1965. https://doi.org/10.3390/su11071965

Hoogma, R., Kemp, R., Schot, J., & Truffer, B. (2005). Experimenting for sustainable transport: The approach of strategic niche management. In *Experimenting for Sustainable Transport: The Approach of Strategic Niche Management*. Routledge. https://doi.org/10.4324/9780203994061

IEA. (2022). *Global EV Outlook 2022 Securing supplies for an electric future*. 221. www.iea.org/t&c/

Irle, R. (2019). EV-Volumes - The Electric Vehicle World Sales Database. In *The Electric Vehicle World Sales Database*. https://www.ev-volumes.com/

Jarass, J., & Heinrichs, D. (2014). New Urban Living and Mobility. *Transportation Research Procedia*, *1*(1), 142–153. https://doi.org/10.1016/j.trpro.2014.07.015

Jarašūniene, A. (2007). Research into intelligent transport systems (ITS) technologies and efficiency. *Transport*, *22*(2), 61–67. https://doi.org/10.1080/16484142.2007.9638100

Jones, P., & Lucas, K. (2012). The social consequences of transport decision-making: Clarifying concepts, synthesising knowledge and assessing implications. *Journal of Transport Geography*, *21*, 4–16. https://doi.org/10.1016/j.jtrangeo.2012.01.012

Jou, K. K. (2011). Pedestrian areas and sustainable development. *World Academy of Science, Engineering and Technology*, *77*(5), 483–490. https://doi.org/10.5281/ZENODO.1082615

Kamruzzaman, M., Baker, D., Washington, S., & Turrell, G. (2013). Residential dissonance and mode choice. *Journal of Transport Geography*, *33*, 12–28. https://doi.org/10.1016/j.jtrangeo.2013.09.004

Kamruzzaman, M., Baker, D., Washington, S., & Turrell, G. (2014). Advance transit oriented development typology: Case study in brisbane, australia. *Journal of Transport Geography*, *34*, 54–70. https://doi.org/10.1016/j.jtrangeo.2013.11.002

Kamruzzaman, M., Baker, D., Washington, S., & Turrell, G. (2016). Determinants of residential dissonance: Implications for transit-oriented development in Brisbane. *International Journal of Sustainable Transportation*, *10*(10), 960–974. https://doi.org/10.1080/15568318.2016.1191094

Kanamori, R., Morikawa, T., & Ito, T. (2012). Evaluation of special lanes as incentive policies for promoting electric vehicles. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *7580 LNAI*, 78–89. https://doi.org/10.1007/978-3-642-35612-4_6

Köhler, J. (2006). Transport and the environment: The need for policy for long-term radical change. *IEE Proceedings: Intelligent Transport Systems*, *153*(4). https://doi.org/10.1049/ip-its:20060003

Köhler, Jonathan, Whitmarsh, L., Nykvist, B., Schilperoord, M., Bergman, N., & Haxeltine, A. (2009). A transitions model for sustainable mobility. *Ecological Economics*, *68*(12), 2985–2995. https://doi.org/10.1016/j.ecolecon.2009.06.027

Leach, F., Kalghatgi, G., Stone, R., & Miles, P. (2020). The scope for improving the efficiency and environmental impact of internal combustion engines. In *Transportation Engineering* (Vol. 1, p. 100005). Elsevier. https://doi.org/10.1016/j.treng.2020.100005

Lee, G., Jeong, Y., & Kim, S. (2015). Impact of individual and urban traits and urban form on vehicle hours traveled. *Journal of Asian Architecture and Building Engineering*, *14*(3), 601–608. https://doi.org/10.3130/jaabe.14.601

Logan, S. W., Bogart, K. R., Ross, S. M., & Woekel, E. (2018). Mobility is a fundamental human right: Factors predicting attitudes toward self-directed mobility. *Disability and Health Journal*, *11*(4), 562–567. https://doi.org/10.1016/j.dhjo.2018.06.001

Loo, B. P. Y., & du Verle, F. (2017). Transit-oriented development in future cities: towards a two-level sustainable mobility strategy. *International Journal of Urban Sciences*, *21*, 54–67. https://doi.org/10.1080/12265934.2016.1235488

Luckman, J. (1967a). An Approach to the Management of Design. *Source: OR*, *18*(4), 345–358. https://www.jstor.org/stable/3007686

Luckman, J. (1967b). An Approach to the Management of Design. *Operational Research Society*, *18*(4), 345–358. https://www.jstor.org/stable/3007686

Marshall, S. (2000). The potential contribution of land use policies towards sustainable mobility through activation of travel reduction mechanisms. *Innovation*, *13*(1), 63–79. https://doi.org/10.1080/135116100111667

McDowall, W. (2016). Are scenarios of hydrogen vehicle adoption optimistic? A comparison with historical analogies. *Environmental Innovation and Societal Transitions*, *20*, 48–61. https://doi.org/10.1016/j.eist.2015.10.004

Mcleod, S., Scheurer, J., & Curtis, C. (2017). Urban Public transit: Planning Principles and Emerging Practice. *Journal of Planning Literature*, *32*(3), 223–239. https://doi.org/10.1177/0885412217693570

McNally, M. G., Rafiq, R., & Uddin, M. Y. S. (2023). Impacts of the COVID-19 Pandemic on Telecommuting and Travel. In *Springer Tracts on Transportation and Traffic* (Vol. 20, pp. 217–232). Springer Science and Business Media Deutschland GmbH. https://doi.org/10.1007/978-3-031-00148-2_14

Menendez, M., & Daganzo, C. F. (2007). Effects of HOV lanes on freeway bottlenecks. *Transportation Research Part B: Methodological*, *41*(8), 809–822. https://doi.org/10.1016/j.trb.2007.03.001

Meyer, M. D. (1999). Demand management as an element of transportation policy: Using carrots and sticks to influence travel behavior. *Transportation Research Part A: Policy and Practice*, *33*(7–8), 575–599. https://doi.org/10.1016/S0965-8564(99)00008-7

Ministerie van Binnenlandse Zaken en koninkrijksrelaties. (2022a). *Programma NOVEX | Rapport | Rijksoverheid.nl*. https://www.rijksoverheid.nl/documenten/rapporten/2022/07/01/programma-novex

Ministerie van Binnenlandse Zaken en koninkrijksrelaties. (2022b). *Programma Woningbouw | Rapport | Rijksoverheid.nl*. https://www.rijksoverheid.nl/documenten/rapporten/2022/03/11/programma-woningbouw

Ministerie van Infrastructuur en Waterstaat. (2021). *Integrale Mobiliteitsanalyse 2021*. https://open.overheid.nl/repository/ronl-15e1e4fa-4eda-457d-8941-41687f24ced1/1/pdf/bijlage-2-ima-2021-hoofdrapport-deel-1.pdf

Ministerie van Infrastructuur en Waterstaat. (2022a). *Afsprakenlijst Bestuurlijke Overleggen MIRT 9, 10 en 11 november 2022 | Rapport | Rijksoverheid.nl*. https://www.rijksoverheid.nl/documenten/rapporten/2022/11/14/afsprakenlijst-bo-s-mirt-2022

Ministerie van Infrastructuur en Waterstaat. (2022b). *Lijst tweede ronde versnellingsafspraken | Rapport | Rijksoverheid.nl*. https://www.rijksoverheid.nl/documenten/rapporten/2022/11/14/lijst-tweede-ronde-versnellingsafspraken

Mouratidis, K., Peters, S., & van Wee, B. (2021). Transportation technologies, sharing economy, and teleactivities: Implications for built environment and travel. *Transportation Research Part D: Transport and Environment*, *92*, 102716. https://doi.org/10.1016/j.trd.2021.102716

Mueller, N., Rojas-Rueda, D., Khreis, H., Cirach, M., Andrés, D., Ballester, J., Bartoll, X., Daher, C., Deluca, A., Echave, C., Milà, C., Márquez, S., Palou, J., Pérez, K., Tonne, C., Stevenson, M., Rueda, S., & Nieuwenhuijsen, M. (2020). Changing the urban design of cities for health: The superblock model. *Environment International*, *134*, 105132. https://doi.org/10.1016/j.envint.2019.105132

Musso, A., Corazza, M. V., & Tozzi, M. (2012). Car Sharing in Rome: a Case Study to Support Sustainable Mobility. *Procedia - Social and Behavioral Sciences*, *48*, 3482–3491. https://doi.org/10.1016/j.sbspro.2012.06.1312

Næss, P. (2022). Compact urban development in Norway: Spatial changes, underlying policies and travel impacts. *Advances in Transport Policy and Planning*, *9*, 95–133. https://doi.org/10.1016/BS.ATPP.2021.02.003

Ogra, A., & Ndebele, R. (2013). The Role of 6Ds : Density , Diversity , Design , Destination , Distance , and Demand Management in Transit Oriented Development (TOD). *Neo-International Conference on Habitable Environments, May 2013*, 539–546.

https://www.researchgate.net/publication/268813431_The_Role_of_6Ds_Density_Diversity_Design_Destination_Distance_and_Demand_Management_in_Transit_Oriented_Development_TOD

Omtzigt, P. (2021). Tweede Kamer der Staten-Generaal. *Tweede Kamer Der Staten-Generaal*, *32 851*(71), 1–8. https://www.tweedekamer.nl/kamerstukken/moties/detail?id=2021D47333&did=2021D47333

Paolo, L., & Gull, T. (2022). *Electric cars fend off supply challenges to more than double global sales – Analysis - IEA*. Iea.Org. https://www.iea.org/commentaries/electric-cars-fend-off-supply-challenges-to-more-than-double-global-sales

Parker, M. E. G., Li, M., Bouzaghrane, M. A., Obeid, H., Hayes, D., Frick, K. T., Rodríguez, D. A., Sengupta, R., Walker, J., & Chatman, D. G. (2021). Public transit use in the United States in the era of COVID-19: Transit riders' travel behavior in the COVID-19 impact and recovery period. *Transport Policy*, *111*, 53–62. https://doi.org/10.1016/j.tranpol.2021.07.005

Pritchard, J. (2022). MaaS to pull us out of a car-centric orbit: Principles for sustainable Mobility-as-a-Service in the context of unsustainable car dependency. In *Case Studies on Transport Policy* (Vol. 10, Issue 3, pp. 1483–1493). Elsevier. https://doi.org/10.1016/j.cstp.2022.08.004

Rijksdienst voor Ondernemend Nederland. (2020). *Woningbouwimpuls (WBI)*. https://www.rvo.nl/subsidies-financiering/woningbouwimpuls

Rijksoverheid. (n.d.). *Lijst tweede ronde versnellingsafspraken | Rapport | Rijksoverheid.nl*. 2022. Retrieved January 30, 2023, from https://www.rijksoverheid.nl/documenten/rapporten/2022/11/14/lijst-tweede-ronde-versnellingsafspraken

Rotmans, J., Loorbach, D., & Kemp, R. (2007). *Transition management: origin, evolution, critique*.

Sagaria, S., Duarte, G., Neves, D., & Baptista, P. (2022). Photovoltaic integrated electric vehicles: Assessment of synergies between solar energy, vehicle types and usage patterns. *Journal of Cleaner Production*, *348*, 131402. https://doi.org/10.1016/j.jclepro.2022.131402

Santos, G., & Nikolaev, N. (2021). Mobility as a Service and Public transit: A Rapid Literature Review and the Case of Moovit. *Sustainability 2021, Vol. 13, Page 3666*, *13*(7), 3666. https://doi.org/10.3390/SU13073666

Santos, M. J., Martins, S., Amorim, P., & Almada-Lobo, B. (2021). A green lateral collaborative problem under different transportation strategies and profit allocation methods. *Journal of Cleaner Production*, *288*, 125678. https://doi.org/10.1016/j.jclepro.2020.125678

Schipper, F., Emanuel, M., & Oldenziel, R. (2020). Sustainable Urban Mobility in the Present, Past, and Future. *Technology and Culture*, *61*(1), 307–317. https://doi.org/10.1353/TECH.2020.0004

Shaheen, S., Cohen, A., & Zohdy, I. (2016). Shared Mobility: Current Practices and Guiding Principles. *Fhwa-Hop-16-022 2.*, *Washington D.C.*, 120. https://doi.org/10.21949/1503647

Shaw, D., & Sykes, O. (2004). The concept of polycentricity in European spatial planning: Reflections on its interpretation and application in the practice of spatial planning. In *International Planning Studies* (Vol. 9, Issue 4, pp. 283–306). https://doi.org/10.1080/13563470500050437

Sofeska, E. (2016). Relevant Factors in Sustainable Urban Development of Urban Planning Methodology and Implementation of Concepts for Sustainable Planning (Planning Documentation for the Master Plan Skopje 2001–2020). *Procedia Environmental Sciences*, *34*, 140–151. https://doi.org/10.1016/j.proenv.2016.04.014

Šoštarić, M., Vidović, K., Jakovljević, M., & Lale, O. (2021). Data-driven methodology for sustainable urban mobility assessment and improvement. *Sustainability (Switzerland)*, *13*(13), 7162. https://doi.org/10.3390/su13137162

Wefering, F., Rupprecht, S., Bührmann, S., Böhler-Baedeker, S., Backhaus, W., Laubenheimer, M., Lindenau, M., Vanegmond, P., Wegeler, G., Forrester, J., Trasporti Territorio, T., Bosetti, S., Malgieri, P., & Chiffi, C. (2014). *Guidelines-Developing and Implementing a Sustainable Urban Mobility Plan For more information European Platform on Sustainable Urban Mobility Plans www.eltis.org/mobility-plans Title: Guidelines. Developing and Implementing a Sustainable Urban Mobility Pl*. www.eltis.org

Wolday, F., Tønnesen, A., & Næss, P. (2019). Workplace location, polycentricism, and car commuting. *Journal of Transport and Land Use*, *12*(1), 785–810. https://doi.org/10.5198/jtlu.2019.1488

Yang, Y., Wu, X., Zhou, P., Gou, Z., & Lu, Y. (2019). Towards a cycling-friendly city: An updated review of the associations between built environment and cycling behaviors (2007–2017). In *Journal of Transport and Health* (Vol. 14, p. 100613). Elsevier. https://doi.org/10.1016/j.jth.2019.100613

Yorio, Z., Oram, R., El-Tawab, S., Salman, A., Heydari, M. H., & Park, B. B. (2018). Data analysis and information security of an Internet of Things (IoT) intelligent transit system. *2018 Systems and Information Engineering Design Symposium, SIEDS 2018*, 24–29. https://doi.org/10.1109/SIEDS.2018.8374744

Zhang, J., & Tan, P. Y. (2023). Assessment of spatial equity of urban park distribution from the perspective of supply-demand interactions. *Urban Forestry and Urban Greening*, *80*, 127827. https://doi.org/10.1016/j.ufug.2022.127827

Zhou, F., Zheng, Z., Whitehead, J., Perrons, R. K., Washington, S., & Page, L. (2020). Examining the impact of car-sharing on private vehicle ownership. *Transportation Research Part A: Policy and Practice*, *138*, 322–341. https://doi.org/10.1016/j.tra.2020.06.003

Ziyad, M., Naranje, V., Suresh, S., Mishra, V. P., & Salunkhe, S. (2021). Intelligent Traffic System for Sustainable Mobility.

Proceedings of 2nd IEEE International Conference on Computational Intelligence and Knowledge Economy, ICCIKE 2021, 504–507. https://doi.org/10.1109/ICCIKE51210.2021.9410725

Appendices

Appendix A: AIDA matrix

		Design ideology				Role of motorized traffic			Road design		Use of space				Mobility incentivization					Ownership		Zoning		
		Polycentric city design	Compact city	TOD	(Horizontal) urban sprawl	Superblocks (no through traffic)	(Focus on) high PTALs	(Focus on) automobility	EV-lanes	Cycling highways	Focus on PT	Focus on automobility	Private parking (driveway)	Private parking (roadside)	Public parking fields	Green / social	Safe walking infrastructure	Safe cycling infrastructure	Charging infrastructure	Car infrastructure	High PTAL's and PT safety	Shared	Private	Mixed	Strategic	District
Design ideology	Polycentric city design					0	0	0	0	0	0	1	x	x	x	x	0	0	0	0	0	x	x	x	x	x
	Compact city					0	0	1	0	0	0	1	x	x	x	x	0	0	0	1	0	x	x	x	x	x
	TOD					1	0	1	1	0	0	1	x	x	x	x	0	0	0	1	0	x	x	x	x	x
	(Horizontal) urban sprawl					1	0	0	0	0	0	0	x	x	x	x	1	1	0	0	0	x	x	x	x	x
Role of motorized traffic	Superblocks (no throug traffic)							1	0	1	1		x	x	x	x	0	0	0	1	1	x	x	0	0	0
	(Focus on) high PTAL's							1	1	0	1		x	x	x	x	0	0	1	1	0	x	x	0	0	0
	(Focus on) automobility							0	1	1	0		x	x	x	x	1	1	0	0	0	x	x	0	0	0
Road design	EV-lanes												0	0	0	0	0	0	0	0	0	0	0	x	x	x
	Cycling highways												0	0	0	0	0	0	0	1	0	0	0	x	x	x
	Focus on PT												0	0	0	0	0	0	0	1	0	0	1	x	x	x
	Focus on automobility												0	0	0	1	1	1	0	0	0	0	0	x	x	x
Use of space	Private parking (driveway)																0	0	0	0	0	1	0	x	x	x
	Private parking (roadside)																0	1	0	0	0	1	0	x	x	x
	Public parking fields																0	0	0	0	0	0	1	x	x	x
	Green / social																0	0	0	0	0	0	0	x	x	x
Mobility incentivization	Safe walking infrastructure																					x	x	0	0	1
	Safe cycling infrastructure																					x	x	0	0	0
	Car infrastructure																					x	x	0	0	0
	EV infrastructure																					x	x	0	0	0
	High PTAL's and PT safety																					x	x	0	0	0
Ownership and mode choice	Shared																							x	x	x
	Private																							x	x	x
Zoning	Mixed																									
	Strategic																									
	District																									

Appendix B: AIDA results

Design nr.	Design ideology	Role motorized traffic	Road design	Use of space	Mobility incentivization	Ownership	Zoning
1	Polycentric city	Superblocks	Cycling highways	Priv. parking (driveway)	Walking infrastructure	Private	Mixed
2	Polycentric city	Superblocks	Cycling highways	Priv. parking (driveway)	Walking infrastructure	Private	Strategic
3	Polycentric city	Superblocks	Cycling highways	Priv. parking (driveway)	Cycling infrastructure	Private	Mixed
4	Polycentric city	Superblocks	Cycling highways	Priv. parking (driveway)	Cycling infrastructure	Private	Strategic
5	Polycentric city	Superblocks	Cycling highways	Priv. parking (driveway)	Cycling infrastructure	Private	District
6	Polycentric city	Superblocks	Cycling highways	Priv. parking (driveway)	Car infrastructure	Private	Mixed
7	Polycentric city	Superblocks	Cycling highways	Priv. parking (driveway)	Car infrastructure	Private	Strategic
8	Polycentric city	Superblocks	Cycling highways	Priv. parking (driveway)	Car infrastructure	Private	District
9	Polycentric city	Superblocks	Cycling highways	Priv. parking (roadside)	Walking infrastructure	Private	Mixed
10	Polycentric city	Superblocks	Cycling highways	Priv. parking (roadside)	Walking infrastructure	Private	Strategic
11	Polycentric city	Superblocks	Cycling highways	Priv. parking (roadside)	Car infrastructure	Private	Mixed
12	Polycentric city	Superblocks	Cycling highways	Priv. parking (roadside)	Car infrastructure	Private	Strategic
13	Polycentric city	Superblocks	Cycling highways	Priv. parking (roadside)	Car infrastructure	Private	District
14	Polycentric city	Superblocks	Cycling highways	Pub. parking fields	Walking infrastructure	Shared	Mixed
15	Polycentric city	Superblocks	Cycling highways	Pub. parking fields	Walking infrastructure	Shared	Strategic
16	Polycentric city	Superblocks	Cycling highways	Pub. parking fields	Cycling infrastructure	Shared	Mixed
17	Polycentric city	Superblocks	Cycling highways	Pub. parking fields	Cycling infrastructure	Shared	Strategic
18	Polycentric city	Superblocks	Cycling highways	Pub. parking fields	Cycling infrastructure	Shared	District
19	Polycentric city	Superblocks	Cycling highways	Pub. parking fields	Car infrastructure	Shared	Mixed
20	Polycentric city	Superblocks	Cycling highways	Pub. parking fields	Car infrastructure	Shared	Strategic
21	Polycentric city	Superblocks	Cycling highways	Pub. parking fields	Car infrastructure	Shared	District
22	Polycentric city	Superblocks	Cycling highways	Green/social	Walking infrastructure	Shared	Mixed
23	Polycentric city	Superblocks	Cycling highways	Green/social	Walking infrastructure	Shared	Strategic
24	Polycentric city	Superblocks	Cycling highways	Green/social	Walking infrastructure	Private	Mixed
25	Polycentric city	Superblocks	Cycling highways	Green/social	Walking infrastructure	Private	Strategic
26	Polycentric city	Superblocks	Cycling highways	Green/social	Cycling infrastructure	Shared	Mixed
27	Polycentric city	Superblocks	Cycling highways	Green/social	Cycling infrastructure	Shared	Strategic
28	Polycentric city	Superblocks	Cycling highways	Green/social	Cycling infrastructure	Shared	District
29	Polycentric city	Superblocks	Cycling highways	Green/social	Cycling infrastructure	Private	Mixed
30	Polycentric city	Superblocks	Cycling highways	Green/social	Cycling infrastructure	Private	Strategic
31	Polycentric city	Superblocks	Cycling highways	Green/social	Cycling infrastructure	Private	District
32	Polycentric city	Superblocks	Cycling highways	Green/social	Car infrastructure	Shared	Mixed
33	Polycentric city	Superblocks	Cycling highways	Green/social	Car infrastructure	Shared	Strategic
34	Polycentric city	Superblocks	Cycling highways	Green/social	Car infrastructure	Shared	District
35	Polycentric city	Superblocks	Cycling highways	Green/social	Car infrastructure	Private	Mixed

36	Polycentric city	Superblocks	Cycling highways	Green/social	Car infrastructure	Private	Strategic
37	Polycentric city	Superblocks	Cycling highways	Green/social	Car infrastructure	Private	District
38	Polycentric city	high PTAL's	PT focus	Pub. parking fields	Walking infrastructure	Shared	Mixed
39	Polycentric city	high PTAL's	PT focus	Pub. parking fields	Walking infrastructure	Shared	Strategic
40	Polycentric city	high PTAL's	PT focus	Pub. parking fields	Cycling infrastructure	Shared	Mixed
41	Polycentric city	high PTAL's	PT focus	Pub. parking fields	Cycling infrastructure	Shared	Strategic
42	Polycentric city	high PTAL's	PT focus	Pub. parking fields	Cycling infrastructure	Shared	District
43	Polycentric city	high PTAL's	PT focus	Pub. parking fields	High PTAL's & safe PT	Shared	Mixed
44	Polycentric city	high PTAL's	PT focus	Pub. parking fields	High PTAL's & safe PT	Shared	Strategic
45	Polycentric city	high PTAL's	PT focus	Pub. parking fields	High PTAL's & safe PT	Shared	District
46	Polycentric city	high PTAL's	PT focus	Green/social	Walking infrastructure	Shared	Mixed
47	Polycentric city	high PTAL's	PT focus	Green/social	Walking infrastructure	Shared	Strategic
48	Polycentric city	high PTAL's	PT focus	Green/social	Cycling infrastructure	Shared	Mixed
49	Polycentric city	high PTAL's	PT focus	Green/social	Cycling infrastructure	Shared	Strategic
50	Polycentric city	high PTAL's	PT focus	Green/social	Cycling infrastructure	Shared	District
51	Polycentric city	high PTAL's	PT focus	Green/social	High PTAL's & safe PT	Shared	Mixed
52	Polycentric city	high PTAL's	PT focus	Green/social	High PTAL's & safe PT	Shared	Strategic
53	Polycentric city	high PTAL's	PT focus	Green/social	High PTAL's & safe PT	Shared	District
54	Polycentric city	automobility	EV-lanes	Priv. parking (driveway)	Car infrastructure	Private	Mixed
55	Polycentric city	automobility	EV-lanes	Priv. parking (driveway)	Car infrastructure	Private	Strategic
56	Polycentric city	automobility	EV-lanes	Priv. parking (driveway)	Car infrastructure	Private	District
57	Polycentric city	automobility	EV-lanes	Priv. parking (driveway)	Charging infrastructure	Private	Mixed
58	Polycentric city	automobility	EV-lanes	Priv. parking (driveway)	Charging infrastructure	Private	Strategic
59	Polycentric city	automobility	EV-lanes	Priv. parking (driveway)	Charging infrastructure	Private	District
60	Polycentric city	automobility	EV-lanes	Priv. parking (driveway)	High PTAL's & safe PT	Private	Mixed
61	Polycentric city	automobility	EV-lanes	Priv. parking (driveway)	High PTAL's & safe PT	Private	Strategic
62	Polycentric city	automobility	EV-lanes	Priv. parking (driveway)	High PTAL's & safe PT	Private	District
63	Polycentric city	automobility	EV-lanes	Priv. parking (roadside)	Car infrastructure	Private	Mixed
64	Polycentric city	automobility	EV-lanes	Priv. parking (roadside)	Car infrastructure	Private	Strategic
65	Polycentric city	automobility	EV-lanes	Priv. parking (roadside)	Car infrastructure	Private	District
66	Polycentric city	automobility	EV-lanes	Priv. parking (roadside)	Charging infrastructure	Private	Mixed
67	Polycentric city	automobility	EV-lanes	Priv. parking (roadside)	Charging infrastructure	Private	Strategic
68	Polycentric city	automobility	EV-lanes	Priv. parking (roadside)	Charging infrastructure	Private	District
69	Polycentric city	automobility	EV-lanes	Priv. parking (roadside)	High PTAL's & safe PT	Private	Mixed
70	Polycentric city	automobility	EV-lanes	Priv. parking (roadside)	High PTAL's & safe PT	Private	Strategic

71	Polycentric city	automobility	EV-lanes	Priv. parking (roadside)	High PTAL's & safe PT	Private	District
72	Polycentric city	automobility	EV-lanes	Pub. parking fields	Car infrastructure	Shared	Mixed
73	Polycentric city	automobility	EV-lanes	Pub. parking fields	Car infrastructure	Shared	Strategic
74	Polycentric city	automobility	EV-lanes	Pub. parking fields	Car infrastructure	Shared	District
75	Polycentric city	automobility	EV-lanes	Pub. parking fields	Charging infrastructure	Shared	Mixed
76	Polycentric city	automobility	EV-lanes	Pub. parking fields	Charging infrastructure	Shared	Strategic
77	Polycentric city	automobility	EV-lanes	Pub. parking fields	Charging infrastructure	Shared	District
78	Polycentric city	automobility	EV-lanes	Pub. parking fields	High PTAL's & safe PT	Shared	Mixed
79	Polycentric city	automobility	EV-lanes	Pub. parking fields	High PTAL's & safe PT	Shared	Strategic
80	Polycentric city	automobility	EV-lanes	Pub. parking fields	High PTAL's & safe PT	Shared	District
81	Polycentric city	automobility	EV-lanes	Green/social	Car infrastructure	Shared	Mixed
82	Polycentric city	automobility	EV-lanes	Green/social	Car infrastructure	Shared	Strategic
83	Polycentric city	automobility	EV-lanes	Green/social	Car infrastructure	Shared	District
84	Polycentric city	automobility	EV-lanes	Green/social	Car infrastructure	Private	Mixed
85	Polycentric city	automobility	EV-lanes	Green/social	Car infrastructure	Private	Strategic
86	Polycentric city	automobility	EV-lanes	Green/social	Car infrastructure	Private	District
87	Polycentric city	automobility	EV-lanes	Green/social	Charging infrastructure	Shared	Mixed
88	Polycentric city	automobility	EV-lanes	Green/social	Charging infrastructure	Shared	Strategic
89	Polycentric city	automobility	EV-lanes	Green/social	Charging infrastructure	Shared	District
90	Polycentric city	automobility	EV-lanes	Green/social	Charging infrastructure	Private	Mixed
91	Polycentric city	automobility	EV-lanes	Green/social	Charging infrastructure	Private	Strategic
92	Polycentric city	automobility	EV-lanes	Green/social	Charging infrastructure	Private	District
93	Polycentric city	automobility	EV-lanes	Green/social	High PTAL's & safe PT	Shared	Mixed
94	Polycentric city	automobility	EV-lanes	Green/social	High PTAL's & safe PT	Shared	Strategic
95	Polycentric city	automobility	EV-lanes	Green/social	High PTAL's & safe PT	Shared	District
96	Polycentric city	automobility	EV-lanes	Green/social	High PTAL's & safe PT	Private	Mixed
97	Polycentric city	automobility	EV-lanes	Green/social	High PTAL's & safe PT	Private	Strategic
98	Polycentric city	automobility	EV-lanes	Green/social	High PTAL's & safe PT	Private	District
99	compact city	Superblocks	Cycling highways	Priv. parking (driveway)	Walking infrastructure	Private	Mixed
100	compact city	Superblocks	Cycling highways	Priv. parking (driveway)	Walking infrastructure	Private	Strategic
101	compact city	Superblocks	Cycling highways	Priv. parking (driveway)	Cycling infrastructure	Private	Mixed
102	compact city	Superblocks	Cycling highways	Priv. parking (driveway)	Cycling infrastructure	Private	Strategic
103	compact city	Superblocks	Cycling highways	Priv. parking (driveway)	Cycling infrastructure	Private	District
104	compact city	Superblocks	Cycling highways	Priv. parking (driveway)	Car infrastructure	Private	Mixed
105	compact city	Superblocks	Cycling highways	Priv. parking (driveway)	Car infrastructure	Private	Strategic
106	compact city	Superblocks	Cycling highways	Priv. parking (driveway)	Car infrastructure	Private	District
107	compact city	Superblocks	Cycling highways	Priv. parking (roadside)	Walking infrastructure	Private	Mixed

108	compact city	Superblocks	Cycling highways	Priv. parking (roadside)	Walking infrastructure	Private	Strategic
109	compact city	Superblocks	Cycling highways	Priv. parking (roadside)	Car infrastructure	Private	Mixed
110	compact city	Superblocks	Cycling highways	Priv. parking (roadside)	Car infrastructure	Private	Strategic
111	compact city	Superblocks	Cycling highways	Priv. parking (roadside)	Car infrastructure	Private	District
112	compact city	Superblocks	Cycling highways	Pub. parking fields	Walking infrastructure	Shared	Mixed
113	compact city	Superblocks	Cycling highways	Pub. parking fields	Walking infrastructure	Shared	Strategic
114	compact city	Superblocks	Cycling highways	Pub. parking fields	Cycling infrastructure	Shared	Mixed
115	compact city	Superblocks	Cycling highways	Pub. parking fields	Cycling infrastructure	Shared	Strategic
116	compact city	Superblocks	Cycling highways	Pub. parking fields	Cycling infrastructure	Shared	District
117	compact city	Superblocks	Cycling highways	Pub. parking fields	Car infrastructure	Shared	Mixed
118	compact city	Superblocks	Cycling highways	Pub. parking fields	Car infrastructure	Shared	Strategic
119	compact city	Superblocks	Cycling highways	Pub. parking fields	Car infrastructure	Shared	District
120	compact city	Superblocks	Cycling highways	Green/social	Walking infrastructure	Shared	Mixed
121	compact city	Superblocks	Cycling highways	Green/social	Walking infrastructure	Shared	Strategic
122	compact city	Superblocks	Cycling highways	Green/social	Walking infrastructure	Private	Mixed
123	compact city	Superblocks	Cycling highways	Green/social	Walking infrastructure	Private	Strategic
124	compact city	Superblocks	Cycling highways	Green/social	Cycling infrastructure	Shared	Mixed
125	compact city	Superblocks	Cycling highways	Green/social	Cycling infrastructure	Shared	Strategic
126	compact city	Superblocks	Cycling highways	Green/social	Cycling infrastructure	Shared	District
127	compact city	Superblocks	Cycling highways	Green/social	Cycling infrastructure	Private	Mixed
128	compact city	Superblocks	Cycling highways	Green/social	Cycling infrastructure	Private	Strategic
129	compact city	Superblocks	Cycling highways	Green/social	Cycling infrastructure	Private	District
130	compact city	Superblocks	Cycling highways	Green/social	Car infrastructure	Shared	Mixed
131	compact city	Superblocks	Cycling highways	Green/social	Car infrastructure	Shared	Strategic
132	compact city	Superblocks	Cycling highways	Green/social	Car infrastructure	Shared	District
133	compact city	Superblocks	Cycling highways	Green/social	Car infrastructure	Private	Mixed
134	compact city	Superblocks	Cycling highways	Green/social	Car infrastructure	Private	Strategic
135	compact city	Superblocks	Cycling highways	Green/social	Car infrastructure	Private	District
136	compact city	high PTAL's	PT focus	Pub. parking fields	Walking infrastructure	Shared	Mixed
137	compact city	high PTAL's	PT focus	Pub. parking fields	Walking infrastructure	Shared	Strategic
138	compact city	high PTAL's	PT focus	Pub. parking fields	Cycling infrastructure	Shared	Mixed
139	compact city	high PTAL's	PT focus	Pub. parking fields	Cycling infrastructure	Shared	Strategic
140	compact city	high PTAL's	PT focus	Pub. parking fields	Cycling infrastructure	Shared	District
141	compact city	high PTAL's	PT focus	Pub. parking fields	High PTAL's & safe PT	Shared	Mixed
142	compact city	high PTAL's	PT focus	Pub. parking fields	High PTAL's & safe PT	Shared	Strategic
143	compact city	high PTAL's	PT focus	Pub. parking fields	High PTAL's & safe PT	Shared	District
144	compact city	high PTAL's	PT focus	Green/social	Walking infrastructure	Shared	Mixed

145	compact city	high PTAL's	PT focus	Green/social	Walking infrastructure	Shared	Strategic
146	compact city	high PTAL's	PT focus	Green/social	Cycling infrastructure	Shared	Mixed
147	compact city	high PTAL's	PT focus	Green/social	Cycling infrastructure	Shared	Strategic
148	compact city	high PTAL's	PT focus	Green/social	Cycling infrastructure	Shared	District
149	compact city	high PTAL's	PT focus	Green/social	High PTAL's & safe PT	Shared	Mixed
150	compact city	high PTAL's	PT focus	Green/social	High PTAL's & safe PT	Shared	Strategic
151	compact city	high PTAL's	PT focus	Green/social	High PTAL's & safe PT	Shared	District
152	compact city	automobility	EV-lanes	Priv. parking (driveway)	Car infrastructure	Private	Mixed
153	compact city	automobility	EV-lanes	Priv. parking (driveway)	Car infrastructure	Private	Strategic
154	compact city	automobility	EV-lanes	Priv. parking (driveway)	Car infrastructure	Private	District
155	compact city	automobility	EV-lanes	Priv. parking (driveway)	Charging infrastructure	Private	Mixed
156	compact city	automobility	EV-lanes	Priv. parking (driveway)	Charging infrastructure	Private	Strategic
157	compact city	automobility	EV-lanes	Priv. parking (driveway)	Charging infrastructure	Private	District
158	compact city	automobility	EV-lanes	Priv. parking (driveway)	High PTAL's & safe PT	Private	Mixed
159	compact city	automobility	EV-lanes	Priv. parking (driveway)	High PTAL's & safe PT	Private	Strategic
160	compact city	automobility	EV-lanes	Priv. parking (driveway)	High PTAL's & safe PT	Private	District
161	compact city	automobility	EV-lanes	Priv. parking (roadside)	Car infrastructure	Private	Mixed
162	compact city	automobility	EV-lanes	Priv. parking (roadside)	Car infrastructure	Private	Strategic
163	compact city	automobility	EV-lanes	Priv. parking (roadside)	Car infrastructure	Private	District
164	compact city	automobility	EV-lanes	Priv. parking (roadside)	Charging infrastructure	Private	Mixed
165	compact city	automobility	EV-lanes	Priv. parking (roadside)	Charging infrastructure	Private	Strategic
166	compact city	automobility	EV-lanes	Priv. parking (roadside)	Charging infrastructure	Private	District
167	compact city	automobility	EV-lanes	Priv. parking (roadside)	High PTAL's & safe PT	Private	Mixed
168	compact city	automobility	EV-lanes	Priv. parking (roadside)	High PTAL's & safe PT	Private	Strategic
169	compact city	automobility	EV-lanes	Priv. parking (roadside)	High PTAL's & safe PT	Private	District
170	compact city	automobility	EV-lanes	Pub. parking fields	Car infrastructure	Shared	Mixed
171	compact city	automobility	EV-lanes	Pub. parking fields	Car infrastructure	Shared	Strategic
172	compact city	automobility	EV-lanes	Pub. parking fields	Car infrastructure	Shared	District
173	compact city	automobility	EV-lanes	Pub. parking fields	Charging infrastructure	Shared	Mixed
174	compact city	automobility	EV-lanes	Pub. parking fields	Charging infrastructure	Shared	Strategic
175	compact city	automobility	EV-lanes	Pub. parking fields	Charging infrastructure	Shared	District
176	compact city	automobility	EV-lanes	Pub. parking fields	High PTAL's & safe PT	Shared	Mixed
177	compact city	automobility	EV-lanes	Pub. parking fields	High PTAL's & safe PT	Shared	Strategic
178	compact city	automobility	EV-lanes	Pub. parking fields	High PTAL's & safe PT	Shared	District
179	compact city	automobility	EV-lanes	Green/social	Car infrastructure	Shared	Mixed
180	compact city	automobility	EV-lanes	Green/social	Car infrastructure	Shared	Strategic

181	compact city	automobility	EV-lanes	Green/social	Car infrastructure	Shared	District
182	compact city	automobility	EV-lanes	Green/social	Car infrastructure	Private	Mixed
183	compact city	automobility	EV-lanes	Green/social	Car infrastructure	Private	Strategic
184	compact city	automobility	EV-lanes	Green/social	Car infrastructure	Private	District
185	compact city	automobility	EV-lanes	Green/social	Charging infrastructure	Shared	Mixed
186	compact city	automobility	EV-lanes	Green/social	Charging infrastructure	Shared	Strategic
187	compact city	automobility	EV-lanes	Green/social	Charging infrastructure	Shared	District
188	compact city	automobility	EV-lanes	Green/social	Charging infrastructure	Private	Mixed
189	compact city	automobility	EV-lanes	Green/social	Charging infrastructure	Private	Strategic
190	compact city	automobility	EV-lanes	Green/social	Charging infrastructure	Private	District
191	compact city	automobility	EV-lanes	Green/social	High PTAL's & safe PT	Shared	Mixed
192	compact city	automobility	EV-lanes	Green/social	High PTAL's & safe PT	Shared	Strategic
193	compact city	automobility	EV-lanes	Green/social	High PTAL's & safe PT	Shared	District
194	compact city	automobility	EV-lanes	Green/social	High PTAL's & safe PT	Private	Mixed
195	compact city	automobility	EV-lanes	Green/social	High PTAL's & safe PT	Private	Strategic
196	compact city	automobility	EV-lanes	Green/social	High PTAL's & safe PT	Private	District
197	compact city	automobility	Automobility focus	Priv. parking (driveway)	Car infrastructure	Private	Mixed
198	compact city	automobility	Automobility focus	Priv. parking (driveway)	Car infrastructure	Private	Strategic
199	compact city	automobility	Automobility focus	Priv. parking (driveway)	Car infrastructure	Private	District
200	compact city	automobility	Automobility focus	Priv. parking (driveway)	Charging infrastructure	Private	Mixed
201	compact city	automobility	Automobility focus	Priv. parking (driveway)	Charging infrastructure	Private	Strategic
202	compact city	automobility	Automobility focus	Priv. parking (driveway)	Charging infrastructure	Private	District
203	compact city	automobility	Automobility focus	Priv. parking (driveway)	High PTAL's & safe PT	Private	Mixed
204	compact city	automobility	Automobility focus	Priv. parking (driveway)	High PTAL's & safe PT	Private	Strategic
205	compact city	automobility	Automobility focus	Priv. parking (driveway)	High PTAL's & safe PT	Private	District
206	compact city	automobility	Automobility focus	Priv. parking (roadside)	Car infrastructure	Private	Mixed
207	compact city	automobility	Automobility focus	Priv. parking (roadside)	Car infrastructure	Private	Strategic
208	compact city	automobility	Automobility focus	Priv. parking (roadside)	Car infrastructure	Private	District
209	compact city	automobility	Automobility focus	Priv. parking (roadside)	Charging infrastructure	Private	Mixed
210	compact city	automobility	Automobility focus	Priv. parking (roadside)	Charging infrastructure	Private	Strategic
211	compact city	automobility	Automobility focus	Priv. parking (roadside)	Charging infrastructure	Private	District
212	compact city	automobility	Automobility focus	Priv. parking (roadside)	High PTAL's & safe PT	Private	Mixed
213	compact city	automobility	Automobility focus	Priv. parking (roadside)	High PTAL's & safe PT	Private	Strategic
214	compact city	automobility	Automobility focus	Priv. parking (roadside)	High PTAL's & safe PT	Private	District
215	compact city	automobility	Automobility focus	Pub. parking fields	Car infrastructure	Shared	Mixed
216	compact city	automobility	Automobility focus	Pub. parking fields	Car infrastructure	Shared	Strategic
217	compact city	automobility	Automobility focus	Pub. parking fields	Car infrastructure	Shared	District

218	compact city	automobility	Automobility focus	Pub. parking fields	Charging infrastructure	Shared	Mixed
219	compact city	automobility	Automobility focus	Pub. parking fields	Charging infrastructure	Shared	Strategic
220	compact city	automobility	Automobility focus	Pub. parking fields	Charging infrastructure	Shared	District
221	compact city	automobility	Automobility focus	Pub. parking fields	High PTAL's & safe PT	Shared	Mixed
222	compact city	automobility	Automobility focus	Pub. parking fields	High PTAL's & safe PT	Shared	Strategic
223	compact city	automobility	Automobility focus	Pub. parking fields	High PTAL's & safe PT	Shared	District
224	TOD	high PTAL's	PT focus	Pub. parking fields	Walking infrastructure	Shared	Mixed
225	TOD	high PTAL's	PT focus	Pub. parking fields	Walking infrastructure	Shared	Strategic
226	TOD	high PTAL's	PT focus	Pub. parking fields	Cycling infrastructure	Shared	Mixed
227	TOD	high PTAL's	PT focus	Pub. parking fields	Cycling infrastructure	Shared	Strategic
228	TOD	high PTAL's	PT focus	Pub. parking fields	Cycling infrastructure	Shared	District
229	TOD	high PTAL's	PT focus	Pub. parking fields	High PTAL's & safe PT	Shared	Mixed
230	TOD	high PTAL's	PT focus	Pub. parking fields	High PTAL's & safe PT	Shared	Strategic
231	TOD	high PTAL's	PT focus	Pub. parking fields	High PTAL's & safe PT	Shared	District
232	TOD	high PTAL's	PT focus	Green/social	Walking infrastructure	Shared	Mixed
233	TOD	high PTAL's	PT focus	Green/social	Walking infrastructure	Shared	Strategic
234	TOD	high PTAL's	PT focus	Green/social	Cycling infrastructure	Shared	Mixed
235	TOD	high PTAL's	PT focus	Green/social	Cycling infrastructure	Shared	Strategic
236	TOD	high PTAL's	PT focus	Green/social	Cycling infrastructure	Shared	District
237	TOD	high PTAL's	PT focus	Green/social	High PTAL's & safe PT	Shared	Mixed
238	TOD	high PTAL's	PT focus	Green/social	High PTAL's & safe PT	Shared	Strategic
239	TOD	high PTAL's	PT focus	Green/social	High PTAL's & safe PT	Shared	District
240	(Horizontal) sprawl	high PTAL's	PT focus	Pub. parking fields	High PTAL's & safe PT	Shared	Mixed
241	(Horizontal) sprawl	high PTAL's	PT focus	Pub. parking fields	High PTAL's & safe PT	Shared	Strategic
242	(Horizontal) sprawl	high PTAL's	PT focus	Pub. parking fields	High PTAL's & safe PT	Shared	District
243	(Horizontal) sprawl	high PTAL's	PT focus	Green/social	High PTAL's & safe PT	Shared	Mixed
244	(Horizontal) sprawl	high PTAL's	PT focus	Green/social	High PTAL's & safe PT	Shared	Strategic
245	(Horizontal) sprawl	high PTAL's	PT focus	Green/social	High PTAL's & safe PT	Shared	District
246	(Horizontal) sprawl	automobility	EV-lanes	Priv. parking (driveway)	Car infrastructure	Private	Mixed
247	(Horizontal) sprawl	automobility	EV-lanes	Priv. parking (driveway)	Car infrastructure	Private	Strategic
248	(Horizontal) sprawl	automobility	EV-lanes	Priv. parking (driveway)	Car infrastructure	Private	District
249	(Horizontal) sprawl	automobility	EV-lanes	Priv. parking (driveway)	Charging infrastructure	Private	Mixed
250	(Horizontal) sprawl	automobility	EV-lanes	Priv. parking (driveway)	Charging infrastructure	Private	Strategic
251	(Horizontal) sprawl	automobility	EV-lanes	Priv. parking (driveway)	Charging infrastructure	Private	District
252	(Horizontal) sprawl	automobility	EV-lanes	Priv. parking (driveway)	High PTAL's & safe PT	Private	Mixed

253	(Horizontal) sprawl	automobility	EV-lanes	Priv. parking (driveway)	High PTAL's & safe PT	Private	Strategic
254	(Horizontal) sprawl	automobility	EV-lanes	Priv. parking (driveway)	High PTAL's & safe PT	Private	District
255	(Horizontal) sprawl	automobility	EV-lanes	Priv. parking (roadside)	Car infrastructure	Private	Mixed
256	(Horizontal) sprawl	automobility	EV-lanes	Priv. parking (roadside)	Car infrastructure	Private	Strategic
257	(Horizontal) sprawl	automobility	EV-lanes	Priv. parking (roadside)	Car infrastructure	Private	District
258	(Horizontal) sprawl	automobility	EV-lanes	Priv. parking (roadside)	Charging infrastructure	Private	Mixed
259	(Horizontal) sprawl	automobility	EV-lanes	Priv. parking (roadside)	Charging infrastructure	Private	Strategic
260	(Horizontal) sprawl	automobility	EV-lanes	Priv. parking (roadside)	Charging infrastructure	Private	District
261	(Horizontal) sprawl	automobility	EV-lanes	Priv. parking (roadside)	High PTAL's & safe PT	Private	Mixed
262	(Horizontal) sprawl	automobility	EV-lanes	Priv. parking (roadside)	High PTAL's & safe PT	Private	Strategic
263	(Horizontal) sprawl	automobility	EV-lanes	Priv. parking (roadside)	High PTAL's & safe PT	Private	District
264	(Horizontal) sprawl	automobility	EV-lanes	Pub. parking fields	Car infrastructure	Shared	Mixed
265	(Horizontal) sprawl	automobility	EV-lanes	Pub. parking fields	Car infrastructure	Shared	Strategic
266	(Horizontal) sprawl	automobility	EV-lanes	Pub. parking fields	Car infrastructure	Shared	District
267	(Horizontal) sprawl	automobility	EV-lanes	Pub. parking fields	Charging infrastructure	Shared	Mixed
268	(Horizontal) sprawl	automobility	EV-lanes	Pub. parking fields	Charging infrastructure	Shared	Strategic
269	(Horizontal) sprawl	automobility	EV-lanes	Pub. parking fields	Charging infrastructure	Shared	District
270	(Horizontal) sprawl	automobility	EV-lanes	Pub. parking fields	High PTAL's & safe PT	Shared	Mixed
271	(Horizontal) sprawl	automobility	EV-lanes	Pub. parking fields	High PTAL's & safe PT	Shared	Strategic
272	(Horizontal) sprawl	automobility	EV-lanes	Pub. parking fields	High PTAL's & safe PT	Shared	District
273	(Horizontal) sprawl	automobility	EV-lanes	Green/social	Car infrastructure	Shared	Mixed
274	(Horizontal) sprawl	automobility	EV-lanes	Green/social	Car infrastructure	Shared	Strategic
275	(Horizontal) sprawl	automobility	EV-lanes	Green/social	Car infrastructure	Shared	District
276	(Horizontal) sprawl	automobility	EV-lanes	Green/social	Car infrastructure	Private	Mixed
277	(Horizontal) sprawl	automobility	EV-lanes	Green/social	Car infrastructure	Private	Strategic
278	(Horizontal) sprawl	automobility	EV-lanes	Green/social	Car infrastructure	Private	District
279	(Horizontal) sprawl	automobility	EV-lanes	Green/social	Charging infrastructure	Shared	Mixed
280	(Horizontal) sprawl	automobility	EV-lanes	Green/social	Charging infrastructure	Shared	Strategic
281	(Horizontal) sprawl	automobility	EV-lanes	Green/social	Charging infrastructure	Shared	District
282	(Horizontal) sprawl	automobility	EV-lanes	Green/social	Charging infrastructure	Private	Mixed
283	(Horizontal) sprawl	automobility	EV-lanes	Green/social	Charging infrastructure	Private	Strategic
284	(Horizontal) sprawl	automobility	EV-lanes	Green/social	Charging infrastructure	Private	District
285	(Horizontal) sprawl	automobility	EV-lanes	Green/social	High PTAL's & safe PT	Shared	Mixed
286	(Horizontal) sprawl	automobility	EV-lanes	Green/social	High PTAL's & safe PT	Shared	Strategic
287	(Horizontal) sprawl	automobility	EV-lanes	Green/social	High PTAL's & safe PT	Shared	District

288	(Horizontal) sprawl	automobility	EV-lanes	Green/social	High PTAL's & safe PT	Private	Mixed
289	(Horizontal) sprawl	automobility	EV-lanes	Green/social	High PTAL's & safe PT	Private	Strategic
290	(Horizontal) sprawl	automobility	EV-lanes	Green/social	High PTAL's & safe PT	Private	District
291	(Horizontal) sprawl	automobility	Automobility focus	Priv. parking (driveway)	Car infrastructure	Private	Mixed
292	(Horizontal) sprawl	automobility	Automobility focus	Priv. parking (driveway)	Car infrastructure	Private	Strategic
293	(Horizontal) sprawl	automobility	Automobility focus	Priv. parking (driveway)	Car infrastructure	Private	District
294	(Horizontal) sprawl	automobility	Automobility focus	Priv. parking (driveway)	Charging infrastructure	Private	Mixed
295	(Horizontal) sprawl	automobility	Automobility focus	Priv. parking (driveway)	Charging infrastructure	Private	Strategic
296	(Horizontal) sprawl	automobility	Automobility focus	Priv. parking (driveway)	Charging infrastructure	Private	District
297	(Horizontal) sprawl	automobility	Automobility focus	Priv. parking (driveway)	High PTAL's & safe PT	Private	Mixed
298	(Horizontal) sprawl	automobility	Automobility focus	Priv. parking (driveway)	High PTAL's & safe PT	Private	Strategic
299	(Horizontal) sprawl	automobility	Automobility focus	Priv. parking (driveway)	High PTAL's & safe PT	Private	District
300	(Horizontal) sprawl	automobility	Automobility focus	Priv. parking (roadside)	Car infrastructure	Private	Mixed
301	(Horizontal) sprawl	automobility	Automobility focus	Priv. parking (roadside)	Car infrastructure	Private	Strategic
302	(Horizontal) sprawl	automobility	Automobility focus	Priv. parking (roadside)	Car infrastructure	Private	District
303	(Horizontal) sprawl	automobility	Automobility focus	Priv. parking (roadside)	Charging infrastructure	Private	Mixed
304	(Horizontal) sprawl	automobility	Automobility focus	Priv. parking (roadside)	Charging infrastructure	Private	Strategic
305	(Horizontal) sprawl	automobility	Automobility focus	Priv. parking (roadside)	Charging infrastructure	Private	District
306	(Horizontal) sprawl	automobility	Automobility focus	Priv. parking (roadside)	High PTAL's & safe PT	Private	Mixed
307	(Horizontal) sprawl	automobility	Automobility focus	Priv. parking (roadside)	High PTAL's & safe PT	Private	Strategic
308	(Horizontal) sprawl	automobility	Automobility focus	Priv. parking (roadside)	High PTAL's & safe PT	Private	District
309	(Horizontal) sprawl	automobility	Automobility focus	Pub. parking fields	Car infrastructure	Shared	Mixed
310	(Horizontal) sprawl	automobility	Automobility focus	Pub. parking fields	Car infrastructure	Shared	Strategic
311	(Horizontal) sprawl	automobility	Automobility focus	Pub. parking fields	Car infrastructure	Shared	District
312	(Horizontal) sprawl	automobility	Automobility focus	Pub. parking fields	Charging infrastructure	Shared	Mixed
313	(Horizontal) sprawl	automobility	Automobility focus	Pub. parking fields	Charging infrastructure	Shared	Strategic
314	(Horizontal) sprawl	automobility	Automobility focus	Pub. parking fields	Charging infrastructure	Shared	District
315	(Horizontal) sprawl	automobility	Automobility focus	Pub. parking fields	High PTAL's & safe PT	Shared	Mixed
316	(Horizontal) sprawl	automobility	Automobility focus	Pub. parking fields	High PTAL's & safe PT	Shared	Strategic
317	(Horizontal) sprawl	automobility	Automobility focus	Pub. parking fields	High PTAL's & safe PT	Shared	District