Transport and Well-being in the Netherlands

Analysing the relationships between perceived accessibility, transport poverty, and well-being in the Dutch context

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PREFACE

Before you lies the final product of my graduation project on transport and well-being in the Netherlands which focused on connecting accessibility and well-being of the population using the capabilities approach to bring another perspective to transport and mobility planning. The months that I dedicated to it presented great crises related to transportation, such as pandemics, wars and energy crises. Those complex and rough moments, despite their negative consequences, bring a spark to research and puts innovation an urgency for the whole world to make a shift.

I started this project inspired by the book by Mimi Sheller, Mobility Justice, and a million ideas that thanks to the interest and help of my main supervisor, Pauline van den Berg, helped me to produce this master thesis. Also, this project allowed me to join TNO, where Tanja Vonk was part of the advisory committee and connected me with a lot of incredible people that work there and showed great interest in the topic.

First, I'd like to thank all my supervisors for the feedback, help, and expertise, you were all crucial for me to have more focus on the goals of this research and deliver a project that I am very proud of. Second, and in a very cheesy way, I'd like more than anything to thank my parents. You were the first one that made me realise that I am more than capable to chase my dreams wherever I choose to do so. Thank you for your support, freedom, and trust. Third, of course, my beloved friends. Either from Brazil, the Netherlands or wherever they are in the world, they became my most cherished supporters in the good and bad moments. Special thanks to Tomás, Thomas and Eduardo, my Brazilian brothers in the Netherlands. Thank you for the huge daily encouragement. Obrigada a todos (thank you, everyone)!

This project marks a special moment in my professional career where I put myself as a master's graduate and future scientist that comes from a technical background and has a great interest in social studies, especially related to equity and justice, applied to transportation and movements. I hope this master thesis is not only informative, but also inspiring for the reader to think about the unfairness of mobility on the local, national, and global scale.

Rotterdam, August 2022

Maiara Biscaro Uliana

ABSTRACT

Travel is known to be a key element that provides a way to access economic, social, and other essential activities for people, which in turn can promote social and individual well-being. In this sense, it is crucial to understand how certain groups perceive their daily accessibility, the experience of transport poverty, and how this is related to their well-being. Transport poverty in the present study is defined and composed of four different components: transport affordability, mobility poverty, accessibility poverty, and exposure to transport externalities. If an individual endures at least one of the components, it is understood that they are experiencing transport poverty.

It is still a challenge to identify transport poverty since there is no unified way to measure it, as it is highly dependent on the definition adopted, the threshold, local context, transport planning, and land use. In the Dutch context, some research identifies certain groups that are at risk of facing transport poverty considering a sufficient threshold level of accessibility to jobs, however, the relationship with well-being is not explicitly considered. The present study contributes to quantitative research on transport poverty and its relationship with well-being in the Netherlands using perceived accessibility and well-being data. Also, it brings the application of the capabilities approach to transport as an attempt to connect accessibility and well-being. The capabilities approach is a proposition that argues that the most important aspect of a person's life is their freedom to choose which is dependent on their capabilities set and influences their well-being. In transport literature, the application of the capabilities approach frames accessibility as a capability.

The aim of this study is twofold. First, it examines the relations between perceived accessibility, transport poverty, well-being, and socio-economic and transport characteristics. Next, it visually explores the spatial distribution using maps of the different levels of perceived accessibility, transport poverty, and well-being in Rotterdam and Utrecht.

The data used was part of the Mobimon project, in which 1058 residents from Rotterdam and Utrecht between the ages of 18 and 70 years old answered a series of questions about their travel behaviour and how they experienced the transportation system. The perceived accessibility data considered accessibility to jobs and other key life destinations. Perceived transport poverty data is composed of four different aspects: affordability, mobility poverty, accessibility poverty, and exposure to traffic externalities. Perceived well-being data represents how individuals evaluate their lives and certain domains of their lives. In addition, CBS and ODiN data were applied to the study to enrich the descriptive analysis of the local context of both cities.

Perceived accessibility, transport poverty, and well-being variables were obtained by factor analysis and reducing observed variables into latent ones. Because transport poverty was measured backwards, the variable was named perceive transport adequacy. For investigating the relationship between socio-economic and mobility characteristics, accessibility, transport adequacy, and well-being, t-tests,

ANOVAs, and multiple linear regression were applied to the data. For the visual analysis, maps were created to present the distribution of the different levels of the three latent variables.

The main conclusions reveal that age, household formation, income, migration background, use of mobility aid, having a driver's license, and car ownership have a relation to accessibility, transport poverty, and well-being. In addition, the results about other private transport modes used and public transport shed a light on the impact that they have on the dependent variables. Users of mopeds, scooters and motorcycles have a positive relation to their perceived transport adequacy and well-being. Regarding public transport, train users contribute to accessibility while metro and tram users perceive their transport adequacy negatively and bus users contribute to well-being. Accessibility and transport poverty results also show a positive relationship to the perceived well-being of an individual. An unexpected result from this study shows that when it comes to gender, women have a more positive perception of their accessibility and are less likely to experience transport poverty compared to men.

The maps from Rotterdam and Utrecht show some patterns when it comes to the distribution of different levels of perceived accessibility, transport poverty and well-being. Usually, the same areas that present low levels of one of the variables also present low levels of another variable. Rotterdam shows similar patterns of perceived accessibility, transport adequacy and well-being, with regions located to the east and north part of the city presenting higher values. All the variables in Utrecht reach an average value higher compared to Rotterdam. Regarding the distribution in Utrecht, the southeast and centre present the highest values, followed by some areas in the north and west. Although this spatial distribution is identified, it is a geographical aggregate measurement, and accessibility, transport poverty and well-being should be disaggregated at a personal level rather than a geographical level.

The results from this study contribute to the understanding of the experience of transport poverty in the Dutch context and how it is related to perceived well-being of individuals. The literature review and methodology adopted provide insight into the adoption of the capabilities approach to transport and mobility. The findings may provide useful information for local governments, planners and researchers to incorporate another perspective and bring social innovation to transport policies and planning. Practice recommendations aim in promoting well-being for the individuals, and not only to increase levels of accessibility. Recommendations for future research in the Dutch context include expanding the analysis of transport poverty and well-being to other regions, such as rural areas and analysing the causal relations between the variables.

Keywords: *accessibility, transport poverty, well-being, capabilities approach, transport equity*

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1 Introduction

1.1 Background

The world is currently experiencing an urgent need to shift to a less carbonized energy and transport system to face climate change (Martiskainen et al., 2021). In 2015 all United Nations members signed the 2030 Agenda for Sustainable Development that contains goals to tackle climate change while addressing economic, health, educational and inequality issues as well (UN, 2021). There are seventeen goals on the agenda, and some of them specifically aim to create more resilient, inclusive, safe and sustainable cities (UN, 2021). Martiskainen et al. (2020) argue that to decarbonize society it is crucial to understand and recognize the impacts that such a transition could have on vulnerable groups since they could face energy and transport poverty and have their well-being affected by it.

Although there is no universal definition for poverty, it relates to the inability to afford or access a certain service (Lowans et al., 2021). In that sense, energy poverty is defined by the inability to afford adequate heat, electricity and energy services in a household (Lowans et al., 2021). When it comes to transport poverty, Lucas et al. (2016) argue that the term is not completely defined by the literature, and it is challenging to establish it at a household level since everyone could face transport poverty at a different level. In addition, it becomes even more complex to have a definition since the literature uses several terminologies to discuss transport poverty and has distinct or overlapping definitions at the same time (Lucas et al., 2016).

Despite that, according to research, the most accepted and broad definition so far understands that transport poverty is composed of 4 components: *affordability* (inability to meet the costs of transport), *mobility poverty* (lack of access to (motorized) transport), *accessibility poverty* (lack to access key life activities due to lack of transport) and *exposure to transport externalities* (Lucas et al., 2016). These elements in a broader sense, have been related to social exclusion and the well-being of a person. In the study by Lucas (2012) data from different countries clearly show evidence that reduced mobility (mobility poverty) and lack of access to key life activities (accessibility poverty) lead to social exclusion and/or lower people's life chances and well-being. In addition, Awaworyi Churchill and Smyth (2019) also explain in their study that adversities linked to accessibility and costs of transportation have been linked with lower subjective well-being in previous research.

In the same way that mobility poverty still does not have a unified definition, it also does not have a standardized metric to be measured, which is reflected by the different ways to gather data in multiple countries (Lowans et al., 2021). Lucas et al. (2016) argue that if one of the aspects that identify transport poverty is being measured, it is expected that this element will be the key determinant to understanding who is experiencing transport poverty and the measurement will be highly dependent on the local context, the transport planning and land use of the study area.

Transport poverty, in this sense, is a phenomenon that represents adversity for an individual to travel around. The act of travelling has been found to promote economic and social activity, that results in societal and individual well-being (Delbosc and Currie, 2018). Transportation systems have the purpose to present the opportunity for people to participate in their daily, social and necessary activities essential for their well-being (Allen and Farber, 2019). So, if a person cannot access their daily activities, their well-being could be affected by it.

One way to assess the event or risk of mobility poverty is by analysing transport equity. As Lucas et al. (2019) discuss, there is no single correct way to measure it [transport equity], however, it contains the same elements that compose mobility poverty: accessibility to transport in terms of infrastructure and expenditures, accessibility to key life activities, reduction of exposures to transport externalities and it adds that people and communities should be allowed more participation in decision-making processes.

Martens et al. (2019) describe in their book that a widely accepted definition and a key dimension of the concept of transport equity is referring to "equity or justice as the morally proper distribution of benefits and burdens over members of society". Four key dimensions of transport equity can be measured - mobility/accessibility, traffic-related pollution, traffic safety, and health - considering four different focal variables: resources, opportunities or risks, outcomes, and well-being (Martens et al., 2019).

To assess fairness in the transport system, Kuttler and Moraglio (2021c) present the Capability Approach (CA) as an alternative. CA was conceptualized by Amartya Sen (Sen, 1992) and further developed by Martha Nussbaum (Nussbaum and Sen, 1993) who argues that the most important aspect of an individual's life is their freedom to choose, which leads them to have a certain type of [chosen] life (Vecchio and Martens, 2021). According to Vecchio and Martens (2021), several authors suggest that the Capability Approach presents a framework that can contribute to the impact of the transport system on an individual's life, considering a wide range of individuals and how the resources available shape a person's opportunities and well-being.

1.2 Problem Definition and Description

In the Dutch context, some research has dealt with measuring transport poverty. The study by Jorritsma et al. (2018) on transport poverty explains that it is still not clear how and to what extent it exists in the Netherlands, however, certain social groups are at risk to have their participation in activities affected due to deficient transport options to mention: people with low income, unemployed/job seekers, elderly (especially women), individuals without driver license, people with a migration background and residents of rural areas.

To better understand the phenomena, Martens and Bastiaanssen (2019) assessed patterns of accessibility to translate them into an index to measure accessibility poverty, one of the dimensions of transport poverty risk, in the Rotterdam-the Hague region according to individuals' potential mobility. In this case, job accessibility was measured since it can provide a greater sense of accessibility in general,

and key results show the population that experiences accessibility poverty and their spatial location (Martens and Bastiaanssen, 2019).

One of the suggested follow-up research directions indicated by Jorritsma et al. (2018) is to use quantitative data to evaluate the effect of influencing factors on transport poverty. Also, the study by Martens and Bastiaanssen (2019) does not consider accessibility to other locations either than work, like health care, supermarkets, leisure and social activities. In addition to these topics, the mentioned studies by Jorritsma et al. (2018) and Martens and Bastiaanssen (2019) do not discuss explicitly two issues, (1) people's perception related to transport experience and (2) the relations and underlying factors between transport poverty and well-being of an individual. In the next section, the objectives and questions from this present study will be introduced, as an attempt to include the 2 issues mentioned before.

1.3 Research Objectives and Questions

This present study has the objective to contribute to quantitative research on transport poverty in the Netherlands using perceived accessibility, transport poverty and well-being data collected through surveys from two different cities: Rotterdam and Utrecht. The perceived accessibility data used will consider accessibility to jobs and key life destinations as well to contribute to the research by Martens and Bastiaanssen (2019), since the mentioned study only focuses on accessibility to jobs. The perceived data on transport poverty is based on the definition by Lucas et al. (2016) given in the introduction. The perceived subjective well-being data represents how individuals evaluate their lives and certain domains of their lives, like the transportation system.

This study has two aims. *First,* it investigates the relations between perceived accessibility, transport poverty, well-being, and socio-economic and transport characteristics. *Second,* the research checks the spatial distribution of different levels of perceived accessibility, transport poverty and well-being with maps. The following Figure 1 presents the conceptual model built based on the aims of this research. Perceived transport poverty in the conceptual model takes into account the four components that Lucas et al. (2016) bring: affordability, mobility poverty, accessibility poverty and exposure to transport externalities.

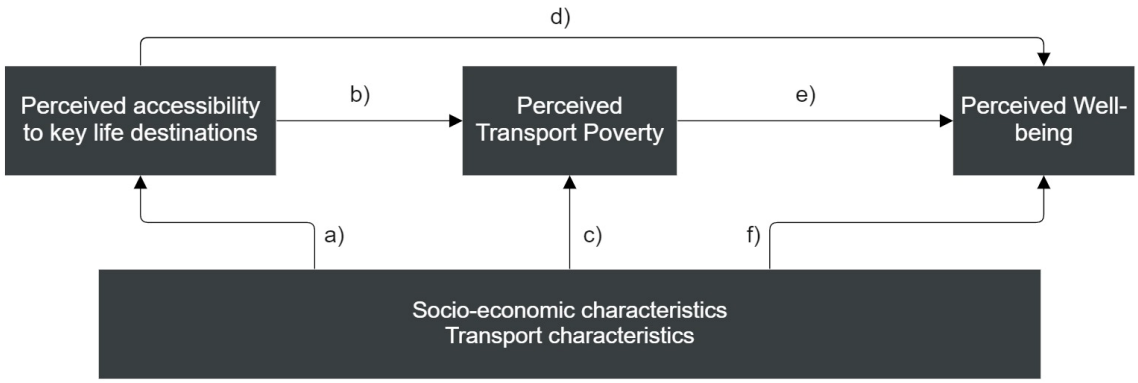

Figure 1: Conceptual model.

The relations presented in the conceptual model in Figure 1 are based on literature. Perceived accessibility is shaped by an individual's socio-economic aspects such as income and age, and car ownership but also by the geographical context – if a person lives closer or further away from the city centre or in an area with a different level of transport provision. In the same sense, these two aspects can cause the experience of transport poverty, or the inability to meet the costs of transportation, lack of access to suitable mobility options, lack of access to key life activities and exposure to transport externalities, as Lucas et al. (2016) discuss. When it comes to perceived well-being, accessibility, transport poverty and socio-economic aspects have also an impact on this variable. So, if an individual or a group has concerns while travelling, it could affect their well-being.

The conceptual model contains the coming research questions (and sub-questions):

- What relations can be identified between well-being, transport poverty accessibility, socio-economic and transport characteristics?
    - What relations can be identified between:
        a) Accessibility, socio-economic and transport characteristics?
        b) Transport poverty and accessibility?
        c) Transport poverty, socio-economic and transport characteristics?
        d) Well-being and accessibility?
        e) Well-being and transport poverty?
        f) Well-being, socio-economic and transport characteristics?

For the visual exploration:

- How are the different levels of perceived accessibility, transport poverty and well-being spatially distributed in Rotterdam and Utrecht?

1.4 Academic and Societal Relevance

The transport system is a fundamental part of the built environment that allows people to move and participate in social, economic and other basic life interactions. Technological innovations can improve the infrastructure and availability of transport. However, if the goal is to create an infrastructure that is relevant to the population, it is key to understand their needs and start the improvements by looking at their perceptions. Research in urban planning and transportation that focuses on people's experiences is beginning to gain importance, although is still quite recent. Since this research takes into account the experienced accessibility by individuals, it builds up to the literature and its contemporary academic relevance.

Investigating the relations of accessibility, transport poverty and well-being are relevant for future policy formulations and innovation in research. Also, investigating accessibility and mobility thinking about an individual's well-being is a recent approach in the transport literature and it has been gaining traction in recent years. Giving more light to this topic might mean creating a shift in the current focus of transport planning. Focusing this research on the Dutch context builds up knowledge on transport poverty and well-being topic in a specific location and collaborates with providing insights for societal benefits.

The new concept discussed in the present study that encompasses transport poverty and well-being considers justice and fairness in the transport system by adopting the capabilities approach. Policy solutions regarding road safety, promoting safe infrastructure for walking and cycling flush surfaces for wheelchair users and low-tech accessibility for the low-income population to access technology are already well known by governments and policy makers (Sheller, 2018).

However, "if we focus solely on place-making, and not on more equitable mobilities, we will simply design the poor out of the way, turning liveability into a luxury for those with high network capital (Sheller, 2018 p. 73). The development of this study brings societal relevance to stimulate urban planners, researchers, governments, and other parties to think about new solutions for mobility that reaches beyond the technological innovation of transport planning and bring social innovation as well.

1.5 Thesis Structure

This study is structured as follows. Chapter 1 contains the introduction, with background information, problem description, research questions and objectives and the academic and societal relevance. Chapters 2, 3, and 4 consists of the literature review on the topics of transport poverty; social exclusion and well-being in transportation; and transport justice and equity.

Chapter 5 presents the methodology used to obtain the results. This chapter is divided into data collection and analysis methods, which include factor analysis, bivariate analysis, regression analysis and spatial analysis. Chapter 6 presents the data collection and descriptive analysis; chapter 7 contains the results from the statistical and map analysis and chapter 8 the conclusions and discussion. Also,

chapter 8 discusses the limitations, and recommendations for research and practice of the study. The reader can also find the list of references and relevant information in the appendix for consultation. Each chapter written brings a conclusion to make a clear overview of the topics discussed and to connect to the subject that will be discussed in the next chapter.

2 Transport Poverty

This chapter discusses the concept of transport poverty. Section 2.1 defines poverty and transport poverty, presenting briefly the connection between energy and transport poverty as well. Section 2.2 describes the Dutch context on transport poverty and section 2.3 finalizes it, with the general conclusions of the chapter.

2.1 Defining poverty and transport poverty

Poverty in a broader sense is defined by the inability to access or afford a certain service (Lowans et al., 2021). When poverty is taken to the transport research field, a brief introduction to energy poverty must be considered because energy poverty overlaps with transport poverty, and both are dependent on energy systems. Hence, people that experience energy poverty could as well experience transport poverty.

Energy poverty appeared in England during the 1970s as “fuel poverty” and it was only in 1991 that the idea was associated with fuel-poor individuals, who could not heat their homes to a certain standard (Lowans et al., 2021). In other words, fuel poverty was described as when an individual was “unable to obtain an adequate level of energy services, particularly warmth for 10 per cent of (household) income” (Boardman, 1991 p.207). Besides heating, energy poverty usually is associated with the inability to reach necessary levels of lighting and hot water and being unable to access technologies for heating and cooking (Martiskainen et al., 2020). Nowadays, the concept and its metrics have been well established in several countries (Lucas et al., 2016).

Transport poverty was first looked at by the notion of transport disadvantage when the Social Exclusion Unit (SEU) was formed in the United Kingdom in 1997, which had the goal to propose advice and policy analysis to the UK government (Kuttler and Moraglio, 2021a). Lucas et al. (2016) discuss in their study that transport poverty is not completely deliberated by academic and policy literature and affirm that the phenomenon is related to individuals instead of households. Unlike fuel poverty which is well defined, monitored and related to policies, transport poverty still has a lack of interest by academia and policy interventions in the UK context (Mattioli et al., 2017). Studies related to the term usually investigate it in the context of social exclusion, equity, and transport justice (Kuttler and Moraglio, 2021a). These concepts and their relations will be further detailed in chapters 3 and 4.

Transport poverty was described by Allen and Farber (2019) as “the compounded lack of ability to travel to important destinations and activities”. Mattioli (2021) argues that Europe, in general, is increasingly car-dependent and having the dominance of automobiles over other types of transport modes can be related to experiencing transport poverty (Mattioli and Colleoni, 2016) because if an individual does not have access to a car, it can lead to experience transport poverty. However, the concept is a “much more complex and multifaceted problem than just lack of access to cars” (Mattioli, 2021, p. 106). To

understand better the multiple facets of transport poverty, Lucas et al. (2016) present the following interpretation, which describes that a person experiences transport poverty when:

1. There is no transportation option suited to their physical condition and capabilities.
2. The options available do not reach key life destinations.
3. The weekly costs of transportation by the household results in a residual income below the poverty line.
4. The person spends a great amount of time travelling, resulting in time poverty or social isolation.
5. The travel options and the infrastructure provided is not safe, not healthy, or dangerous for the person.

These conditions given by Lucas et al. (2016) build the definition of transport poverty around four components: *affordability, mobility, accessibility,* and *transport-related risks*. *Transport affordability* relates to the amount spent on transportation (condition 3 listed before); *mobility poverty* takes into account transportation options suited to the individuals' physical condition and capabilities (condition 1 listed before); *accessibility poverty* considers if the individual is reaching key life activities within a reasonable amount of time (conditions 2 and 4 listed before); finally, *exposure to transport risks* analyses if the options available and the infrastructure are safe, healthy and result is some kind of danger (condition 5 listed before). The relation between the five conditions given by Lucas et a. (2016) and the four components of transport poverty can be visualized as shown in figure 2.

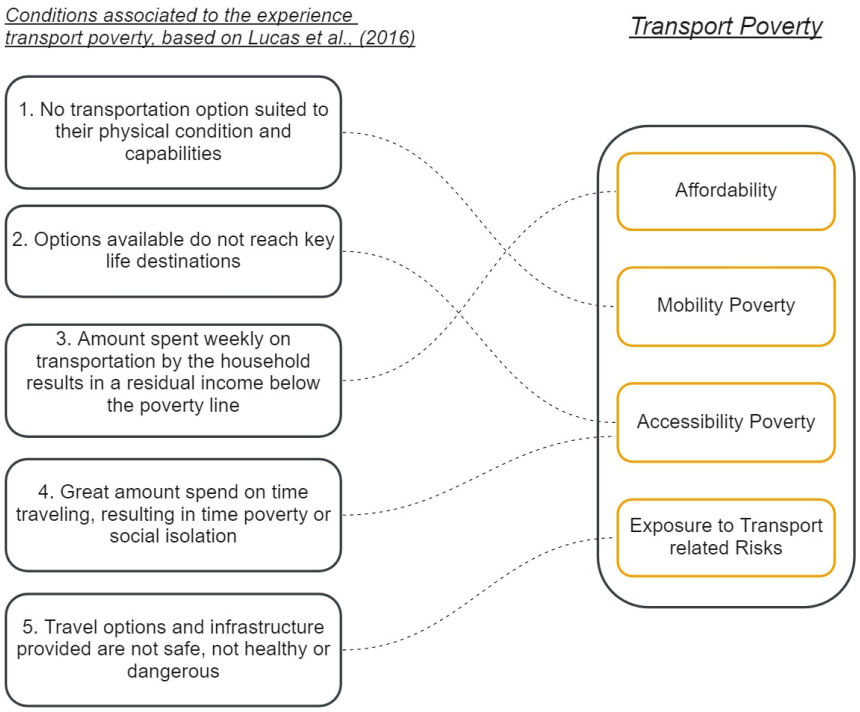

Figure 2: Relation between the five conditions and the four key components that define transport poverty, based on Lucas et al., 2016.

For this particular study, the definition of transport poverty was based upon those four key components (affordability, mobility, accessibility and exposure to transport risks) and will be explained next.

- *Affordability* - transport affordability is one of the components of transport poverty (Mattioli et al., 2017) that is considered in this present study. It “refers to the lack of individual resources to afford transportation options” (Lucas et al., 2016 p.356).
- *Mobility* - the component of *mobility poverty* is described as a systematic scarcity of transportation and mobility options, which can be related to low levels of transit services and transport infrastructure (Lucas et al., 2016). Besides the provision of different levels of mobility options, accessing them is uneven regarding gender, race, class, income and age (Kuttler and Moraglio, 2021c).
- *Accessibility* - *accessibility poverty* relates to the question of whether a person can reach, their daily activities in a reasonable amount of time and costs, with a relatively low effort (Preston and Raje, 2007; SEU, 2003). Lucas et al. (2016) explain that it “acts to reproduce the general conditions of poverty and it is clearly connected with social exclusion”.
- *Risks* - transport risks can be understood from two different perspectives: exposure to externalities – air pollution, noise pollution, pedestrian causalities and deaths – and effects from infrastructure projects related to transportation on people’s lives – direct impact on communities that live close to the project and reallocation of individuals as a consequence of building those projects (Lucas et al., 2016).

Figure 3 was built based on the previous definitions. The outer circle of experience of transport poverty includes the four components discussed above. The diagrams of affordability, mobility, risks and accessibility overlap since an individual could experience more than one of these components simultaneously. In addition, if a person is experiencing already one of these components, it is said that they are already experiencing transport poverty, as argued by Lucas et al. (2016).

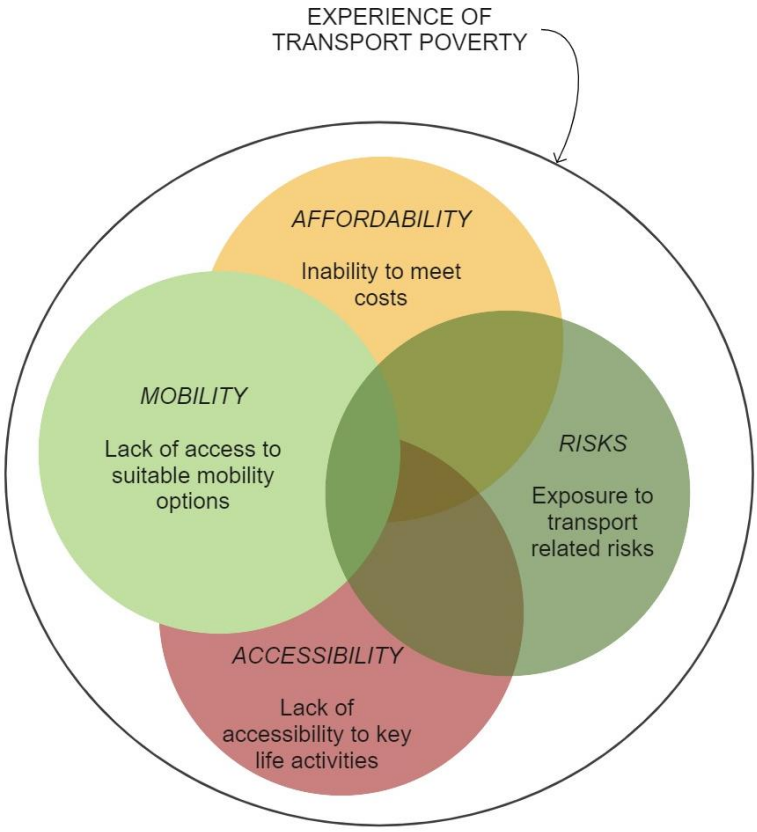

Figure 3: Transport poverty and the four components that build its definition, based on Lucas et al. (2016).

Transport poverty does not have a unified indicator so far in the literature. For Lucas et al. (2016) this can be explained because mobility and its capacity to provide accessibility to jobs and services are to a great extent associated with an individual's geographical location, social environment and time frame, which creates a barrier to creating a single indicator due to these specific patterns and factors. Some points of attention about measuring transport poverty are discussed by Lucas et al. (2016) and are worth mentioning to help understand the complexity behind the matter:

- If one of the aspects (affordability, accessibility, mobility, risks) that characterizes transport poverty is being measured, it is expected that it will be the key determinant to understanding who is experiencing transport poverty and how policy proposals will shape the problem.
- Any benchmarks available about measurements of transport poverty are built up to be indicative.
- Measuring transport poverty is highly dependent on the local context, transport planning and land use in the study area.

Since the present study is related to the Dutch context, in the next section, some light on the studies of transport poverty in the Netherlands will be given.

2.2 Dutch context of transport poverty

In the Dutch context, research has shed some light on the transport poverty subject in recent years. Jorritsma et al. (2018) show in their study preliminary investigation on the topic, by conceptualizing different views on mobility poverty (social exclusion, capabilities, and transport justice perspectives) and identifying in the literature some groups that face transportation issues: low income, job seekers, elderly, people with migration background, people without a driver's license or a car, people with reduced physical mobility and population in rural areas.

People with low income seem to have a low risk to experience transport poverty in the Dutch context (Jorritsma et al., 2018) due to, partially, the strong cycling culture and the relatively compact Dutch cities (Martens et al., 2011; Bastiaanssen et al., 2013; Martens, 2013). Studies on transport poverty and job seekers indicate that lack of transport results in fewer chances for individuals to get a job and more chances for unemployed periods (Jorritsma et al., 2018). Also, studies among job seekers in Rotterdam indicate that transport restrictions can contribute to problems in work reintegration (Bastiaanssen, 2012; Bastiaanssen et al., Martens, 2013).

For the elderly, issues that can be associated with transport poverty are often related to age progress and loneliness (Jorritsma et al., 2018). At older ages, people tend to travel less and often choose a destination close to their living environment (Jorritsma et al., 2018). This, combined with poor health (e.g., physical immobility), lack of social participation, and lower income has been found to influence feelings of loneliness (Jorritsma et al., 2018).

People with a migration background travel less often and make shorter trips, either by car or cycling and have a public transport subscription more often and are less likely to have a car than the Dutch (Jorritsma et al., 2018), which can be linked with the experience of transport poverty since people without a car have limited mobility options and opportunities to participate in social activities (Holder, 2010). However, research on transport poverty in the Dutch context that focuses on carless individuals shows that, even though not having a car is often associated with having less social interaction, the majority of cases show that public transport for longer distances and bicycles for short ones offers a good alternative to achieve social contact (Jorritsma et al., 2018).

Some research that considers physical limitations in the Netherlands found that this group present severe conditions when it comes to transport poverty since they experience issues with both cycling and using public transport, which results in limited social interaction and problems to find a job (Jorritsma et al., 2018). Finally, when it comes to residents from rural areas, some groups experience transport poverty, such as people that do not have a driver's license, inadequate public transport (schedule or location), high costs of transport and limited knowledge about sharing systems and transport by appointment (Jorritsma et al., 2018).

Follow-up research from CBS (2019) based on the preliminary studies from Jorritsma et al. (2018) intended to further develop an indicator of the risk of transport poverty. The tested indicator considers nine variables: car ownership, distance to public transport, distance to amenities, distance to family members, household income, socio-economic status, migration background, health, and household composition, including age (CBS, 2019). The indicator was tested at the household level in two different Dutch cities: Utrecht and Heerlen.

Each variable from the indicator could vary from 0 to 2, where 0 represented a low level of contribution to transport poverty and 2, a high-level contributor (CBS, 2019). With the combination of the risk factors, a single indicator of transport poverty was produced. An important consideration about it is that the indicator only shows the insight of areas that have households at risk of facing transport poverty and does not indicate whether these households experience transport poverty (CBS, 2019).

2.3 Conclusion

Chapter two presented the broad definition of transport poverty and how it is still a concept under development if compared to energy poverty. Figure 4 presents an overview of this chapter.

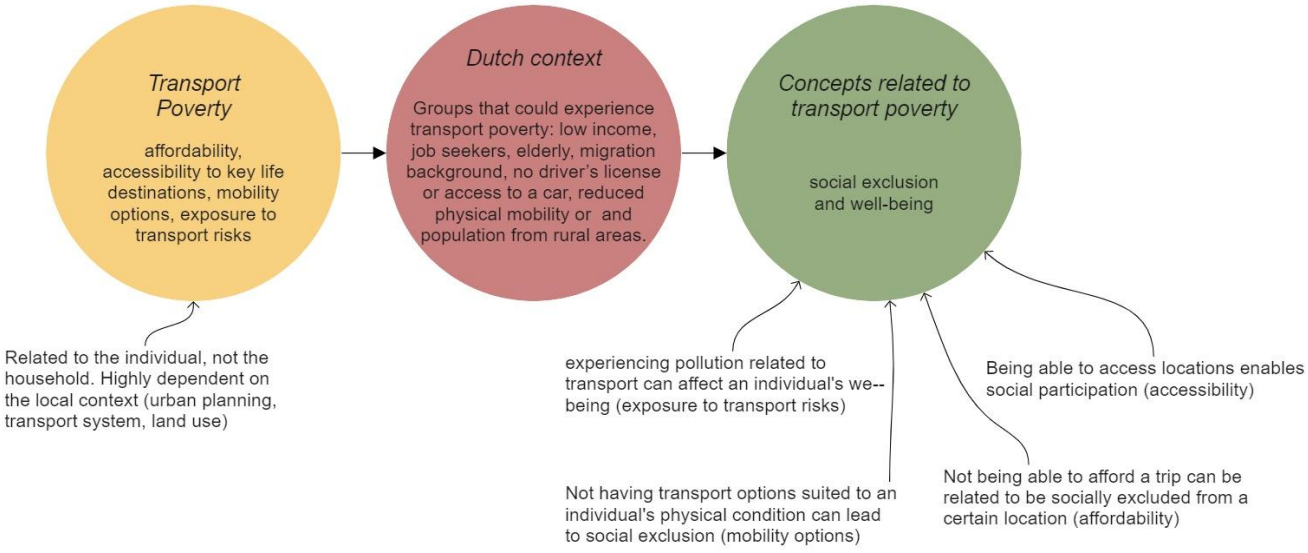

Figure 4: Overview of the concepts discussed in chapter 2.

Transport poverty can be experienced if an individual encounters issues with affordability to travel, accessibility to key life destinations, mobility options or exposure to transport-related risks. These four compounds could be experienced on different levels inside a household and that is why the concept is connected more to the individual than the household itself.

Measuring transport poverty is an indicative measure and is highly dependent on the local context. Considering the Dutch context, there are groups identified by the literature that could experience

transport poverty as low income, job seekers, elderly, individuals with migration background, people without a driver's license or access to a car, people with reduced physical mobility or that could rely on using mobility aid and population from rural areas.

Transport poverty cannot be treated as isolated from concepts such as transport-related social exclusion or well-being. First, being unable to access certain locations has a relationship with social participation, since it allows the individual to engage in social environments. Also, experiencing transport-related risks, such as pollution, affects individual well-being. Another example is having unsatisfactory mobility options suited to an individual's physical condition, which can be related to social exclusion. Finally, not being able to afford a trip can be related to being socially excluded from a certain location. To have a better understanding of the relations that involve transport poverty, social exclusion and well-being, the next chapter will discuss these later two concepts in depth.

3 Social Exclusion and Well-being in Transportation

As discussed in the introduction of the present study, accessibility and transportation have a connection with social exclusion and well-being. Delbosc and Currie (2018) present a number of studies that explored this relation. The authors affirm that the relationship between transportation and well-being is measured through subjective well-being, life satisfaction, quality of life and affected mood, and social exclusion and well-being can be impacted by both mobility and accessibility (Delbosc and Currie, 2018). Each one of these two concepts (social exclusion and well-being) will be detailed further on.

3.1 Social Exclusion

Burchardt et al., (1999) propose that social exclusion happens when an individual is residing in a certain geographical area and, for reasons beyond their control, cannot engage in activities even though it is their desire. In a broader and more explored definition, Levitas et al. (2007 p.9) describe that social exclusion:

"(…) involves the lack or denial of resources, rights, goods and services, and the inability to participate in the normal relationships and activities, available to the majority of people in a society, whether in economic, social, cultural or political arenas. It affects both the quality of life of individuals and the equity and cohesion of society as a whole."

Lucas (2012) writes in her study about transport and social exclusion that the latter term [social exclusion] has been developed to a great extent as a theoretical concept, and there is a consensus that it touches further than a description of poverty. Social exclusion in this sense relates to deprivation with more dimensions, layers and being more dynamic (Lucas, 2012). Levitas et al. (2007) also identify the complexity and multi-dimensional aspects of social exclusion. On top of that, it is a relative process (Luz and Portugal, 2021). As result, social exclusion and poverty are not synonyms, and the first term not necessarily leads to the second one, since a person can be socially excluded and not experience poverty (Kenyon et al., 2002; Presto and Raje, 2007).

More than understanding the inability of access (that is related to poverty definition in this study), social exclusion tries to understand the process of uneven participation in society (Kenyon et al., 2002; Oviedo, 2021). Luz and Portugal (2021) argue that social exclusion can be related to some indicators or causes such as income, low level of education and limited political power, and it leads to scarce participation in society. The outcome of not being able to engage in activities in society because of certain characteristics, or indicators as mentioned before, can be related to being at disadvantage (Higgs and White, 2000).

When it comes to transport-related social exclusion (TRSE), it can be defined as (Kenyon et al., 2002 p.210-211):

"The process by which people are prevented from participating in the economic, political and social life of the community because of reduced accessibility to opportunities, services and social networks, due in whole or in part to insufficient mobility in a society and environment built around the assumption of high mobility."

In the overview offered by Lucas (2012), social exclusion related to transportation reveals the interaction between aspects related to the individual (age, gender, disabilities); to the local scale (geographic location and the provision of transport systems and local services); and to the national scale (labour market, cultural aspects, migration patterns, legislations). The three scales interact in a way that shapes and are shaped between themselves. Combining these aspects with more abstract individual factors such as personality, confidence and resilience which are nested in the local scale, can support, or discourage social contact (UCL, 2015). On the other hand, local scale factors are shaped by the national scale factors, including politics, demographic, national economic context, welfare, transport and housing policies (UCL, 2015). These interactions are represented in Figure 5.

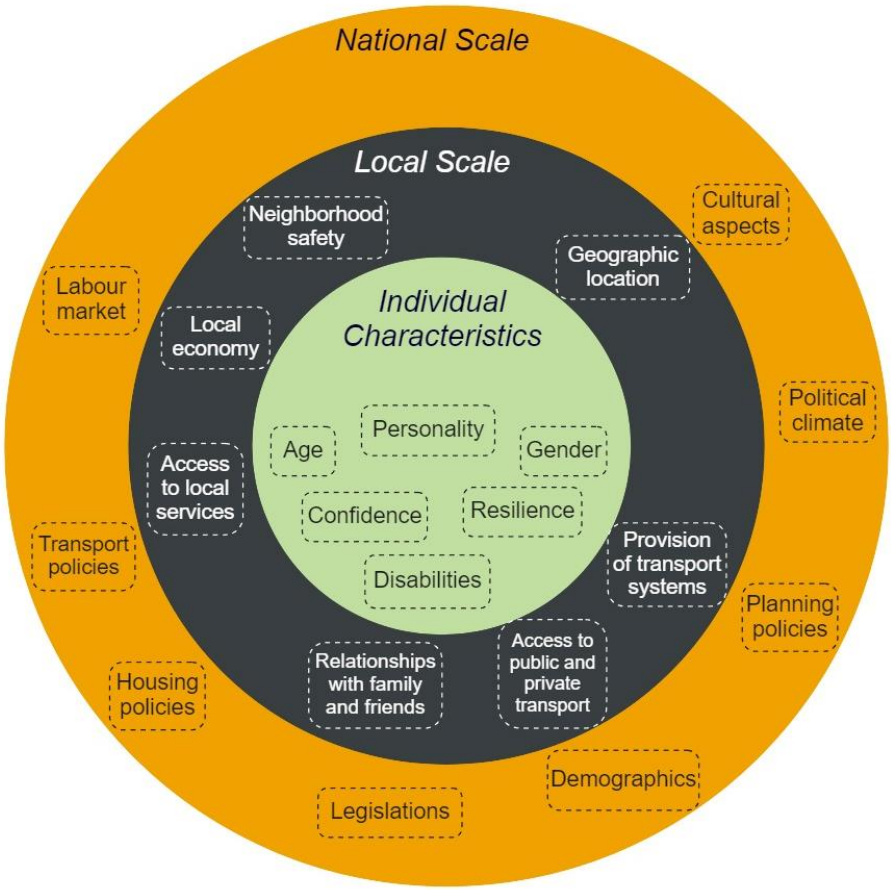

Figure 5: Interaction between factors that influence social exclusion related to transportation, based on Lucas (2012); UCL (2015).

Luz and Portugal (2021) explain that TRSE occurs when accessibility reaches a critical level, and an individual cannot reach opportunities and thus lower their levels of participation in society. The barriers related to low participation may be due to difficulties in travelling or inadequate mobility options (Luz and Portugal, 2021).

Social exclusion is a result of the influence of the transport and social disadvantage according to Lucas (2012). A combination of these two occurrences (to a lesser or greater extent) results in transport poverty that leads to social exclusion with subsequent social and transport inequalities for the individual, group or community (Lucas, 2012). Thus, transport and social disadvantage become part of a "circular dynamic of production and reinforcement" (Kuttler and Moraglio, 2021a) of themselves. This idea is presented in Figure 6, where the circular dynamic of social and transport disadvantage is related to social exclusion, which further relates to social and transport inequality. To close the cycle, those two inequalities connect to the first experience of being social and transport disadvantaged.

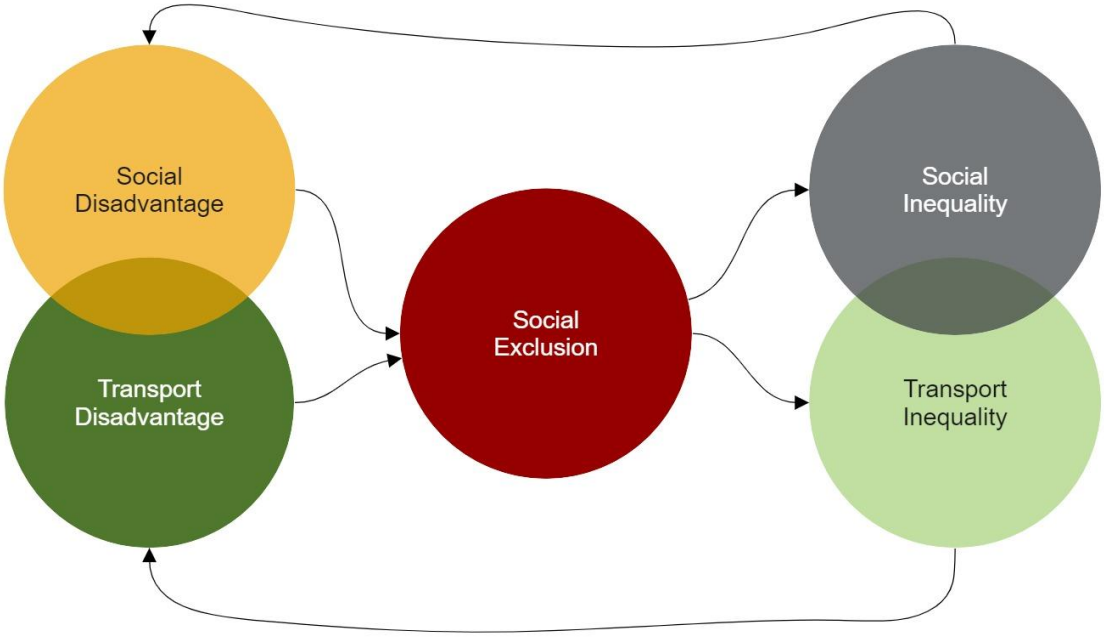

Figure 6: Circular dynamic of disadvantage, exclusion and inequality, based on Lucas (2012) and Kuttler and Moraglio (2021a).

Complementing the previous idea, Cass et al. (2005) argue that socially disadvantaged groups such as unemployed individuals or single-parent households, do not necessarily experience a lack of access that relate to social exclusion. Access and participation in society could have different meanings for each group of individuals and in this sense, "it is, for instance, possible that highly paid commuters are socially excluded from their local neighbourhood precisely because of their high mobility" (Cass et al., 2005). This example builds up the idea that transport and social disadvantage do not have a simple causal relation with social exclusion and are not synonyms of the latter term (Kuttler and Moraglio, 2021a).

It is argued that what is necessary to promote social inclusion related to transportation “varies as the means and modes of mobility change and as the potential for ‘access’ develops with the emergence of new technologies” (Cass et al., 2005). With the advance of new shared mobility concepts such as electric scooters or cars the way that people perceive their accessibility might change, contributing to their access because they would have a shared vehicle to use. Also, could be the fact that because those people do not know the technology enough to use shared transportation, it would not impact their accessibility.

3.2 Well-being

Being able to participate in social, economic, and civic life has been pointed out to have a relation with quality of life (Goodman et al, 2021) and thus subjective well-being. Subjective well-being comes from studies about positive psychology and happiness and involves a person’s subjective self-evaluation of their life and their sense of purpose (OECD, 2013). In theory, subjective well-being describes a person’s individual subjective experience of their life (Davern and Chen, 2010) about emotional experiences such as contentment, happiness and satisfaction (Davern et al., 2007). Studies indicate that an individual can perceive their subjective well-being in different ways, depending on their social and cultural and other personal aspects (Marans, 2015).

As described in the introduction of this study, the act of travelling has been found to build up economic and social activity for a person which results in societal and individual well-being (Delbosc and Currie, 2018). Transportation systems have the purpose to present the opportunity for people to participate in their daily, social and necessary activities essential for their well-being (Allen and Farber, 2019; Ettema et al., 2010; Goodman et al., 2021; Kolodinsky et al., 2013; Ma et al., 2018).

Some authors argue that if there are low levels of accessibility to transport, this could relate to lower subjective well-being (Dolan et al., 2008; Awaworyi Churchill and Smyth, 2019) and some of them present that limited mobility can result in the decline of subjective well-being and levels of social exclusion (Ma et al., 2018; Lucas, 2012; Delbosc and Currie, 2011). To illustrate that, Kuttler and Moraglio (2021b) explain that being able to perform basic needs (such as shopping) increases in significance the older an individual is. However, the realization of those activities often remains repressed due “to inadequate transport options, limited financial means and physical constraints” (Kuttler and Moraglio, 2021b).

Low levels of availability of transport options and accessibility to key life destinations (that are discussed by the authors mentioned in the previous paragraph) are part of the chance to experience transport poverty (mobility poverty and accessibility poverty components) and thus are also connected with well-being. Literature on this topic has been gaining more ground in the past years (Goodman et al., 2021). One example is the study by Awaworyi Churchill and Smyth (2019, p.42) that shows that “the negative effect of living in transport poverty on subjective well-being is comparable to, or stronger than, the

effects of educational status, income, being (un)employed or suffering a major illness" (or individual factors).

According to Delbosc and Currie (2018), the prominent relations between transport and well-being are seen in disadvantaged groups, such as the elderly, disabled people and young adults, and most studies analysed by the authors focus on these groups.

3.3 Transport Poverty, Social Exclusion and Well-Being

The relation between transport disadvantage, social exclusion and well-being has been described in literature at least since the 1960s (Pereira et al., 2016). Social inclusion (as the ability to participate in society) and well-being are directly affected by energy and transport services (Martiskainen et al., 2020). However, Kuttler and Moraglio (2021a) put in their book that studies are still insufficiently able to analyse how exactly transport and mobility disadvantage can be associated with social exclusion and well-being.

The literature emphasizes three types of inequalities that have an influence on an individual's well-being: transport-related resources, travel behaviour and accessibility levels (Pereira et al., 2016). The issue with inequality in the transport system concerns more than just identifying it. To understand inequalities, the concept of equity and justice in the transport system is considered in this research and is discussed in the upcoming chapter.

3.4 Conclusion

Chapter three brings the relation that accessibility and mobility can have on social exclusion and well-being. The first essential definition brought here is that social exclusion and poverty are not synonyms since a person can be socially excluded and not experience poverty. A clear example of this is highly paid commuters that must travel for long times. Also, the chapter brings the definition of subjective well-being, which is a self-evaluation of a person's life. Figure 7 consists of the overall ideas from the present chapter.

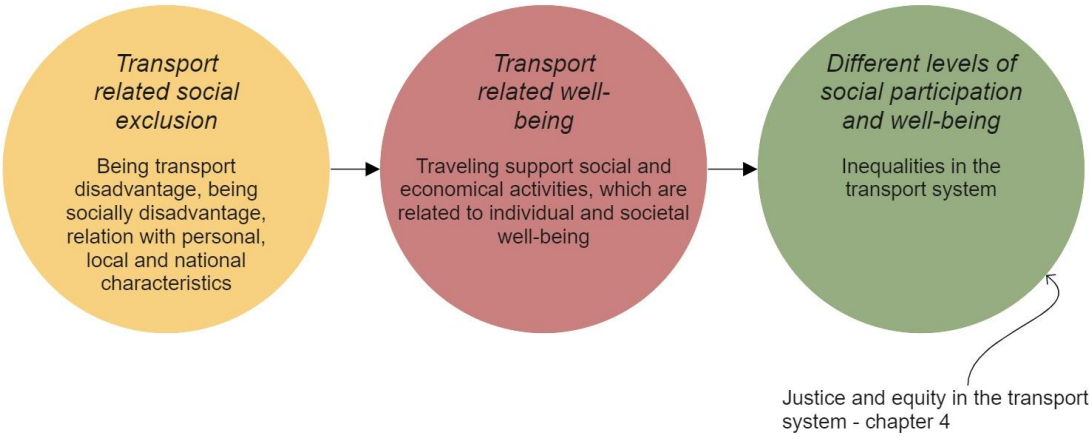

Figure 7: Overview of the concepts discussed in chapter 3.

Transport-related social exclusion results from an interplay between individual characteristics, local scale characteristics and national scale characteristics. Also, the concept results from the influence of social disadvantage and transport disadvantage. When it comes to well-being, it can be improved with travelling, since it supports social and economic interactions.

As the examples at the conclusion of chapter two present, transport poverty can be related to being socially excluded or having an impact on the well-being of a certain group. Since access and participation are relative among certain population groups, it could be the fact that single-parent households, unemployed, highly paid commuters, elderly, disabled people, or young adults that are identified by the literature as experiencing issues with accessibility and mobility options do not necessarily experience social exclusion or have their well-being affected by it.

Identifying different levels of well-being related to transport-related resources, observed travel behaviour and accessibility levels represents the identification of inequalities in the transport system which leads this study to further explore the concepts of justice and equity in the transport system in the next chapter.

4 Transport Justice and Equity

Verlinghieri and Schwanen (2020) claim that neo-liberalization, global urbanization, climate urgency and the COVID-19 pandemic created an ideal scenario to engage in discussions about transport and mobility justice, which can be placed as part of a broader discussion around fairness and justice. Martens et al. (2019) frame “equity or justice as the morally proper distribution of benefits and burdens over members of society”. The study conducted by Allen and Farber (2019) also agrees with that thought. This present study will use equity and justice as interchangeable words, following the previous description given by Martens et al (2019).

The discussion of equity in transport planning and systems considers (1) benefits and burdens that are distributed; (2) to whom they are being distributed; and (3) the measurement used that is determining if that distribution is morally appropriate (Di Ciommo and Shiftan, 2017; Martens et al., 2019). Choosing the measurement that will determine if that distribution is morally appropriate perhaps is one of the most complex components since it will determine how unjust the system is. According to Di Ciommo and Shiftan (2017), the great challenge of assessing equity in transport systems lies with defining and processing the benefits and burdens *and* the distributive principle that will be used.

However, when it comes to disequilibrium and inequities or injustices in the transportation system, Lucas et al. (2019) state that identifying an unbalanced distribution of a certain good *does not* necessarily mean that there is inequity in the system; and from identifying inequity in the system to being able to provide a fairer system by redistributing resources and/or insuring safety for the affected groups is still a long process ahead.

When it comes to assessing transport equity, it is argued that there is no single correct way to measure it, however, there are four subjects that are key concerns for the matter (Lucas et al., 2019):

- Fair allocation of transport modes, infrastructure, costs and services.
- Fair opportunity to access key life activities.
- Reduce exposures to the transportation system, such as pollution, traffic-related adversities and individuals’ safety emphasizing protecting the most vulnerable groups.
- Improve the participation in the decision-making process of policies in the sense of giving greater space for groups and communities that are already suffering from transport-related inequalities and consider their input as an integral part of the policy process.

These key concerns mentioned by Lucas et al. (2019) have a significant relationship with the key components of transport poverty. First, transport equity studies imply that transport modes, infrastructure, costs and services should have a proper distribution, which relates to the *mobility* and *affordability* dimensions of transport poverty. Second, providing a fair opportunity to access key life

activities is linked to *accessibility* poverty. Third, reducing transport-related risks is related to the *exposure to transport externalities*. Lastly, improving participation in the decision-making process of policies would aid in promoting more discussion and understanding in *all aspects related to transport poverty*. These relations between transport equity and transport poverty can be seen in the following Figure 8. The column on the left illustrates the aspects related to transport equity while the column on the right brings transport poverty components.

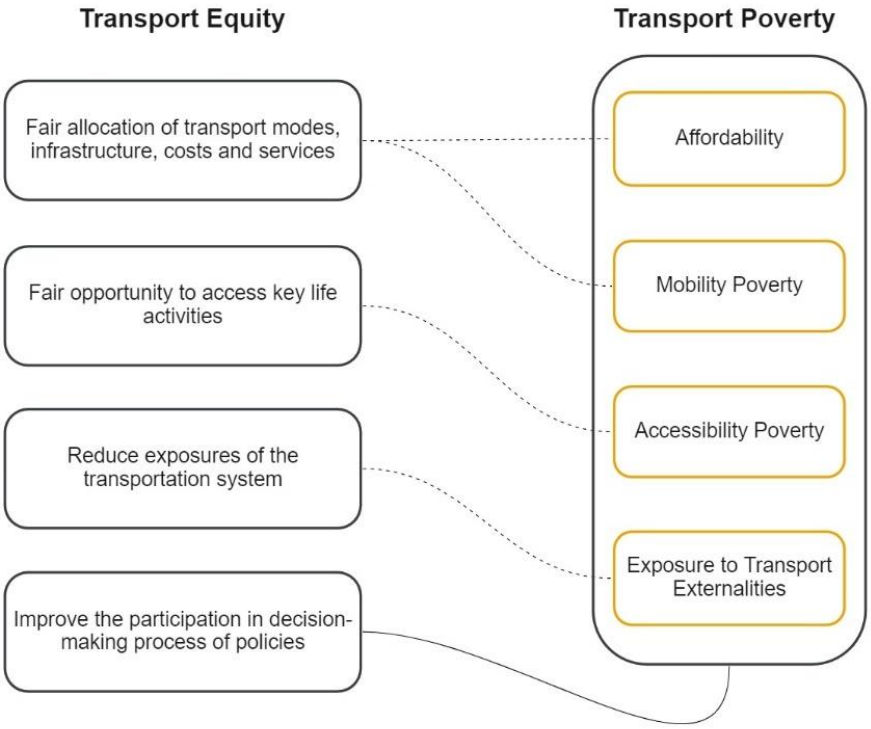

Figure 8: Relation between aspects of transport equity and transport poverty.

Since debates on equity in transport literature recognize the distribution of benefits and burdens; to whom they are being distributed; and the measurement scale used, each of the following sub-chapters will discuss these elements separately for a better understanding of each topic.

4.1 Benefits and burdens that are distributed

Di Ciommo and Shiftan (2017) claim that equity assessments in transport planning need to be better understood and investigated regarding accessibility, mobility and health effects. Martens et al. (2019) delve into these topics and state that, regarding the distribution of benefits and burdens, four categories can be distinguished to be analysed from the equity perspective: mobility and accessibility, pollution due to transport, traffic safety and health. These categories brought by the authors relate to transport poverty as illustrated before in Figure 9. In addition, according to the same authors, these benefits and burdens can be evaluated considering the resources, opportunities and risks, outcomes, and well-being (Martens et al., 2019). These evaluation types are detailed next.

Resources correspond to the intangible goods that a person has, which could be related to owning a car or living close to a public transport stop (Martens et al., 2019). The same concept appears when the capabilities approach is discussed further on in this study. *Opportunities and risks* are related to the possible outcome of having a particular resource, like owning a car and being able to access places that are not covered by public transport but at the same time experiencing high levels of traffic (Martens et al., 2019). Adding to this, *the outcomes* are the actual results of the usage of the resources by an individual, and how the opportunities and risks affected their lives (Martens et al., 2019). Finally, *well-being* is concerned about the state an individual reaches "as a result of the interplay between the allocation of resources, opportunities and objective outcomes on the one hand, and features of the persons and the wider context on the other" (Martens et al., 2019, p. 15). In theory, well-being would be the complex goal evaluator that would also include the resources, opportunities, and outcomes related to the individual and the transport system.

4.2 To whom the benefits and burdens are being distributed

Assessing fairness in the transport system implies that certain groups of the society will be identified as experiencing different levels of distribution of benefits and burdens. Several studies use disaggregation and focus groups to analyse the advantages and disadvantages of a certain transport-related burden or benefit on them. Transport literature shows that low-income households and individuals that do not have a driver's license are more likely to experience disadvantages when it comes to mobility and accessibility (Martens et al., 2019). Among these people, *children, young people, the elderly, single-parent households, low-skilled workers, ethnic minorities, people with disabilities and women* usually are the ones that experience transport disadvantages the most (Martens et al., 2019).

In addition, studies recognize the importance of understanding and evaluating the distribution of benefits and burdens on socially disadvantaged groups that can experience financial constraints, unemployment, peripheral housing location, health problems, low education level and social exclusion (Martens et al., 2019). These groups could be part of different categories of disadvantage at the same time and "may experience the multiple adverse effects of deprived neighbourhoods, in terms of lower employability, deterioration in the quality of social networks, and neighbourhood stigmatization" (Martens et al., 2019, p. 25).

These socially disadvantaged groups receive attention in the literature, once they already suffer from several types of burdens and are exposed to transport-related burdens as well. Figure 5 in the present study can be used as well to understand the importance that studies give to socially disadvantaged groups. The figure illustrated the circular dynamic of disadvantage, exclusion and inequality, based on Lucas (2012) and Kuttler and Moraglio (2021a).

According to Martens et al. (2019), *income* and accessibility have a relationship when it comes to car ownership, trip frequency and distance for instance. People with low income are less likely to own a car and more likely to travel by public transport, which might affect costs and distances travelled and

individuals low-skilled or unemployed might fall in the same category [low incomers] and experience also the same constraints (Martens et al., 2019). As a result of their financial constraints, low-income people would travel less and within shorter distances, which might reflect restricted access to and participation in life activities (Martens et al., 2019).

Not *having access to a car* or *driver's license* is usually linked with low levels of perceived accessibility in a car-centric culture. Car-centric cultures can be associated with car-dependent scenarios, which are situations where car use becomes essential to access destinations and alternative modes are less viable (Mattioli, 2016). Car-dependent cultures in the Global North turned out to be an outcome of a historical process that started in the 20th century (Pooley, 2016), which included the rise of the automotive industry, prioritization of car usage on road spaces, urban sprawl, the struggle of public transport to provide competitive services in the new conditions, development of car consumption culture (Mattioli et al, 2020). Studies show that public transport can take on average twice as long as driving a car for frequent trips in Amsterdam and Stockholm (Liao et al., 2020).

Geographical location also is one of the factors associated with accessibility to key life destinations and groups that could experience inequal distribution of transport-related burdens, but it should be noted that not all residents from a certain location experience issues to transport since they have different sociodemographic profiles (Martens et al., 2020). In a general picture, disadvantaged social groups tend to live in less attractive neighbourhoods due to lower housing prices or social housing policies, which also are places that could present low levels of car ownership and inadequate public transport provision (Martens et al., 2019), although this is not a general rule.

When it comes to *age,* young people and the elderly are more dependent on cycling, walking and public transport and are less likely to own a driver's license, because of that, both age groups tend to travel less and more often to local destinations Martens et al. (2019).

Gender performs an important role when it comes not only to accessibility but also in transport resources and travel patterns (Martens et al., 2019). Women may experience transport disadvantages as a result of poor provision of public transport and are less likely to own a driver's license (Hine and Grieco, 2003).

People that are dependent on *mobility aid* are cited by the literature as being usually the group with the highest limitations on transport and accessibility to their destinations due to road design, vehicles that are not adapted to their needs and travel costs, since they might be "higher for people with impairments due to their high dependence on expensive modes such as taxis" (Martens et al., 2019, p. 29).

Ethnic minority groups might show different experiences when it comes to accessibility and travel behaviour. Some of them might have low shares of car ownership compared to other groups due to low income, which reflects transport disadvantages; however, some other ethnic minority groups might have high rates of car ownership due to cultural aspects, personal safety or racial harassment; also, other

minorities prefer to participate and travel only at the local scale by accessing places that are similar to their cultural realm or places that they are familiar with (Martens et al., 2019).

Research also shows that accessibility and mobility are influenced by the travel modes available to them, especially the difference between people that use public transport and private vehicles (Benenson et al., 2011, 2017; Golub and Martens, 2014).

Although some individuals are identified to experience different levels of burden or benefit related to transport, studies argue that the evaluation of those levels being appropriate still neglects these groups, like the ones that cannot afford transportation costs or who have physical mobility limitations (Di Ciommo and Shiftan, 2017). The next section brings a discussion to understand the characteristics of mechanisms that determine if the distribution identified in the system is fair and how these mechanisms consider certain social groups.

4.3 The measurement used that is determining if that distribution is morally appropriate

Di Ciommo and Shiftan (2017) assert that new equity assessments in transport aim "to replace the traditional measure of travel time savings that favour better-off societal groups who are travelling more, with accessibility gains measures that cater for more vulnerable social groups, without accounting for trips rate". In line with this thought, recent concepts that study social equity in the field of transport include Walzer's Spheres of Justice (Walzer, 1983) and Rawls' A Theory of Justice (Rawls, 1971) to support the idea of enhancing average accessibility while reducing the gap between the highest and lowest levels of it (Martens et al., 2012; Martens, 2017; Pereira et al., 2016).

In theory, there are several approaches to measure if the transport is *fair* by defining a level of accessibility (Kuttler and Moraglio, 2021c). In any case, the ethical perspective behind the framework must be explicit, since different approaches to fairness will provide different answers for policy makers (Pereira et al., 2016).

From the *egalitarian* perspective, all individuals should have the same level of transport service and access (Kuttler and Moraglio, 2021c). It focuses on showing the inequality between social groups or geographical areas and why these groups or locations present different levels of accessibility or transport services (Pereira et al., 2016). The egalitarian approach considers implicitly that there is an acceptable level of inequality in the transport system that can be considered fair, however studies so far do not make clear statements about these levels, what would be an ideal pattern distribution or how far policy makers should go to reduce these inequalities (Pereira et al., 2016).

The sufficientarian perspective is more focused on obtaining the basic needs of transportation of vulnerable groups that could face transport-related social exclusion (Kuttler and Moraglio, 2021c), focusing more on minimum levels of transport goods, services and accessibility that should be available to everyone (Pereira et al., 2016). The dilemma regarding the sufficientarian approach lies in the fact

that “no minimum thresholds can be established without paternalistic assumptions that overlook the diversity of people’s preferences and needs” (Pereira et al., 2016, p 9).

Utilitarianism is one of the most influential theories of justice, after all, it gives the ethical foundation of cost-benefit analysis (Hausman and McPherson, 2006). According to Kymlicka (2002), (1) the utilitarian framework brings human well-being (“utility”) to the core of justice concerns, affirming that it [human well-being] is the only thing with intrinsic value; (2) every person receives the same weight regarding their welfare and interests; and (3) the evaluation of an action or policy considers exclusively its consequences, especially how they can maximize well-being. In this sense, the best action or policy is the one that will maximize aggregate net welfare for the greatest number of people.

In transport equity evaluation, *utilitarianism* desires to promote trips to activities that maximize aggregate utility, which is understood by a person’s willingness to pay (Pereira et al., 2016). Since, in general, the benefits from a transport project have been traditionally evaluated from monetary or travel time gains, a result of the utilitarian evaluation is that it prioritises accessibility improvement to activities that will generate more profit, people with higher incomes and higher values of time (Pereira et al., 2016). Also, since the focus is on an aggregate measure, no particular attention is paid to individual members of society (Martens, 2011; Van Wee, 2012; Van Wee and Roeser, 2013).

The *capability approach* theory, based on the works by Amartya Sen (Sen, 1992) and Martha Nussbaum (Nussbaum and Sen, 1993), rises as an alternative that supports that people have to have the minimum level of access to key life activities (education, employment, shopping and healthcare) and not necessarily the same levels of transport service (Kuttler and Moraglio, 2021c). This framework, according to Pereira et al. (2016), presents both egalitarian and sufficientarian matters, and the basic capabilities and minimum levels established are culture-dependent. Like the sufficientarian approach, the capabilities approach also struggles with finding the sufficient threshold of accessibility, combined with the fact that accessibility has to be understood in a more complex way than in other approaches (Pereira et al., 2016).

Figure number 9 has the overall of the four types of measurements that were discussed before, their aim and some considerations when adopting them as the measurement that determines if the distribution is morally appropriate.

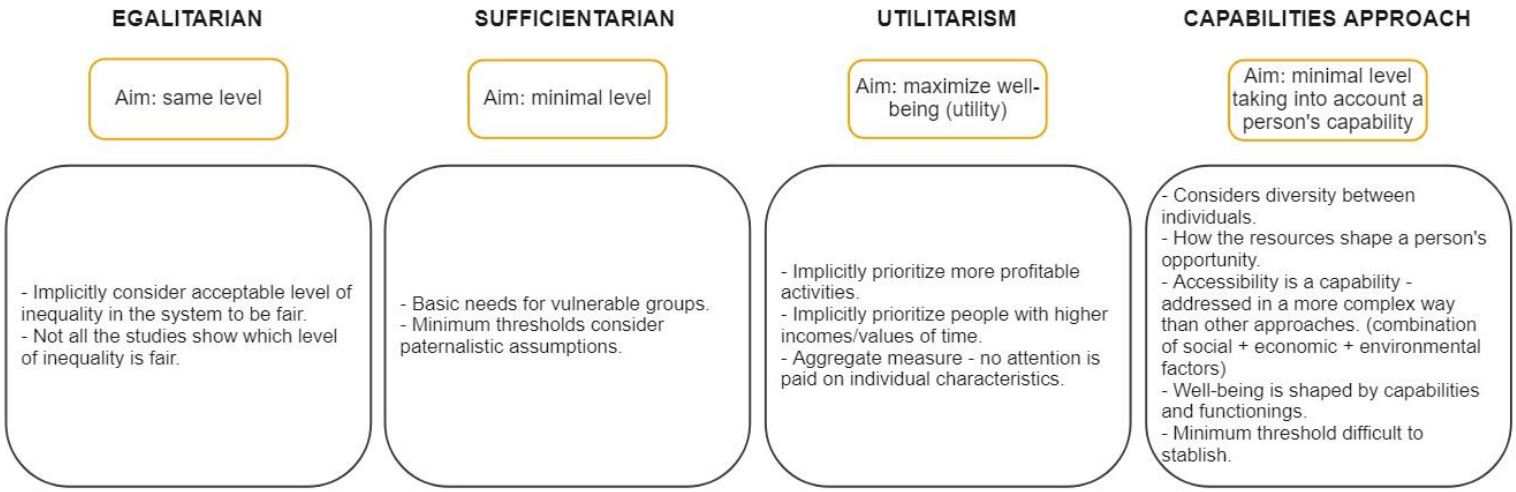

Figure 9: Overview of the four types of equity measurements.

The framework in Figure 10 presents an overview of the three steps regarding how to make an equity assessment in transport. First the selection of the benefit or burden that is being distributed, then the identification of groups that have different levels of benefit/burden and, finally, the measurement that determines if that distribution is morally appropriate.

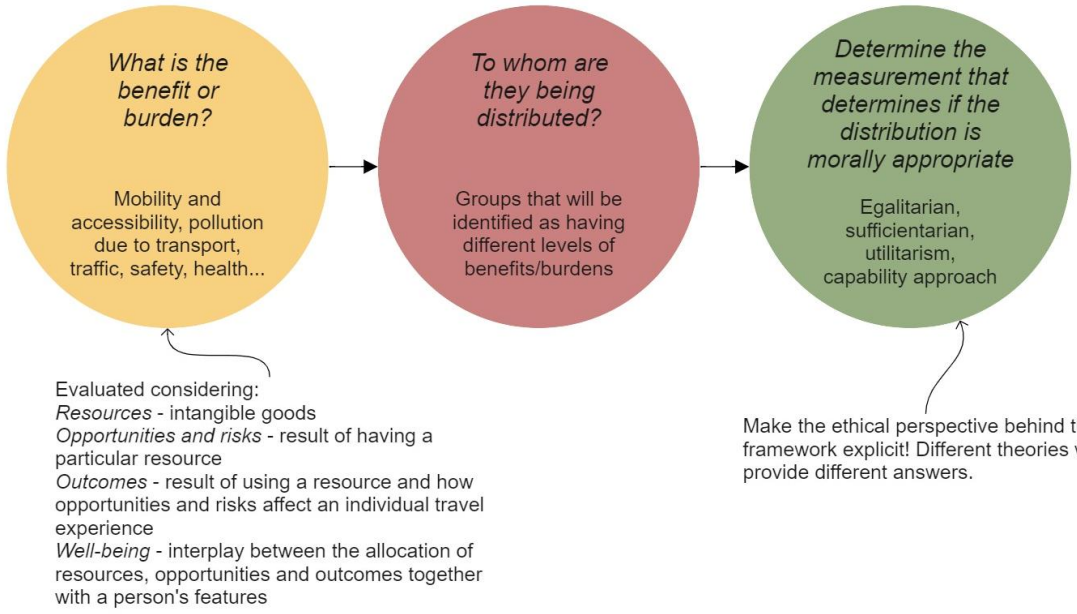

Figure 10: Assessing equity in transport – a framework.

For the present study, the capabilities approach was applied in the conceptual model to understand the different levels of accessibility, since its growing relevance in transport literature. The next section presents a more detailed background of the framework.

4.4 Capabilities approach and its application to transport literature

Capabilities Approach (CA) was conceptualized by Amartya Sen and further grown by Martha Nussbaum and has been recently receiving more attention from the transport and mobility literature (Vecchio and Martens, 2021). This normative proposition (Vecchio and Martens, 2021) argues that the most important aspect of an individual's life is their freedom to choose which leads to having a certain type of life (Nussbaum and Sen, 1993). Many authors agree that the capabilities approach can be applied to evaluate transport systems and new transport projects, and the contribution that they can have to individuals' opportunities and well-being (Vecchio and Martens, 2021).

CA compared to other concepts that discuss fairness in transport literature considers a broader range of diversity among individuals; not only the transport system and mobility resources but also, how these resources shape individuals' opportunities according to their characteristics, aspirations and choices (Vecchio and Martens, 2021). However, Capabilities Approach still presents some challenges. The first one is identifying a minimum threshold of accessibility, which is dependent on the local values and history combined with politically democratic decisions. The second is the fact that the capabilities approach needs to address accessibility as a result of personal characteristics (such as gender, age, income, and use of mobility aid) interacting with the economic, social and built environment (Kuttler and Moraglio, 2021c; Pereira et al., 2016).

The second challenge mentioned before is of great importance since the capabilities approach is essentially concerned with individual freedom of choice, and the interaction between individuals' characteristics and the environment shapes and results in different levels of accessibility (Pereira et al., 2016). With this, using the capabilities approach brings a disaggregate level of measuring fairness focused on the individual and the interaction of personal characteristics with their surroundings.

The approach uses five concepts to explain and understand an individual's level of freedom: resources, conversion factors, capabilities, choices, functionings and well-being (Vecchio and Martens, 2021). Figure 11 shows an overview of the concepts and their relationships.

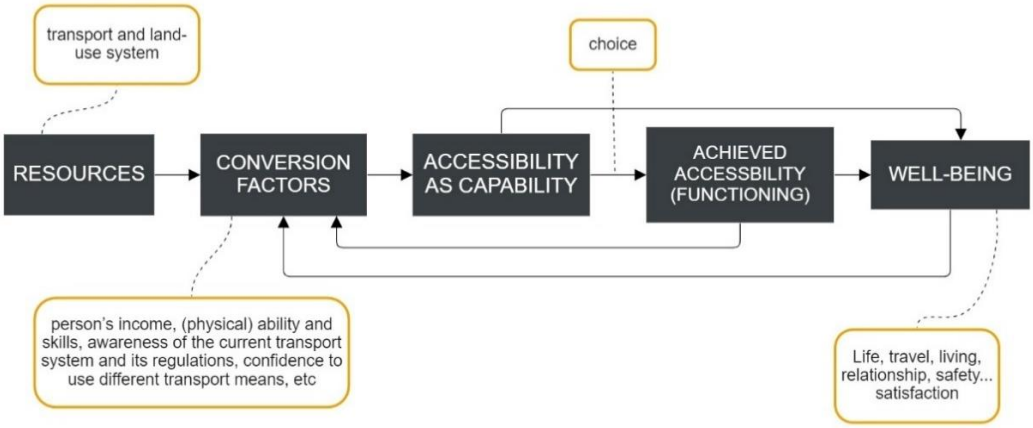

Figure 11: CA framework, based on Vecchio and Martens (2021).

Considering the capabilities approach framework presented in Figure 12, the next paragraphs will discuss each concept, its definition and its application to transport literature.

Resources are intangible goods (which can be limited to transport and land use systems) and commodities that are available to somebody, depending on their features and background including the socio-spatial context that they are inserted in (Luz and Portugal, 2021; Vecchio and Martens, 2021).

Conversion factors establish the possibilities that a person has for the conversion of resources into freedoms (Sen, 1992). Express individual, social and environmental circumstances that form a person's life experience that allows the conversion of a resource into a capability, determining if they can use a certain resource that is available to them (Vecchio and Martens, 2021). Examples: person's income, (physical) ability and skills, awareness of the current transport system, confidence to use different transport means, etc (Meijering et al., 2019).

Capabilities describe a set of capabilities, that are "various combinations of functionings (beings and doings) that the person can achieve (…) reflecting the person's freedom to lead on type of life of another" (Sen, 1992, p. 40). Framing accessibility as a capability translates into the degree to which an individual can move and access key life opportunities and establishes the relationship between the valued activities of someone and the potential of a person to overcome spatial friction, which also relates to other basic capabilities (Vecchio and Martens, 2021). One example: "accessibility to food stores is key for bodily health as a capability, as it enhances the person's possibility to be well-nourished" (Vecchio and Martens, 2021).

Choices express an individual's decision favouring one "state" over another that was selected from the capability set (Sen, 1992). In transport applications, the choice is implicit, once the capabilities represent the set of choices and functionings related to the achieved accessibility, which will be discussed in the next paragraph.

Functionings represent what people do or are, putting into practice (or not) the capability that is available for them and in the case of framing accessibility as a capability, it is the achieved accessibility (Vecchio and Martens, 2021). When an individual access an opportunity, they are choosing to transform the accessibility as capability into a functioning. The larger the capability set, the larger the choice a person can make. A positive achieve accessibility experience will enhance the conversion factor of an individual (Vecchio and Martens, 2021).

Finally, *well-being* is shaped by both capabilities and functionings (Vecchio and Martens, 2021). Although this concept does not receive so much attention in the capabilities literature, well-being is shaped by an individual's capability level, since larger freedom to choose a functioning and a larger choice set has a positive impact on well-being. The achieved accessibility from a person also contributes to well-being. First, "it allows participating in activities and therefore is conductive to other capabilities; and secondly, the movement realised to access a place may generate a positive experience (a person may enjoy the experience of riding a bicycle, or an older adult may feel more

confident if able to undertake a trip autonomously)" (Vecchio and Martens, 2021). In the same trend as in functionings, enhancing subjective well-being related to transport will feedback on conversion factors (Vecchio and Martens, 2021).

Vecchio and Martens (2021) argue in their study that considering accessibility as a capability develops 2 main approaches:

- Aggregate and top-down – aim the attention to the existing transport and land use systems. In this approach transport and land-use are considered the resources, having the ability to reach key-life activity is a capability and reaching it is functioning. It is argued that the assessments here "tend to adopt a 'sufficientarian' approach in their evaluations. (…) Interestingly, other key concepts of the Capabilities Approach – notably conversion factors – are rarely explicitly considered or operationalised" (Vecchio and Martens, 2021).
- Individualized and bottom-up – adopts a person-based perspective. This approach considers an individual's "own assessment of perceived mobility-related capabilities and functionings" (Vecchio and Martens, 2021). In this sense, this bottom-up assessment considers how each values different activities and how the individuals interact with the mobility system. This approach focuses on specific groups, like disadvantaged ones, and how they engage in activities with the existing transport and land-use system.

The framework in Figure 11 that presents the relations of capabilities approach has a relation with the conceptual model adopted in this research, regarding some adaptations and changes. The conceptual model considers perceived transport poverty as a mediating factor between accessibility and well-being, which is not present in the model proposed by Vecchio and Martens (2021). In addition, socio-economic and transport characteristics are considered as one variable, so the resources and conversion factors are combined into one. Also, well-being does not have a feedback loop to conversion factors as a matter of simplification of the model, as shown be figure 12.

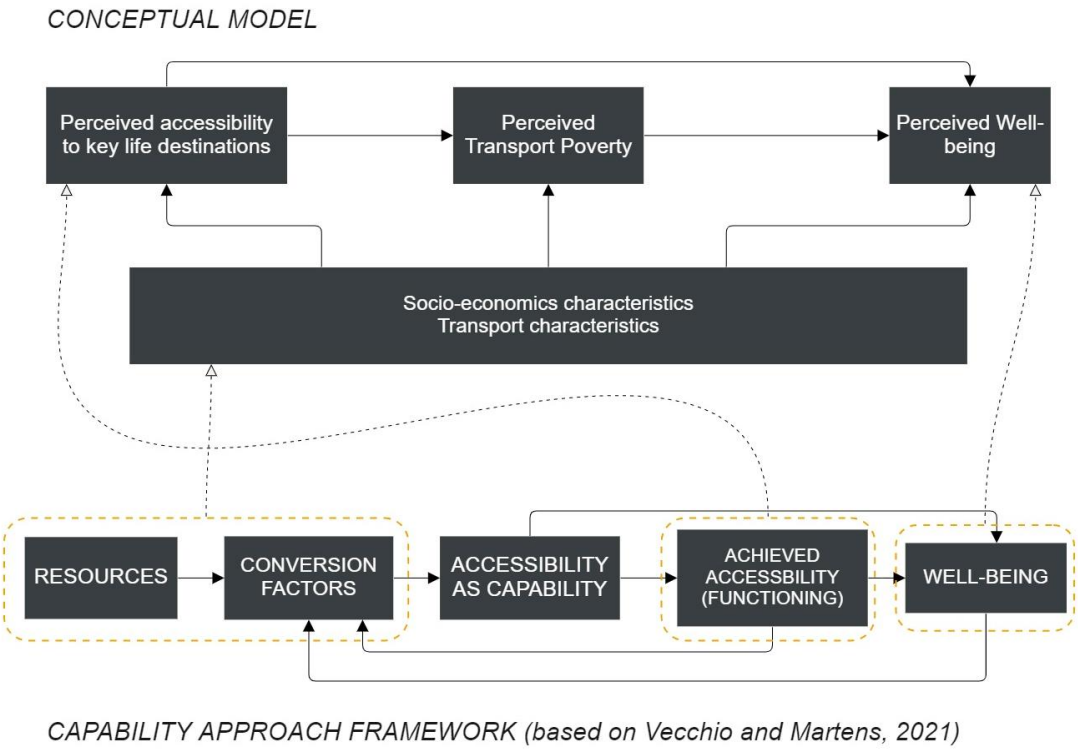

Figure 12: Relations from the conceptual model with the capability approach.

4.5 Conclusion

Chapter four brought concepts that involve justice and equity in the transport system, both terms are used interchangeably. Figure 13 presents the overall content of the present chapter.

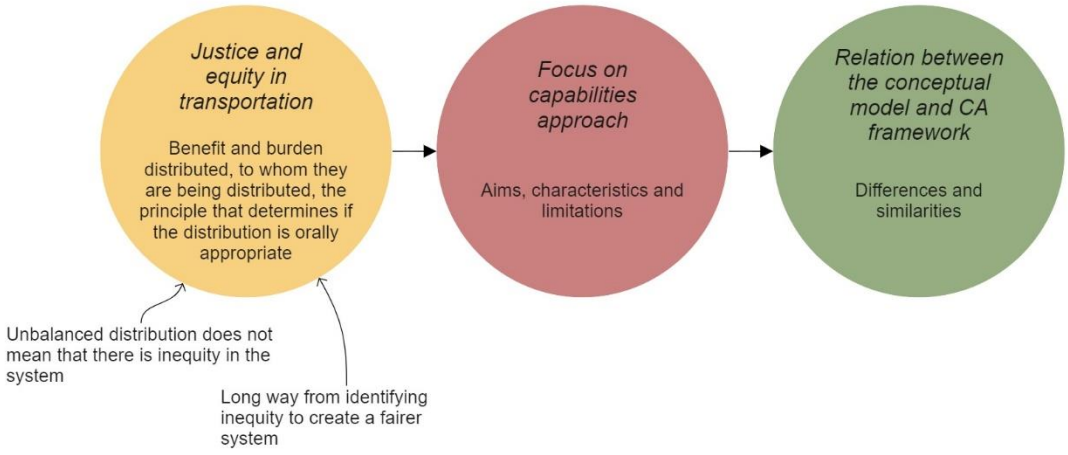

Figure 13: Overview of the concepts discussed in chapter 4.

Identifying different levels of a certain benefit or burden in the transport system (such as accessibility or pollution) can help in identifying transport poverty and other concepts related to it, such as social

exclusion or levels of well-being. However, finding these unbalanced levels to classify them as inequal to provide a fairer system is a long process.

The process to analyse equity in the transport system starts with the benefit or burden that will be distributed, the groups that it will be distributed to and finally determining the measurement that will be used to decide if that distribution is morally appropriate. Among the measurements provided, the chapter focus on one, the capabilities approach, since it was the one used in this study and is related to the conceptual model that was analysed.

The capabilities approach aims to reach a minimum accepted level of accessibility by acknowledging a person's capability. This approach considers how the resources that are available shape a person's opportunity and how their well-being is shaped by their capabilities and functionings. Although this approach has been gaining traction in transport literature, it is still difficult to establish a minimum threshold of accessibility that the system should have.

Lastly, the relation between the conceptual model from this study and the capabilities approach framework is presented, so that it is possible to identify what are the similarities and differences between the two. With a better overview of that, the next chapter discusses the methodology used in the study.

5 Methodology

This chapter contains the methodology adopted. First, a detailed description of the data collection is presented and after, the analysis methods that were applied to the data. The analysis methods consisted of a set of statistical analyses, that comprises factor analysis, bivariate analysis, regression analysis and finally a geographical analysis. Each subchapter focuses on one of the analysis methods conducted in this study. Figure 14 shows the overall methodology of the statistical analysis. First, factor analysis was performed, then the t-tests and ANOVAs and finally the regression analysis was represented in the figure by the numbers 1, 2 and 3. The white boxes show the variables that were used in each step. In addition, each one of these methodologies will be zoomed in the corresponding sections to be further detailed.

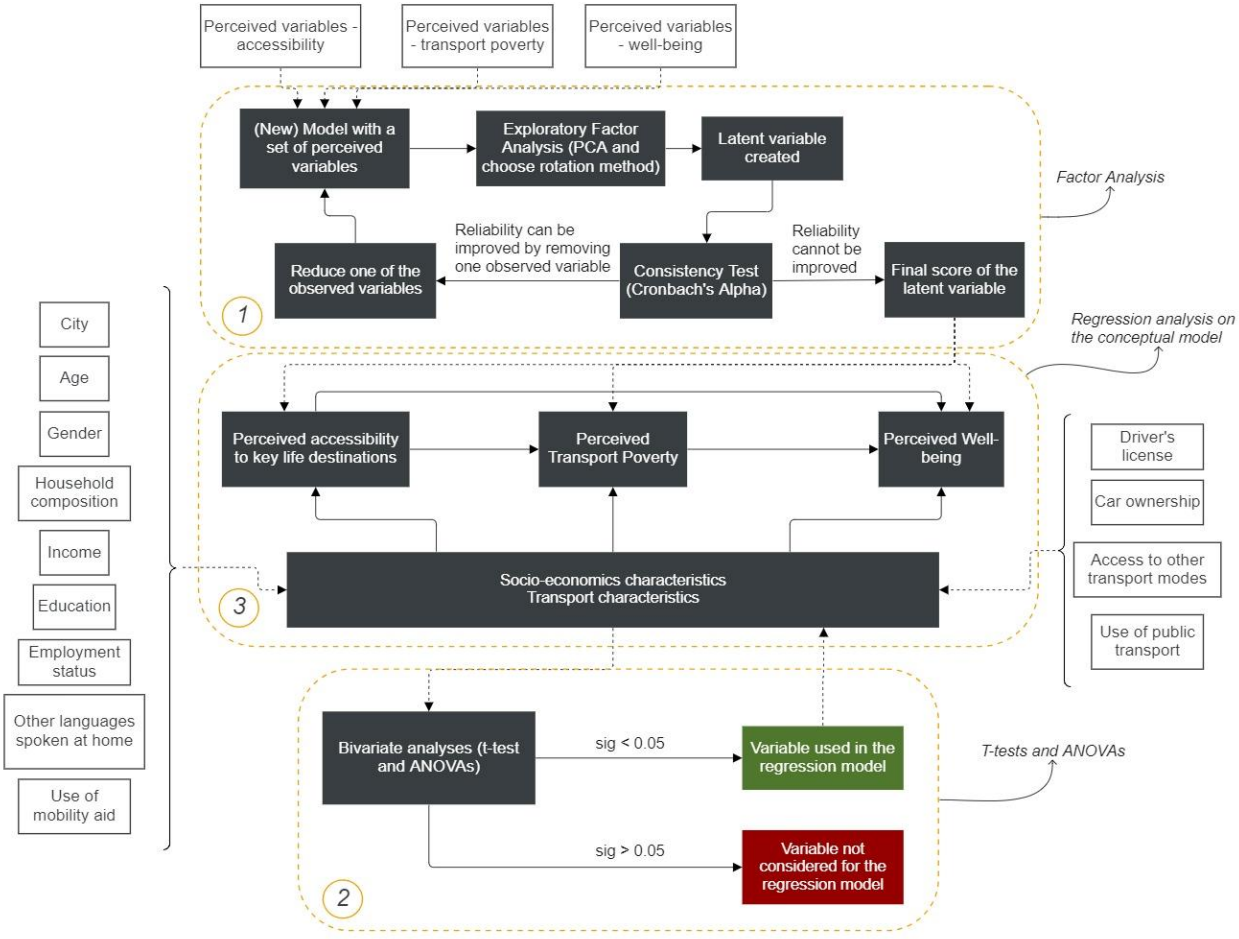

Figure 14: Statistical analysis overview.

A relevant matter to take into account when reading the following methodologies is that this study will only briefly explain them, focusing on the elements that are relevant for the research and that help to

clarify the choices made. For detailed information about each framework is recommended the literature that was used here.

5.1 Data Collection

The main source of this study is a result of a questionnaire applied as part of the Mobimon project, which had the aim to better understand the population that was at risk of transport poverty and how this was experienced in their everyday life. Data collection was realised in two phases: the first one between January 27th, 2021, and February 14th, 2021; and on June 1st, 2021, and June 25th, 2021. The full questionnaire in English can be found in Appendix A. The survey consisted of 4 sections, with 40 questions related to the person's travel behaviour and their experience with the transport system, which included different transport means, destinations that the individual travels to, experience and satisfaction with travelling, satisfaction with several different areas of life and personal factors.

Participants that answered the questionnaire ranged from 18 to 70 years old from Rotterdam and Utrecht. First, the questionnaire consisted of 2 questions regarding the respondent's age and city of residence, which served as filtering questions to achieve the target population that was looked for.

The first section of the questionnaire corresponded to 13 questions about different means of transportation that the person used and in which conditions. First, the questions were regarding having a car and driver's license, how they felt about driving, the type of car that was available, how frequent they drove and the type of parking facilities available. Second, questions about other types of transport available and the parking facilities available were asked. The last part of this section consisted of questions about vehicle sharing services, public transport availability and quality, payment method of public transport and planning method to travel.

The second section consisted of 10 questions related to travel behaviour and transportation experience. Question about the frequency of using different modes of transport was present, including the preferred way of travelling, the main motives to choose that option and if the respondent could reach all their regular destinations if the main travel mode was not available anymore. In addition, this section contained questions about accessibility, including ease to travel to key life destinations, travel time to job location, inaccessibility to places due to lack of suitable transportation options and accessibility to the job location. Finally, the last part of this section consisted of questions regarding the usage of mobility aid and about the broad definition of transport poverty as stated by Lucas et al. (2016) that was adopted in this study.

In the third section of the survey, people were asked to answer 2 questions related to their well-being while rating different areas of their life on a scale from 1 to 10. Finally, section four of the survey collected personal information about the respondent. 10 questions about gender, postal code, household composition, primary and secondary languages spoken at home, social contact with family and friends,

level of education, employment situation and household income were present. The last 3 questions were related to rewarding the respondents with a gift card.

The second part of data collection consists of sociodemographic characteristics from Rotterdam and Utrecht. This type of data was obtained through CBS and information shared by both municipalities related to population composition, age, gender, household formation, income, educational level obtained, employment status and migration background. The data was applied to support the overview of both cities.

The third part of the data collection is related to mobility characteristics. ODiN (Onderweg in Nederland - on the road in the Netherlands) data from CBS was used to gather mobility characteristics from the Dutch population older than 6 years old. With the three types of data used in this study explained, the next section presents the overview of the analysis method adopted.

5.2 Analysis Method

5.2.1 Factor Analysis

Factor analysis is one of the methodologies that is used in this research. It is used to simplify a set of complex variables and explore the dimensions that explain the relationships between multiple variables (Tavakol and Wetzel, 2020). In addition, factor analysis makes it easier to understand the relationship between items on a scale and the underlying factors that the items have in common (Tavakol and Wetzel, 2020). The present study conducts factor analysis in an *exploratory* way. According to Watkins (2018, p 220), exploratory factor analysis (EFA) attempts “to identify the common factors that explain the order and structure among measured variables.”.

To perform factor analysis, one must indicate both the *extraction method* and the *rotation method* (Ellis, 2017). The extraction determines how the factor patterns are seen initially (Ellis, 2017) and the rotation determines how these factor patterns will be converted into a more simple structure (Thurstone, 1947; 1954). For the extraction method, the most relevant ones are principal components analysis (PCA) and maximum likelihood (ML) (Ellis, 2017). PCA is described by the literature as a special case that seeks to explain total variance in the correlation matrix (i.e., specific and error variance) (Tavakol and Wetzel, 2020). For the rotation, the most relevant is varimax, which assumes that the factors are uncorrelated (orthogonal rotation) and Promax, which assumes correlations (oblique rotation) (Ellis, 2017). This study conducted all the factor analyses using *principal components analysis.* Since the outcome was to obtain a single latent variable, the rotation method was not relevant in the analysis.

After choosing the extraction and the rotation appropriate according to the data, the main estimates from a factor analysis are the *factor loadings* (Ellis, 2017), which represent the correlation between the observed variable and the factor (or the latent variable) (Tavakol and Wetzel, 2020). According to Tavakol and Wetzel (2020), a factor loading of more than 0.3 usually indicates a moderate correlation

between observed and latent variables. In addition to the factor loadings, factor analysis also reports the communalities, which express the “percentage of the variance of the manifest variable that is explained by the common factors (Ellis, 2017, p 30).

After conducting the factor analysis, it is well-considered to perform an internal consistency reliability test, which is “the reliability of the total score, based on the statistical relationships between different items in a single test” (Ellis, 2017, p 86). One of the most used reliability tests applied for factor analysis is coefficient *Cronbach’s alpha.* The test provides insight if the observed variables have a positive or negative impact on the reliability of the scale. If an item has a negative impact on the scale, this item can be removed (Ellis, 2017) and factor analysis has to be performed again, with a new set of measured variables. Since SPSS was the software adopted in this research, one of the possibilities that it gives to the user is to analyse if Cronbach’s alpha would be improved by removing one of the measured variables. This analysis was also performed to obtain a higher score for the consistency reliability test.

The following figure 15 shows the workflow that was applied in this study to conduct the factor analysis. First, a model was defined with a set of perceived variables (from accessibility, transport poverty and well-being), and then the exploratory factor analysis could be conducted using the PCA method. Since the goal was to reduce the observed variables into latent ones, only one fixed factor was chosen to be the output from the factor analysis. The consistency test was applied to identify if the model could be accepted, or if a variable had to be removed to improve the reliability.

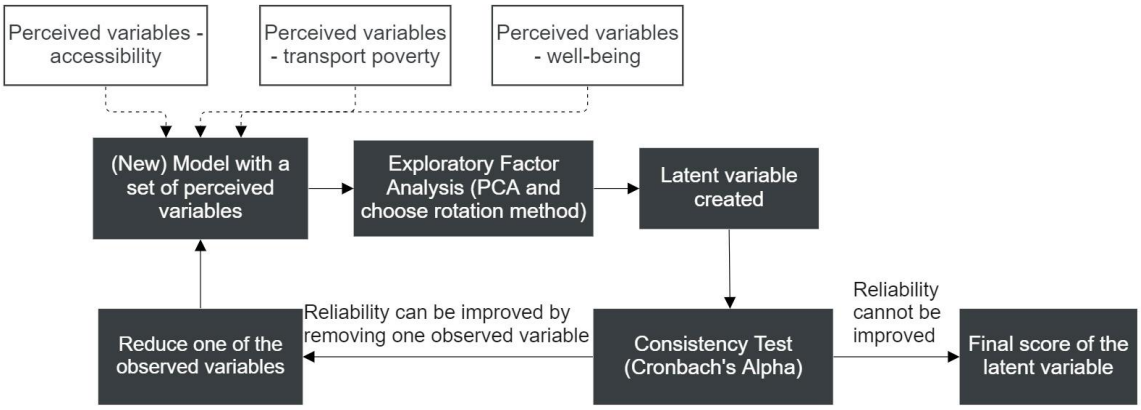

Figure 15: Workflow for factor analysis.

After the factor analysis was performed with the desired latent variables, they were stored as regression values. These regression values were used for the next methodologies applied to this research.

5.2.2 Bivariate analyses - T-test and Analysis of Variance (ANOVA)

T-tests and ANOVA were conducted in SPSS in this research to compare the means of two or more groups to assess how considered independent variables related to sociodemographic and transport

options influence a dependent variable. T-tests are designed to investigate the relationship between an independent variable that has two levels (dichotomous) and a dependent variable on an interval/ratio scale (Field et al., 2013; Ho, 2014). Similar to t-tests, the ANOVA test can measure the differences in means of more than two groups (Ho, 2014). Both statistical analyses here assume that data is presented in a normal distribution and that the scores that go into a mean are independent of each other (Emerson, 2017). Figure 16 details the workflow to perform the t-tests and ANOVAs.

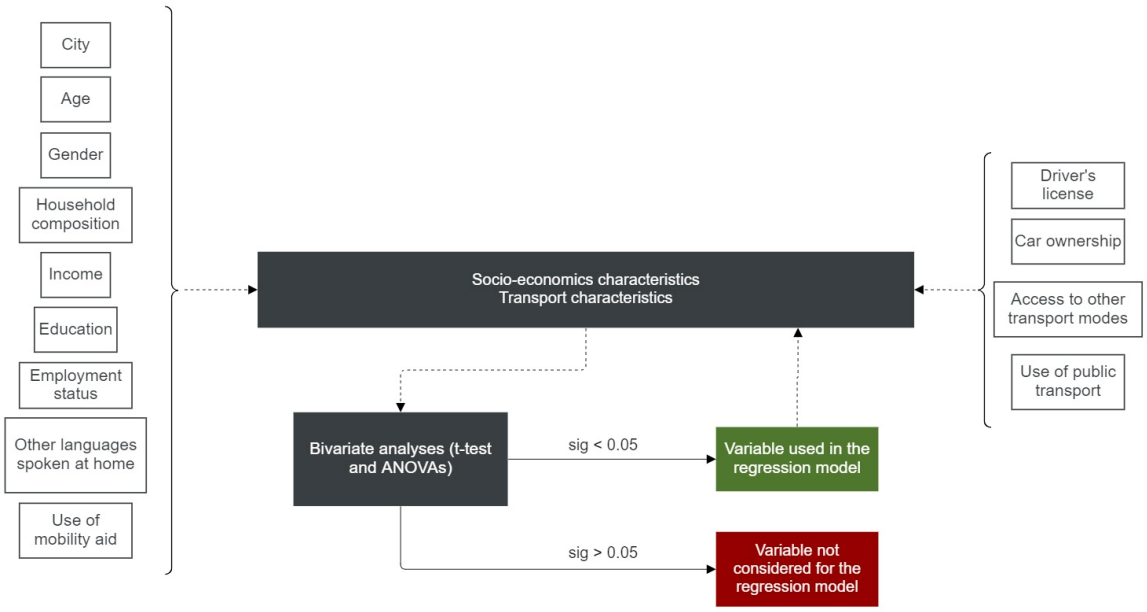

Figure 16: Workflow for t-tests and ANOVAs.

The independent variables considered were city, age, gender, household composition, income, education, employment status, other languages spoken at home (besides Dutch), use of mobility aid, driver's license, car ownership, access to other transport modes, and use of public transport. The dependent variables were related to the latent variables resulting from the factor analysis, named: perceived accessibility, perceived transport poverty and perceived well-being.

5.2.3 Multiple Linear Regression Analysis

Regression analyses were performed also in SPSS to understand the relation between the independent and the dependent variables from the model. Multiple linear regression supports the analysis of the relationship between an outcome variable (dependent - y) and a set of predictor variables (independent - x_n) (Ho, 2014; Tranmer et al., 2020). Multiple linear regression follows the terms presented in equation 1, based on Tranmer et al. (2020)

$$y_n = \beta_0 + \beta_1 x_{1n} + \beta_2 x_{2n} + \cdots + \beta_{in} x_{in} + e_n \quad (1)$$

y_n is the outcome variable of the model that contains *n* predictors.

β_0 is the constant – when all the set of predictors is equal to 0, y equals the constant.

β_{in} are the betas that represent how much the value of y increases for a one-unit increase in the x associated with the beta. *in* corresponds to the number of variables.
x_{in} correspond to each independent variable, which *in* corresponds to the number of variables.
e_n is the error term, or the residual value associated with each respondent. For linear regression, it is assumed that the mean value of the error terms for all the respondents is equal to 0.

An important reminder about regression is that although this type of analysis allows for identifying the relation of a predictor toward an outcome variable, it does not allow to make causal inferences (Tranmer et al., 2020).

SPSS presents some results that this research uses for the interpretation of the multiple linear regression, which are: R2 adjusted, significance from the model (the outcome variable), betas (the standardized coefficients related to each predictor) and significance from the predictor variables. R2 adjusted presents the percentage of variance explained in the outcome variable, which is the model. The significance of the model and the variables adopt the same threshold of p-value: 0.05. For the model, if the output value of SPSS is lower than 0.05 means that it is statistically significant. The same goes for the significance of the predictor variables, if they present a significance level lower than 0.05 means that that predictor is statistically significant for the model.

To perform the multiple linear regressions in this study, some conditions and assumptions were made. First, outliers were treated as described in section 6.2. Missing values of the sample were replaced by mean values. After, the variables that were selected for each model of the regression analysis resulted from the t-tests and ANOVAs, so variables that did not show significance were left out.

An important assumption for multiple linear regression is that the predictor variables need to have a linear relation with the outcome variable. To achieve that outcome, adaptations were made to the data. As most of the predictor variables are categorical with more than 2 categories, they had to be transformed by applying dummy code. Dummy coding allows for the presentation of different categories of the same variable as if they were dichotomous, using ones and zeros (Field et al., 2013). For each predictor variable, the number of dummies that were recorded as new variables was the number of categories of that predictor minus 1, which was the category chosen to be the baseline group. The baseline usually represents a control group or the one that represents the largest part of the sample (Field et al., 2013).

In total, 3 models were produced, pertinent to each of the three dependent variables. The models that were regressed were part of the conceptual model from the present study. In Figure 17 it is possible to check the workflow of which conceptual model represents each variable.

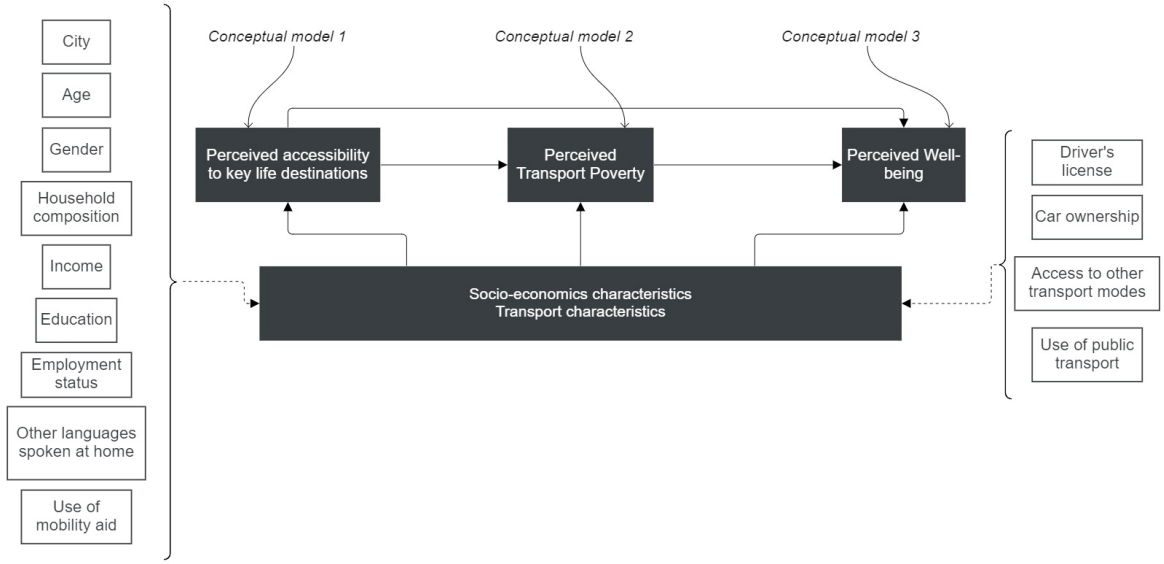

Figure 17: Workflow from the regression analysis.

Model 1 took into consideration socioeconomic and transport characteristics as the predictors and perceived accessibility as the outcome variable. Model 2 has 2 variations. Model 2.a performed the regression with perceived transport poverty as the dependent variable and socioeconomic and transport characteristics as the predictors. Model 2.b added to model 2 perceived accessibility as a predictor as well. Model 3 presents 3 variations. Model 3.a used perceived well-being as the outcome variable and socioeconomic and transport characteristics as the predictors. Model 3.b added to model 3.a considering perceived transport poverty also as a predictor. Finally, model 3.c added to model 3.b perceived accessibility as a predictor. The following Table 1 displays the model, the dependent variable that was investigated in each model and the independent variables associated with it.

Model	*Dependent (or outcome) Variable*	*Independent (or predictor) Variables*
1	Perceived Accessibility	Socioeconomics and transport characteristics
2.a	Perceived Transport Poverty	Socioeconomics and transport characteristics
2.b	Perceived Transport Poverty	Socioeconomic, transport characteristics and perceived accessibility
3.a	Perceived Well-being	Socioeconomics and transport characteristics
3.b	Perceived Well-being	Socioeconomic, transport characteristics and perceived transport poverty
3.c	Perceived Well-being	Socioeconomic, transport characteristics, perceived accessibility and perceived transport poverty

Table 1: Models analysed with linear regression.

With the last statistical analysis described, next the spatial analysis conducted is described.

5.2.4 Spatial Analyses

In urban studies, visualization aids the statistical analysis presented in tables and graphs. Power BI was used in this study since it is an application that produces friendly data visualizations and can be integrated with ArcGIS. ArcGIS uses a geographic information system (GIS) that creates, conducts, analyses and maps different types of data. According to Esri (2022), “GIS connects data to a map, integrating location data (where things are) with all types of descriptive information (what things are like there). (…) GIS helps users understand patterns, relationships, and geographic context”.

Since the data collected provided the first four digits of the respondent’s postal code, it was possible to relate that information to the respondent’s geographical location. In addition to the collected data, ODiN (on the road in the Netherlands) data from CBS was used to enhance the geographical analyses. ODiN collects data on the mobility of a large sample of the Dutch population older than 6 years old.

The maps produced supported the visualization of different levels of accessibility, transport poverty and well-being (results from the factor analysis normalized on a scale between 0 to 10) and their relation in terms of socioeconomics and mobility characteristics (significant according to the bivariate and regression analysis).

5.3 Conclusion

Chapter five explained in detail the methodology that was adopted in the present study. The framework in Figure 18 includes the overview.

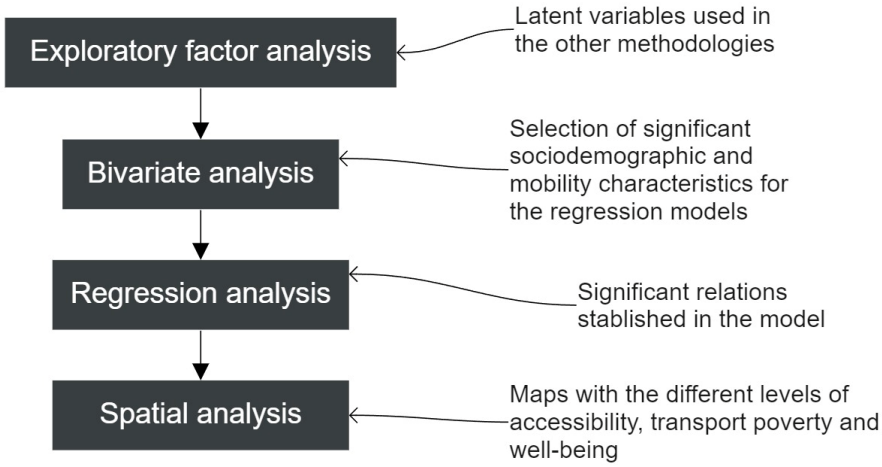

Figure 18: Overview of the methodologies discussed in chapter 5.

First, the data collection and the questionnaire were described to give the reader a better understanding of the type of data that was used. For details on the questions, the reader should check Appendix A.

The first methodology that was explained in this chapter was factor analysis. Within this section, the reader can understand better why to use it, the options to conduct this type of analysis, tests applied to check the coherence of the measured variables, how to interpret its results and the workflow adopted in the research to conduct it.

The following section dives into explaining the bivariate analysis conducted with the data. This methodology was used to select the significant independent variables that could be related to the dependent variables (or the variables that resulted from the factor analysis). This selection was later used in the regression analysis, which considered six different models. The regression analysis section explains the steps used and the models that were investigated in this research.

Finally, the last methodology adopted concerns spatial analyses, which aid in the visualization of the different levels of the latent variables resulting from the factor analysis and the relation with the significant socioeconomic and mobility characteristics. With the complete overview of the methodology presented here, the next chapter gives a detailed overview of the data collection and descriptive statistics of the data.

6 Data Collection and Descriptive Analyses

6.1 Data Collection

In this section, a description of the surveys applied to the population of Rotterdam and Utrecht will be presented. Next, data from CBS from both cities were also adopted to give a better context of both cities. Lastly, ODiN data was also used to present an overview related to mobility.

The survey applied from Mobimon collected the perceived data that was used in this research online using Qualtrix and was presented face-to-face to members of more vulnerable groups. Section 5.1 discussed when it was applied and the general structure of the questionnaire, for more details it is advised to check the questions in Appendix A. The survey was applied to the vulnerable population recruited via Labyrinth, which is a specialized agency in research and consultancy, and to the general population via the panel company PanelClix. The focus area of the research were the cities of Rotterdam and Utrecht since they are among the biggest in the Netherlands and have high shares of immigrants and vulnerable groups. The data went through some steps of cleaning to prepare it for further analysis. The total sample consists of 1203 collected answers. Invalid responses such as the ones that contained missing values for postal codes were removed from the dataset, leaving it with 1066 entries. Final cleaning was conducted regarding gender. For genderfluid and others the number of respondents was too low to be considered a separate group. Hence, these cases were removed, resulting in a final dataset of 1058 entries. The descriptive analysis from it is presented in section 6.2.

CBS data was collected through the website of both municipalities. The sociodemographic characteristics presented in section 6.3 support giving a clearer overview of them and are alike the sociodemographic characteristics that were collected in the surveys. ODiN (Onderweg in Nederland - On the road in the Netherlands) comprehends mobility data from the Netherlands of people 6 years old or older. The data includes a one-day trip diary inside Dutch territory. The data collected from ODiN illustrates the frequency of transport modes used in Rotterdam and Utrecht. The transport modes selected from ODiN database are similar to the ones collected in the survey used in this research for relation purposes. ODiN descriptive can be read in section 6.4.

6.2 Descriptive statistics from the survey

In this section socioeconomic and mobility characteristics are presented related to the sample obtained after the data cleaning. Socioeconomic characteristics include city of residence, age, gender, household composition, income, educational level, employment status, language spoken at home and use of mobility aid. Mobility characteristics include owning a driver's license, owning a car, other types of transport modes that were used and public transportation available to the respondent.

6.2.1 Socioeconomic Characteristics

The socioeconomic characteristics considered regard city, age, gender, household formation, income, educational background, employment status if another language was spoken at home besides Dutch and use of mobility aid. Table 2 presents the overall results, and each socioeconomic characteristic will be further explained.

Socioeconomic characteristic	Responses	Percentage
City		
Rotterdam	524	49.5%
Utrecht	534	50.5%
Age		
18-25	272	25.7%
26-35	293	27.7%
36-50	243	23.0%
51-70	250	23.6%
Gender		
Women	598	56.5%
Men	460	43.5%
Household formation		
Living alone	286	27.0%
Living with partner/spouse	296	28.0%
Living with children	218	20.6%
Other/did not say	258	24.4%
Income		
Less than 980 euro	155	14.8%
Between 980-1870 euro	262	24.9%
Between 1870-2680 euro	233	22.2%
Between 2680-3800 euro	136	12.9%
Between 3800-5460 euro	79	7.5%
More than 5460 euro	36	3.4%
Don't know/don't want to say	150	14.3%
Education		
Primary/Secondary/Other	234	22.1%
Tertiary (MBO)	282	26.7%
Tertiary (University Bachelor)	301	28.4%
Tertiary (University Master)	241	22.8%
Employment Status		
Fulltime job	376	35.5%
Part-time job	240	22.7%
Not paid/other/did not say	442	41.8%
Other languages spoken at home		
Yes	393	37.2%
No	665	62.8%
Usage of mobility aid		
No	1017	96.1%
Yes	41	3.9%

Table 2: Socioeconomic characteristics.

The two questions about city and age filtered the target group intended for this study: people between the ages of 18 to 70 years old living in Rotterdam or Utrecht. Considering the respondents' geographical location 49.5% are based in Rotterdam and 50.5% in Utrecht. The questionnaire received answers from people between 18 to 70 years old. Overall, 25.71% were between 18 and 25 years old, 27.69% between 26 and 35 years old, 22.97% between 36 and 50 years old and 23.63% between 51 and 70 years old. The distribution can be observed in Figure 19.

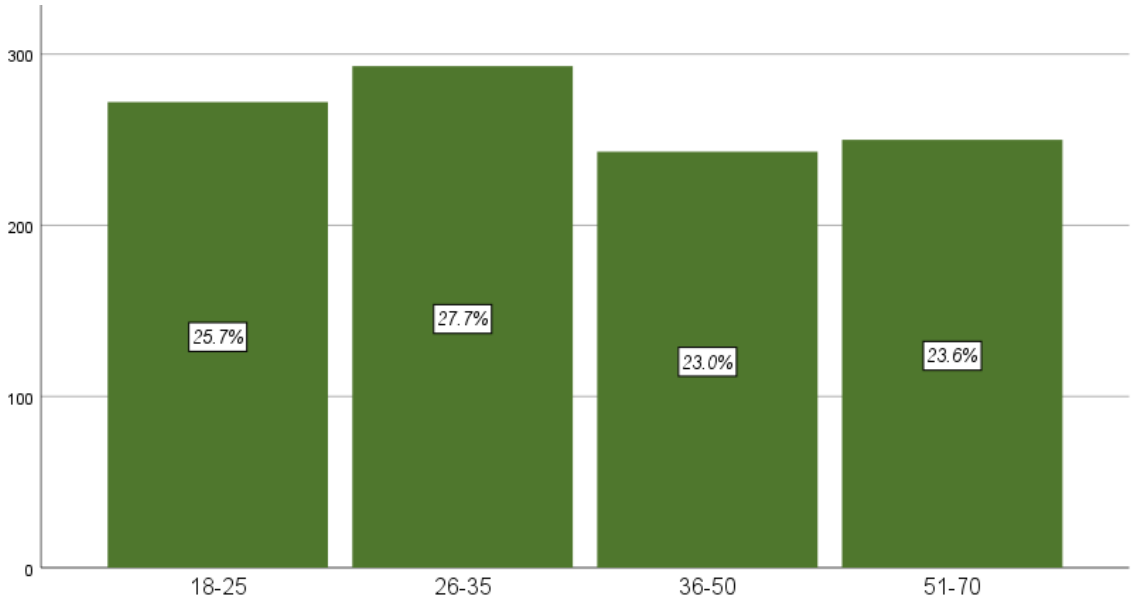

Figure 19: Histogram of age per cohort.

For gender, there was an overall response of 56.5% of women and 43.5% of men. Related to the household composition, respondents could choose between living alone; living together with a partner/spouse; living together with children; living with other family members, or living with friends/housemates; a condition that varies (e.g. a few days per week with children); and other living situation. The results show that about 27% of the respondents live alone, while 28% are living with a partner/spouse, 20.6% are living with children and about 24.4% are living in other household formations or prefer not to say. Among the other household formations, living together with other family members represent 9.9% and living with housemates/friends represents 10.8%. The distribution is presented in Figure 20 below.

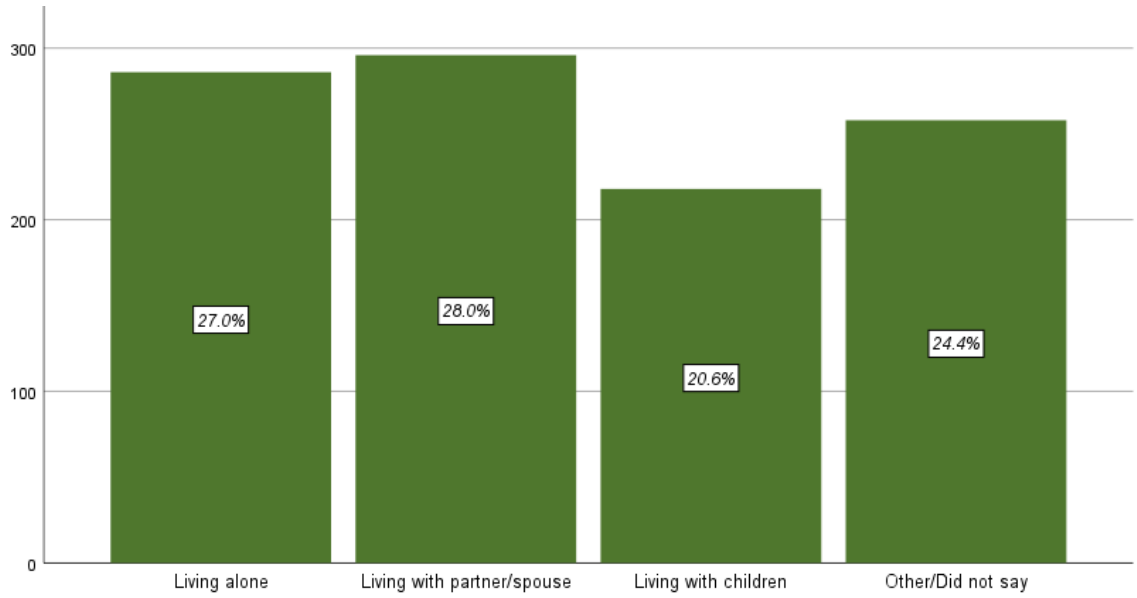

Figure 20: Histogram of household formation with merged categories.

Income was divided in 7 different categories: earning less than 980 euros (14.7%); between 980 and 1870 euros (24.9%); between 1870 and 2680 euros (22.2%); between 2680 and 3800 euros (12.9%); between 3800 and 5460 euros (7.5%); more than 5460 euros (3.4%) or don't know or prefer not to say (14.3%). The values represent the income per month and can be observed in Figure 21.

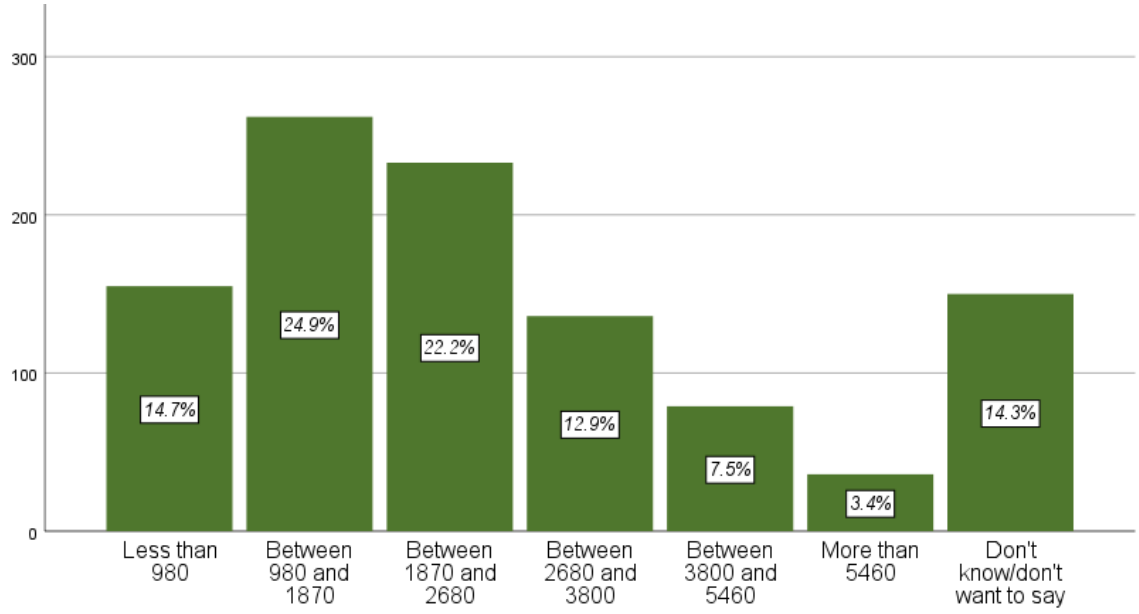

Figure 21: Histogram of estimated net monthly household income.

When asked about their highest level of education, respondents could choose between primary; secondary (VMBO, Mulo, Onderbouw Havo/VWO); secondary (bovenbouw Havo/VWO); tertiary (MBO 1); tertiary (MBO 2-4, HBS); tertiary (University of applied sciences/ university bachelor); tertiary (university of applied sciences/Master/PhD); and other levels of education. For convenience, some of

the categories were aggregated and their distribution in Figure 22, shows that 22.1% have either primary, secondary, other or did not say their educational background; while 26.7% have MBO; 28.4% have a University Bachelor's and 22.8% have either a University Master or PhD.

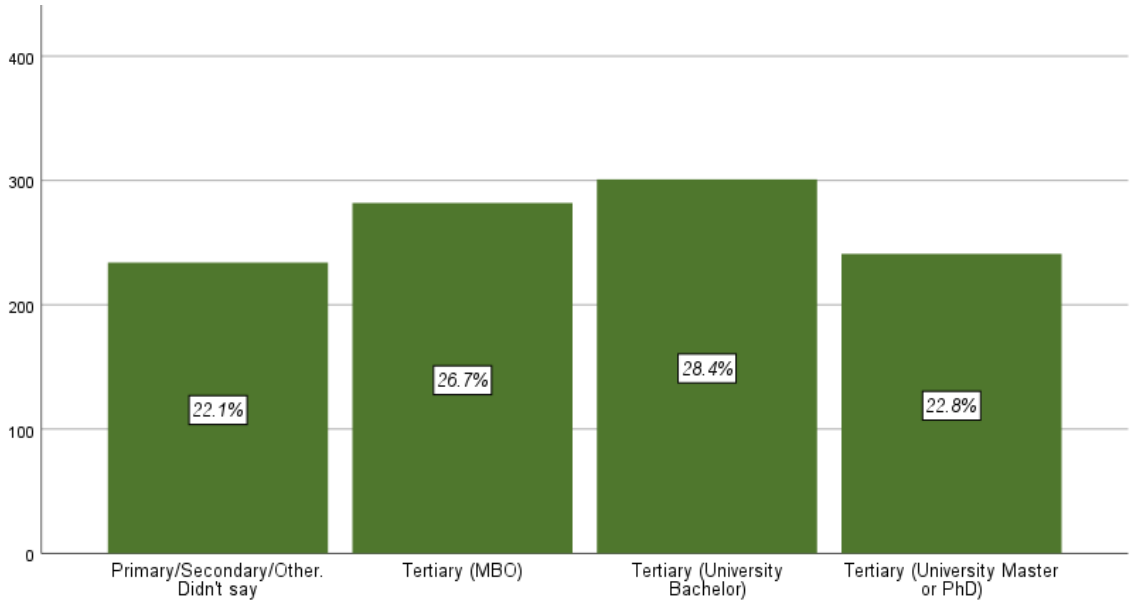

Figure 22: Histogram of the highest level of education obtained.

Respondents could opt between a full-time job, permanent contract; full-time job, temporary contract; part-time job, permanent contract; part-time job, temporary contract; seasonal job; entrepreneur/self-employed; retired; student; stay-at-home parent; caregiver; unemployed (looking for a job); unemployed (temporarily unable to work); and other job situation. The results for employment status indicated that 35.5% of the sample have a full-time job, 22.7% a part-time one, and about 41.8% have a non-paid position, or other types of job or prefer not to say. From not paid positions, students represent 12.6% and unemployed 9.3%. The histogram in Figure 23 displays the distribution of the aggregated categories of employment status.

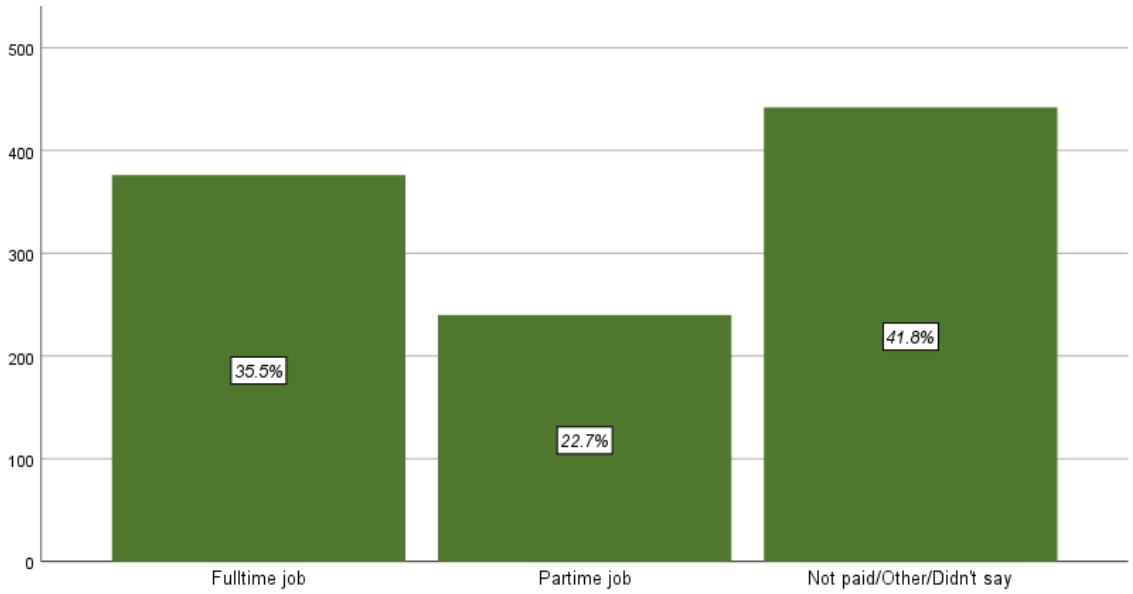

Figure 23: Histogram of employment status.

Two questions were asked regarding language spoken at home, the first question about primary language and the second question about speaking any other language. Both took into consideration speaking Arabic, Berber, Chinese, German, English, French, Dutch, Papiamento, Polish, Turkish and others. For convenience, these two questions were grouped in speaking only Dutch at home or speaking other languages, which might suggest migration background in the household. In total, 393 respondents (37.15%) of the sample speak another language at home, while 665 respondents (62.85%) of the sample speak only Dutch.

Among the respondents, 96.1% (1017 out of 1058) do not use any type of mobility aid. The share that makes use of mobility aids (41 or 3.9%) selected one of the following: a walking cane, crutches, or a white cane; a walker; a(n) (electric) mobility scooter; or a(n) (electric) wheelchair.

6.2.2 Mobility Characteristics

Mobility characteristics comprehend the responses regarding having a driver's license, car ownership, usage of other transport modes besides cars and usage of public transport. Table 3 has the overall results and each mobility characteristic that was considered was detailed further on.

Mobility characteristic	Responses	Percentage
Driver's license		
No	312	29.5%
Yes	746	70.5%
Car Ownership		
Yes	668	63.1%
No	390	36.9%

Mobility characteristic	Responses	Percentage
Other transport modes		
Bicycle + cargo bike (bakfiets)	558	52.7%
E-bike	114	10.8%
Moped, speed pedelec, (electric) scooter, motorcycle	201	19.0%
None or other	185	17.5%
Public transport		
Bus	119	11.2%
Tram or metro	249	23.5%
Train	490	46.3%
Other PT (regiotaxi, bellbus, etc)	200	18.9%

Table 3: Mobility characteristics of the respondents

The sample collected shows that 70.5% of the respondents own a driver's license and 63.1% have car access, either personal, family, leased, friends, carshare or other forms of car ownership.

When taking into account other transport means that the respondents use (that are neither public transport nor car), people could choose between bicycle; e-bike; moped or speed pedelec (up to 45km/h); (electric) scooter; cargo bike (bakfiets); motorcycle; none; and other. Similar categories were grouped. Finally, 52.7% use either bicycle or cargo bikes; 10.8% e-bike; 19% moped, speed pedelec, (electric) scooter or motorbike; and 17.5% use none of these options or other that was not listed. The distribution can be seen in the following Figure 24.

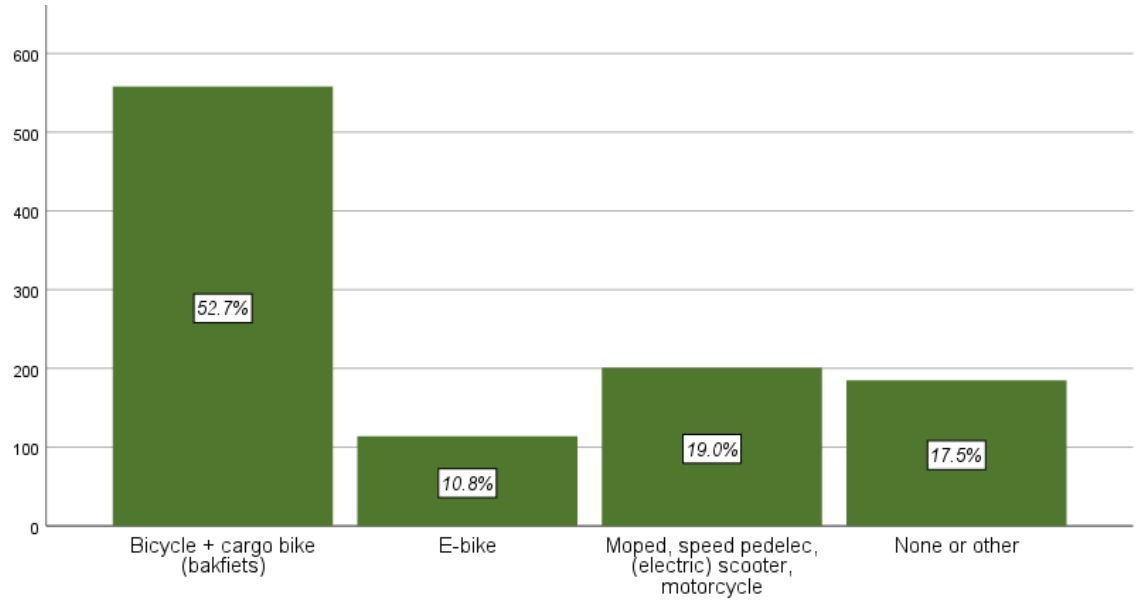

Figure 24: Histogram of other transport means used, besides the car and public transport.

For public transport availability, the choices presented were bus, tram, metro, train, regiotaxi/belbus (dial-a-bus), none or other. For this question, some categories were also grouped. The sample showed that 11.2% have access to the bus; 23.5% to tram or metro; 46.3% to the train; and 18.9% have access

to other types of public transport (like regiotaxi or belbus). The distribution of the available public transport is observed in Figure 25.

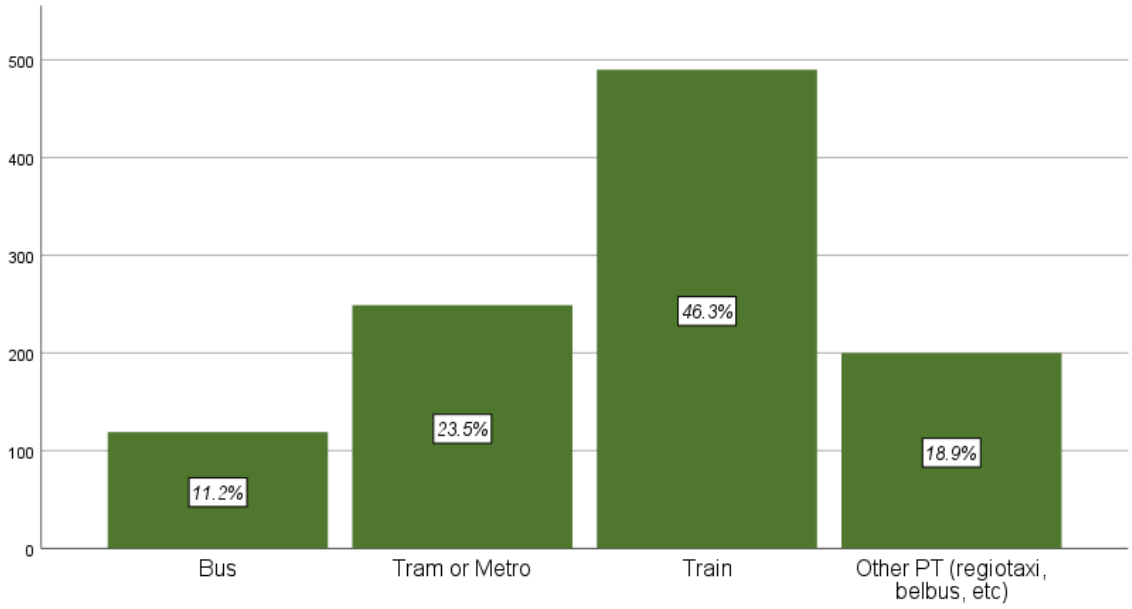

Figure 25: Histogram of public transport available.

6.3 Descriptive – CBS data from Rotterdam and Utrecht

This section describes the socioeconomic characteristics related to the target cities from the present study, Rotterdam and Utrecht to compare the representativeness of the sample. Figures 26.1 and 26.2 show their maps.

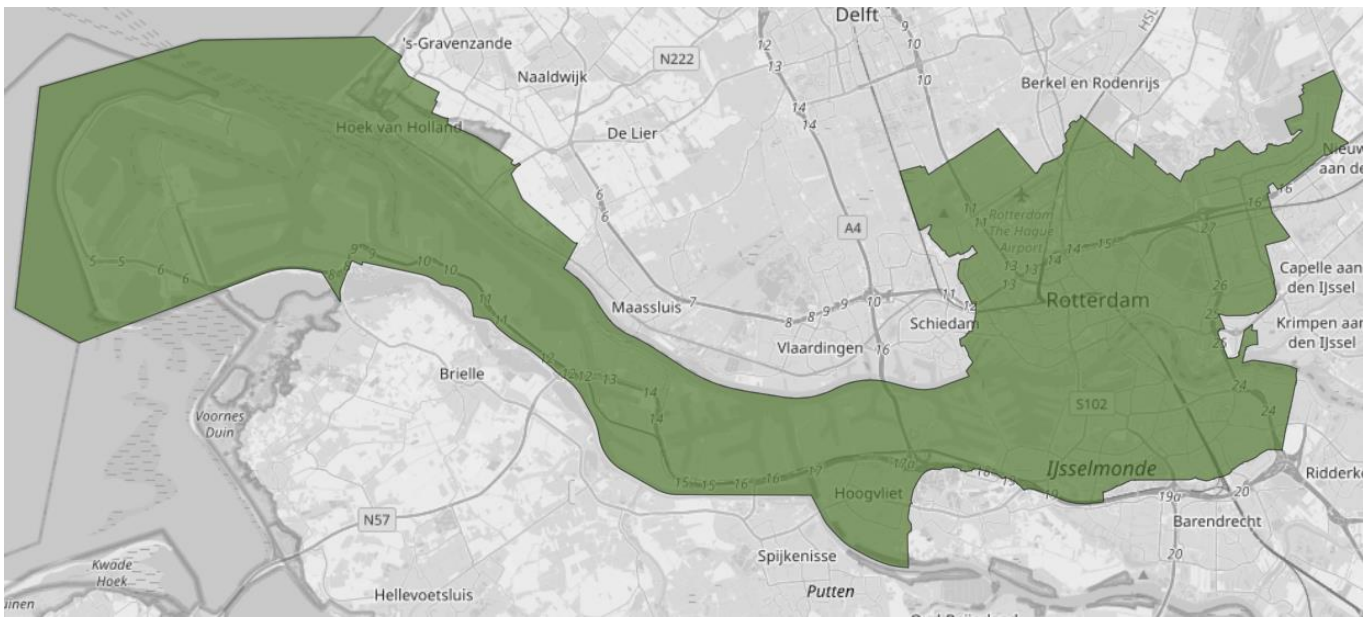

Figure 26.1: Rotterdam region.

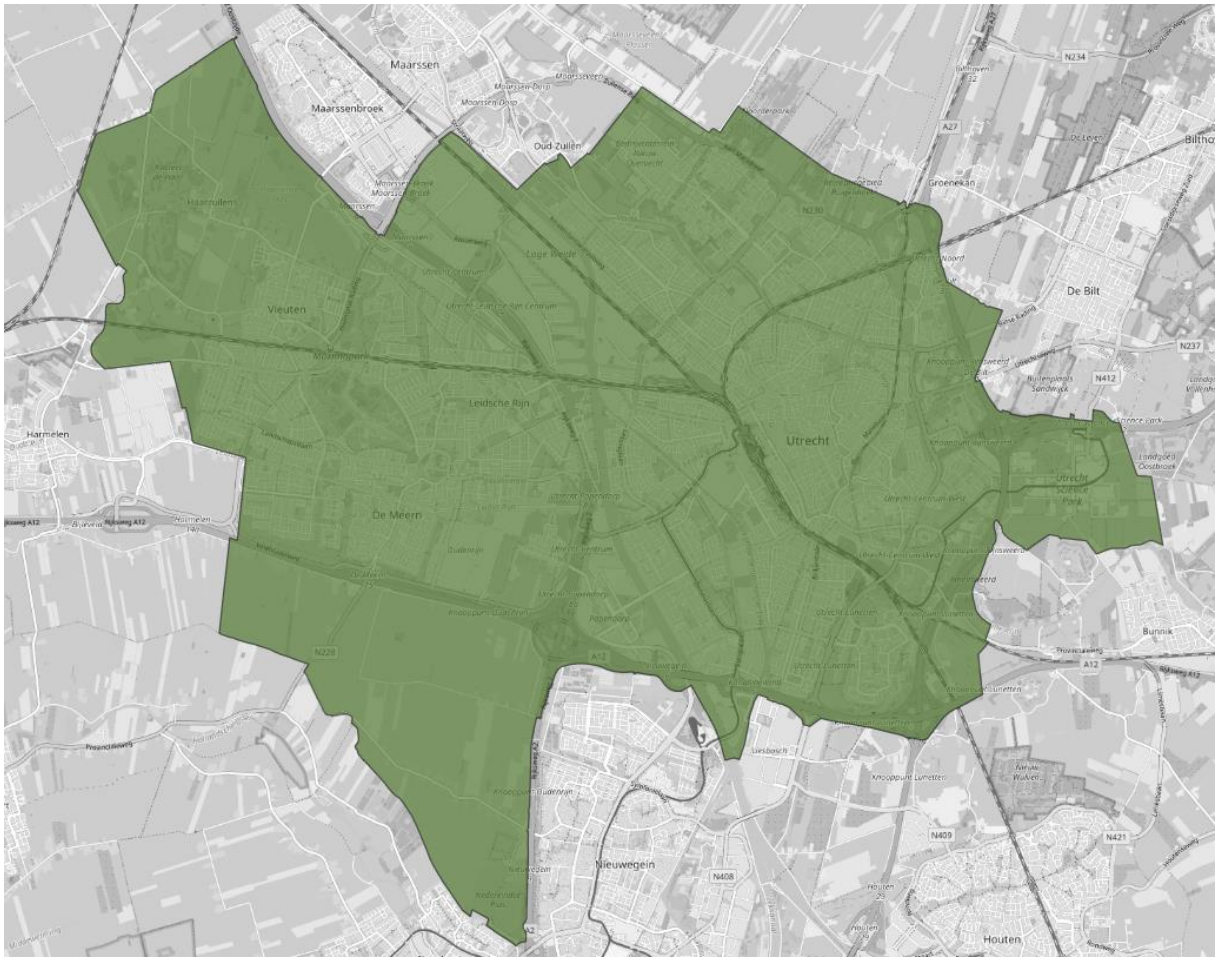

Figure 26.2: Utrecht region.

Rotterdam is located in South Holland province, with a total of 651.269 inhabitants in 2021, where about 329.376 (50.6%) are women and 321.849 (49.4%) are men. Utrecht is in the province that carries the same name, and the city had in 2021 359.355 inhabitants, 182.812 (50.9%) women and 176.543 (49.1%) men. The sample from the questionnaire presented 56.50% women and 43.50% men, which shows that it is overrepresenting women in both cities. The next Figures 27.1 and 27.2 show the age distribution of each city.

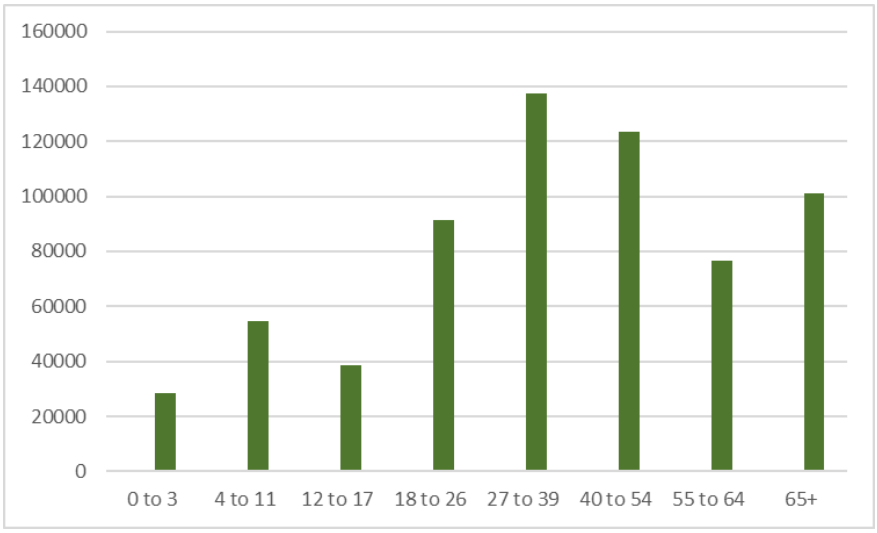

Figure 27.1: Age distribution – Rotterdam.

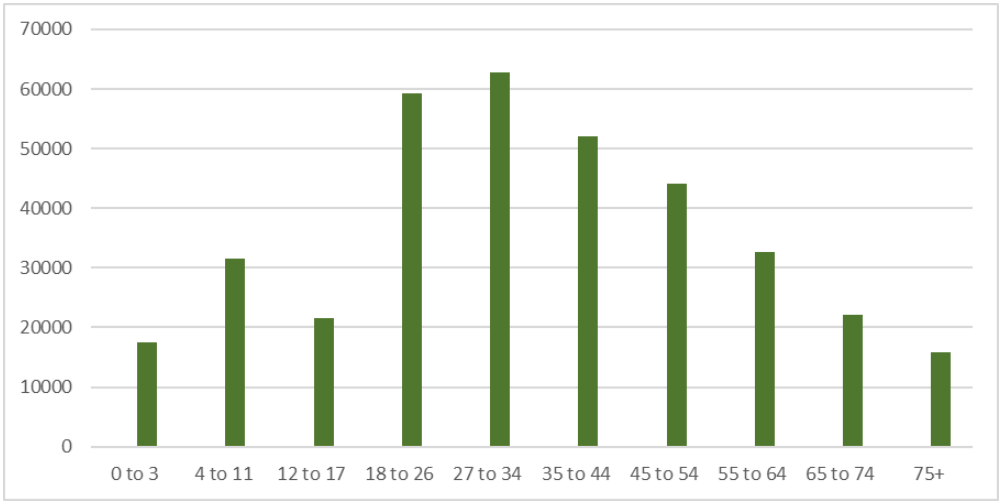

Figure 27.2: Age distribution – Utrecht.

The sample collected stratified data from each city to have about the same number of respondents in each. In this sense, the number of respondents is not equally represented by the population, since Rotterdam had in 2021, 651.259 inhabitants and Utrecht 359.355.

The survey limited the age of the respondents between 18 and 70 years old, so it is biased to compare the sample with data from CBS. Similar age categories from the sample are overrepresented in percentages to the categories from CBS, either from Rotterdam or Utrecht. This overrepresentation is highlighted in green in Table 4.

			Rotterdam – CBS			Utrecht – CBS		
			0 to 3	28.425	4.4%	*0 to 3*	17.531	4.9%
			4 to 11	54.768	8.4%	*4 to 11*	31.589	8.8%
Sample			*12 to 17*	38.429	5.9%	*12 to 17*	21.480	6.0%
18-25	272	25,71%	*18 to 26*	91.187	14.0%	*18 to 26*	59.338	16.5%
26-35	293	27,69%	*27 to 39*	137.348	21.1%	*27 to 34*	62.840	17.5%
36-50	243	22,97%	*40 to 54*	123.380	18.9%	*35 to 44*	51.996	14.5%
51-70	250	23,63%	*55 to 64*	76.669	11.7%	*45 to 54*	44.088	12.3%
			65+	101.063	15.5%	*55 to 64*	32.580	9.1%
						65 to 74	22.058	6.1%
						75+	15.855	4.4%

Table 4: Overrepresentation of the age categories from the sample, compared to data from CBS of Rotterdam and Utrecht.

When it comes to household formation, in 2020 Rotterdam had 328283 households, and about 48.4% lived alone, 22.3% lived with a partner/spouse and 29.3% lived with children. Utrecht presented a similar situation in 2022, with 162450 households, 51% living alone, 21% living with a partner/spouse, 27% living with children and 1% in other categories. The following Table 5 has an overview of both cities.

		Rotterdam	*Utrecht*
Household formation	Living alone	48.4%	51%
	Living with partner/spouse	22.3%	21%
	Living with children	29.3%	27%
	Other formations	-	1%

Table 5: Household formation – Rotterdam and Utrecht.

Income categories from Rotterdam and Utrecht are divided into 10 categories, in which 1 to 3 are low income, 4 to 7 represent medium income and 8 to 10 are high income. In 2020, 42% of the Rotterdam population occupied the lowest income categories, 35% medium income and 24% high income. While in Utrecht 29% represented the lowest income categories, 34% medium income categories and 36% high-income categories. The percentage of each one of the 10 categories can be visualized in table 6.

Income categories differ in the questionnaire and the CBS data. For comparison levels, here it is considered that the first two categories of the questionnaire are low income, the middle 2 are medium income and those earning more than 3800 euros are high income. Taking that into account, the sample from the questionnaire is underrepresenting the high-income categories, as displayed in table 6.

Income	*Respondents*	*%*	*Income category*	*Rotterdam*	*Utrecht*	
Less than 980 euro	155	14,75%	1	17%	12%	
Between 980-1870 euro	262	24,93%	2	14%	9%	
Between 1870-2680 euro	233	22,17%	3	11%	8%	
Between 2680-3800 euro	136	12,94%	4	10%	8%	
Between 3800-5460 euro	79	7,52%	5	9%	9%	
More than 5460 euro	36	3,43%	6	8%	8%	
Don't know/don't want to say	150	14,27%	7	8%	9%	
			8	8%	10%	1 – 3 low
			9	8%	12%	4 – 7 medium
			10	8%	14%	8 – 10 High

Table 6: Income category levels from the sample and CBS data.

Education is classified as low, medium or high education level reached. Rotterdam presents about 32% of the population with low educational level, 38% medium and 30% high level reached. Utrecht presents a considerable difference in this distribution when 19% reached a low educational level, 28% medium and 53% high level. For education, the categories from CBS and the questionnaire also differ. For comparison purposes, primary, secondary and other education is considered low; tertiary MBO or Bachelor is medium, and tertiary Master or PhD is considered a high level of education obtained. In this sense, the sample underrepresents low and high educational levels from Rotterdam and overrepresents medium educational levels. Compared to Utrecht, the sample overrepresents low and medium educational levels and underrepresents high educational levels, as displayed in table 7.

Education	*Respondents*	*%*	*Education category*	*Rotterdam*	*Utrecht*
Primary/Secondary/Other	234	22,10%	Low	32%	19%
Tertiary (MBO)	282	26,70%	Medium	38%	28%
Tertiary (University Bachelor)	301	28,40%	High	30%	53%
Tertiary (University Master/PhD)	241	22,80%			

Table 7: Educational levels from the sample and CBS data.

Employment status is presented in two different divisions in each city. Rotterdam had in 2019 315.511 workers, and 53.129 non-working people. Utrecht presented in 2021 about 288.087 people working, 87.3% with a full-time job and 12.7% with a part-time job.

For migration background, in 2021, Rotterdam had about 47.1% of its population being Dutch, which means that more than half of it had a migration background. In Utrecht, the numbers differ, with 63.6% of its population being Dutch and less than half of it having a migration background. The sample from Mobimon did not explicitly concern migration background, however, 665 respondents (62.9%) of them do not speak another language at home, which could be associated with not having a migration background. Comparing these results with CBS data, Rotterdam has 47.13% of the population with no migration background, which shows that the questionnaire overrepresents Dutch background, while

Utrecht has 63.59% of the population with Dutch background, as shown in table 8, which is proportionate to the sample collected in the questionnaires.

Rotterdam			*Utrecht*		
None (NL)	306.960	47.1%	None (NL)	228.524	63.6%
Migration background	344.309	52.3%	Migration background	130.790	36.4%

Table 8: Migration background composition, Rotterdam and Utrecht, 2021.

6.4 Descriptive – ODiN data from Rotterdam and Utrecht

This section presents descriptive data from Rotterdam and Utrecht relative to the frequency of use of the car (as the driver), bicycle, e-bicycle, mopeds, bus and train. Rotterdam data includes 9.580 respondents, while Utrecht consists of 6.877 respondents. The focus of this section is to emphasize the differences between frequent use of a certain mode (daily, almost daily and a few times a week) and low frequency of use of a certain mode (never or almost never).

When it comes to car drive frequency, about 40% of Rotterdam respondents use the car daily or almost daily and a few times a week. When it comes to the low frequency of car usage, 27.9% never or almost never use the car. In Utrecht, about 35% of the respondents use the car daily/almost daily or a few times a week, while 19.0% never or almost never use the car. Figure 28 brings the visual representation of car drive frequency in Rotterdam and Utrecht.

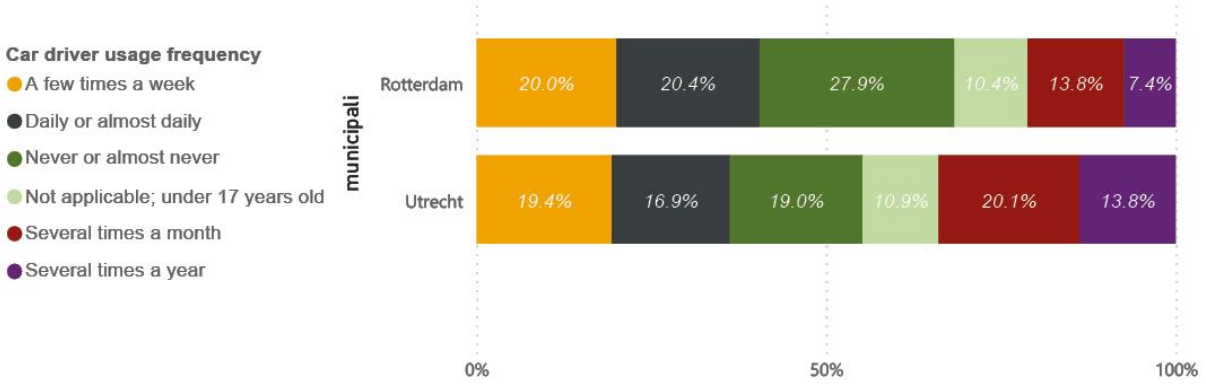

Figure 28: Car drive frequency in Rotterdam (left) and Utrecht (right).

Bike usage represents a considerably different between the two cities. While in Rotterdam around 55% use the bike every day or almost every day, this rate goes up to around 78% in Utrecht. And while in Rotterdam 24.5% of the respondents almost never use the bike, this rate goes down to 9.4% in Utrecht. Detailed shares are presented in Figure 29.

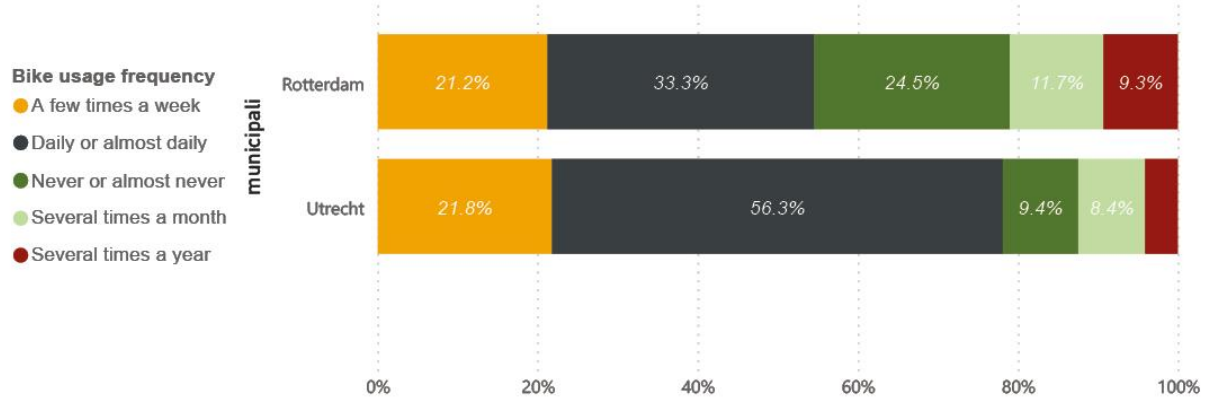

Figure 29: Bike usage frequency in Rotterdam (left) and Utrecht (right).

For electric bike usage, the data is similar in both Rotterdam and Utrecht. About 7.5% use this mode every day or almost daily and a few times a week, while the highest share of the respondents never or almost never use it (86.1% and 87.5% respectively). Figure 30 brings the complete shares for e-bike usage.

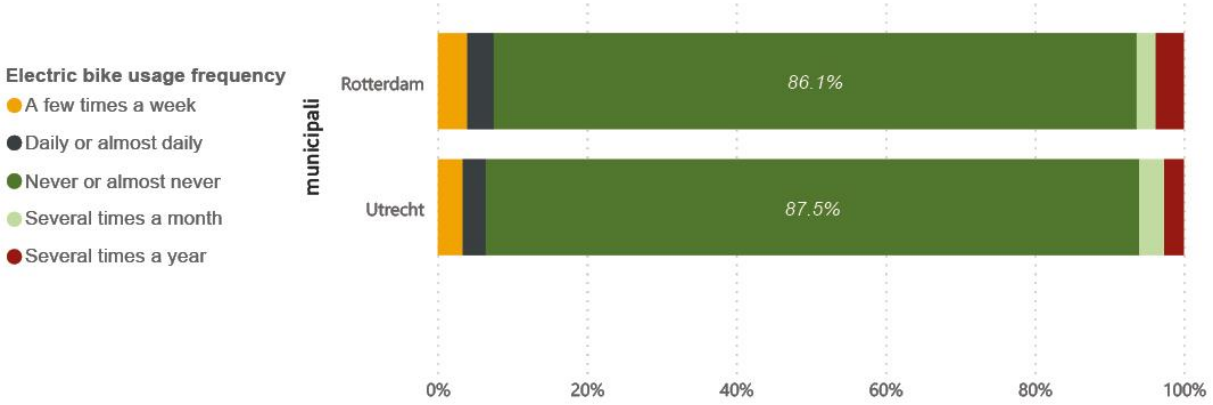

Figure 30: E-bike usage frequency in Rotterdam (left) and Utrecht (right).

For mopeds also the data is relatively similar. Both Rotterdam and Utrecht show low shares of frequent users of mopeds (around 2%), while the highest share of the respondents never or almost never uses this mode (91.1% and 95.7% respectively). Figure 31 brings the frequency of moped use.

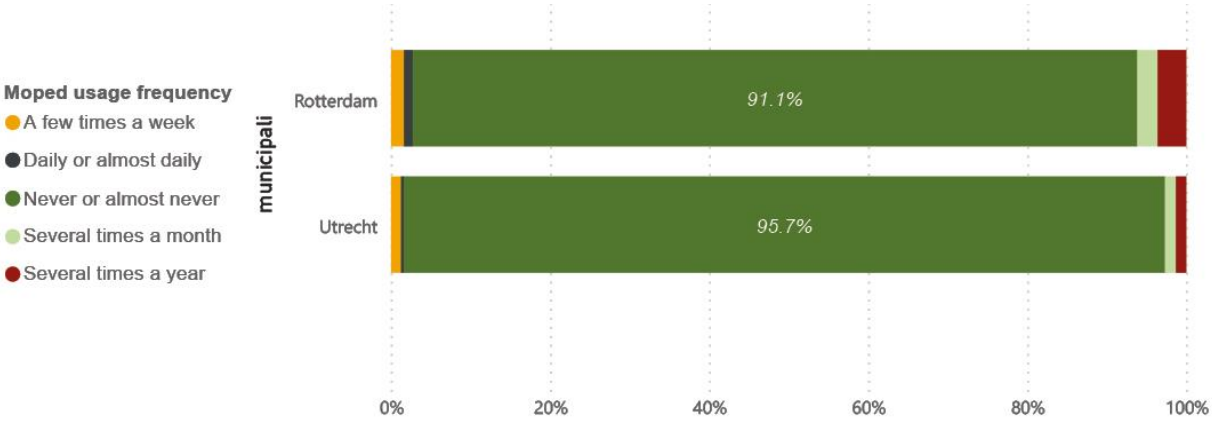

Figure 31: Moped usage frequency in Rotterdam (left) and Utrecht (right).

Bus usage frequency in Rotterdam is higher for frequent users. Around 33% of the respondents use this type of public transport daily, almost daily or a few times a week, while in Utrecht the share is around 17%. The respondents that almost never take the bus are similar in both cities, 14.3% and 16.7% respectively. Figure 32 presents the complete shares of bus frequency use.

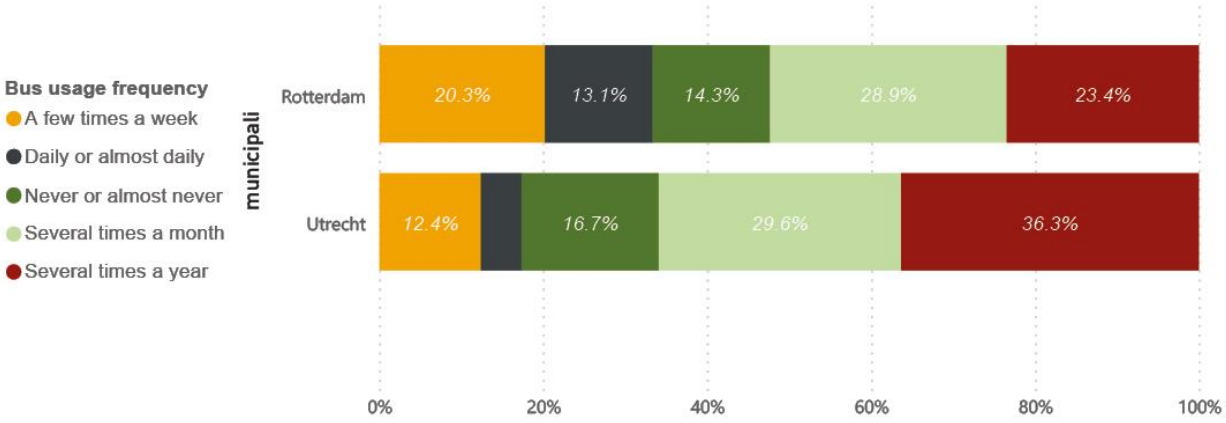

Figure 32: Bus usage frequency in Rotterdam (left) and Utrecht (right).

Finally, train frequency in Rotterdam and Utrecht also differs for high-frequency and low-frequency use. In Rotterdam, about 15% of the respondents use to take the train daily, almost every day or a few times a week, while in Utrecht the share goes up to 23%. For the respondents that never or almost never the share is considerably higher in Rotterdam, with 32.51% and Utrecht with 16.51%. Figure 33 brings the complete shares.

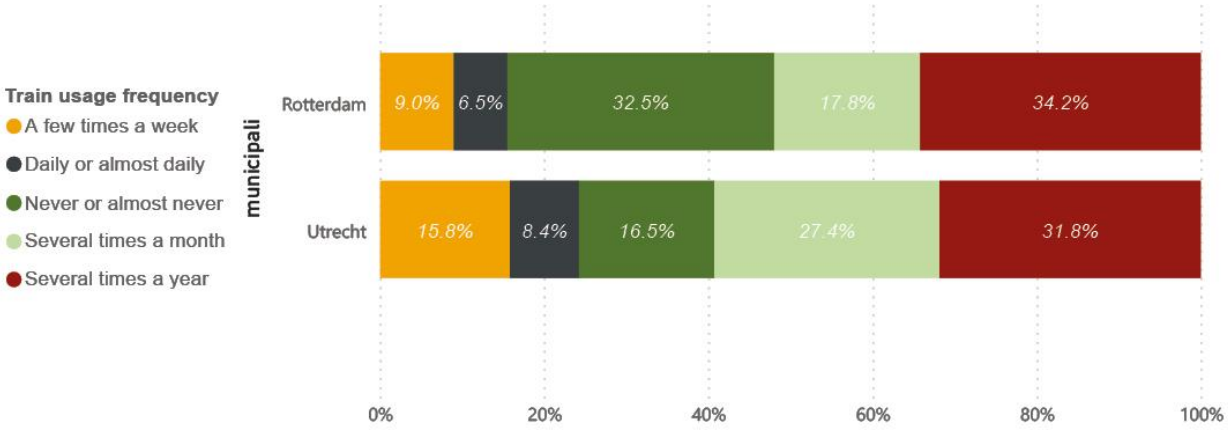

Figure 33: Train usage frequency in Rotterdam (left) and Utrecht (right).

The six transport modes frequency discussed here bring some insight into each city discussed in this study. In the next section, these frequencies are related to the data collected from the Mobimon survey. Correlating the data collected from the questionnaire to ODiN complements the scenario of transport mode share by bringing the frequencies as well. First, 29.5% of the respondents from the Mobimon survey do not have a driver's license, and ODiN data shows that Rotterdam and Utrecht have, respectively, 40% and 35% of people that use the car frequently, which puts the share of people that own a driver's license underrepresented by the number of people that use the car.

When it comes to cycling, 52.7% use the bicycle, which is relatively the same in Rotterdam (55%) for frequent users, but not the case for Utrecht, which presents 78% of bicycle frequent users. E-bikes show similar shares: 10.8% of the respondents of Mobimon and about 7.5% of ODiN data. For moped usage, there is a clear difference between the Mobimon survey, with a share of 19% of users, but ODiN data shows that around 2% are frequent users.

Public transport usage can be correlated between the questionnaire and ODiN data with two categories: bus and train. For bus usage, the questionnaire showed that 11.20% use this transport mode, while ODiN brings that Rotterdam has a share of 33% of frequent bus users while Utrecht has 17%. Finally, train users are 46.30% according to the survey, but when it comes to high frequency, Rotterdam has a share of 15% and Utrecht 23%.

6.5 Conclusion

Chapter six presented the data collection and descriptive analysis from the sample, CBS and ODiN. Also, in sections 6.3 and 6.4 the data collected from CBS and ODiN was compared to the data obtained from the Mobimon questionnaire to show the representativeness of the sample and to understand the mobility scenario from both cities. With a clearer overview of the socioeconomic and mobility characteristics that were considered in this study, the next chapter examines the results from the methodology detailed in chapter 5 to this sample from the data set.

7 Results

The current chapter describes the results from the methodology adopted in this study. Section 7.1 discusses the results from the factor analysis, section 7.2 from the t-tests and ANOVAs, section 7.3 from the multiple regression analysis, 7.4 from the spatial analysis and, the overall conclusions from the chapter are found in section 7.5.

7.1 Factor Analysis

Factor analysis was performed with three different variables, perceived accessibility, transport poverty and well-being. Next, each section will focus on one of these variables.

7.1.1 Perceived Accessibility

An exploratory factor analysis was conducted to reduce the perceived accessibility of the respondents into one latent factor. Perceived accessibility was measured as the ease to reach a particular destination on a 5-item Likert scale, with 1 = completely disagree, 5 = completely agree and a not applicable option, in case the person did not make use of the destination. The question is in Appendix A, with the full survey. More locations on top of work were considered, as a follow-up research recommendation from Martens and Bastiaanssen (2019). The key destinations that were addressed in the specific questions were the following:

- Work, volunteering and internship.
- University, school and study location.
- Supermarket, local shopping area.
- GP, pharmacy, health centre.
- Hospital.
- Friends, and family at their home.
- Gym, team or hobby.
- Children's school or day-care.

The accessibility to university, school and study location; and children's school or day-care were the two categories with the lowest share of respondents compared to the other ones (586 and 410 respectively). However, since they still represent a considerable share of the sample (55.4% and 38.75% respectively) all the locations were acknowledged in the model. The missing values related to these categories were replaced by mean values from each one of them.

The factor analysis performed with the measured variables used the PCA method. The main results can be seen in Table 9. The one factor that resulted from the analysis was named "perceived

accessibility to key destinations". The values in the "Factor loadings" column represent the correlation between each variable and the factor (or latent variable). In the present study, if the correlation is higher than 0.3, the variable is considered the latent variable since it indicates a moderate correlation according to Tavakol and Wetzel (2020). The communalities represent the proportion of variance accounted for each variable – or how much they contribute to measuring the latent variable.

Variable	*Factor loadings*	*Communalities (h2)*
supermarket, local shopping area	0.800	0.641
GP, pharmacy, health centre	0.795	0.632
hospital	0.764	0.584
friends, family at their home	0.744	0.554
work, volunteering, internship	0.740	0.548
gym, team, hobby	0.734	0.538
university, school, study location	0.676	0.458
Children's school or day-care	0.656	0.431

Table 9: variables, factor loadings and communalities related to perceived accessibility; 8 items considered, scores by size.

After, the internal consistency of the model was checked with Cronbach's Alpha. The result can be seen in Table 10, which displays the value of Cronbach's alpha from the current model and if it could be improved if any of the items were deleted. The left part of the table displays the number of valid cases considered, which represents the number of respondents. It also, shows the reliability statistics, with Cronbach's Alpha value and the number of items (in this case, the key destinations) that are being considered for the consistency of the model. The right side of the table displays each item considered for the model and the outcome in Cronbach's alpha value if that item was deleted. Since no improvements could be made to its value, "perceived accessibility to key life destinations" resulted as the final factor, obtained from the 8 items.

Cronbach's Alpha				*Item*	*Cronbach's Alpha if item deleted*
Cases		N	%	Work, volunteering, internship	0.866
	Valid	1058	100	University, school, study location	0.873
	Excluded	0	0	Supermarket, local shopping area	0.858
	Total	1058	100	GP, pharmacy, health centre	0.859
Reliability Statistics				Hospital	0.863
Cronbach's Alpha		*N of Items*		Friends and family at their home	0.866
0.881		8		Gym, team, hobby	0.867
				Children's school or day-care	0.875

Table 10: Cronbach's Alpha for perceived accessibility, 8 items considered and Cronbach's alpha if item deleted.

The factor resulting from the factor analysis was saved as a latent variable called "perceived accessibility" to be further used for the other statistical and spatial analyses. Next, factor analysis was executed in another series of items that measured perceived transport poverty.

7.1.2 Perceived Transport Poverty

The next factor analysis performed included a set of items related to transport poverty. The latent variable was measured as the degree to which a person would agree with specific statements. Each one of them was based on Lucas et al. (2016) definition of transport poverty. The full question is in the survey in Appendix A and had a 5-item Likert scale, with 1 = completely disagreeing and 5 = completely agreeing with the following affirmations:

- Being able to live their lives as they want to.
- Spend more on necessary travel in a week than the person could afford.
- Spend much more time travelling than a person would like.
- There is always a transport option available to the person at the times that they need.
- They can reach all their regular destinations and activities.
- They feel safe while travelling to their regular destinations and activities.
- They have concerns about road safety while travelling to their regular destinations and activities.
- They can travel without any negative consequences to their health.
- They can travel in a way that is suitable to their physical condition and abilities.

Because most of the questions were made in a way that the stronger a person would agree with the statement, the less they would experience transport poverty, the latent variable was named “perceived transport adequacy”, which is the opposite of perceived transport poverty.

Factor analysis was performed also with the PCA method. The factor analysis was conducted to result in only one factor. Table 11 brings the values of the factor loadings by size and communalities from the factor loadings. Because the communality related to the last item presented a low value, an internal consistency test was performed to understand how it would affect the value from Cronbach’s alpha

Variables	*Factor loadings*	*Communalities (h2)*
I can reach all my regular destinations & activities	0.798	0.637
I feel safe while travelling to my regular destinations & activities	0.772	0.597
I am able to live my life as I want to	0.733	0.537
I can travel in a way that is suited to my physical condition & Abilities	0.720	0.518
There is always a transport option available to me at the times I need it	0.698	0.487
I can travel without negative consequences to my health	0.639	0.409
I spend much more time travelling than I’d like	0.573	0.329
I have to spend more on necessary travel in a week than I can afford	0.542	0.293
'I am concerned about road safety while travelling to my regular destinations & activities	0.290	0.084

Table 11: variables, factor loadings and communalities related to perceived transport adequacy; 9 items considered, scores by size.

The internal consistency of the model was checked with Cronbach's Alpha. The consistency of the model could be improved by removing the item *"I am concerned about road safety while travelling to my regular destinations & activities",* as shown in Table 12.

Cronbach's Alpha				*Item*	*Cronbach's Alpha if Item Deleted*
Cases		N	%	I am able to live my life as I want to	0.783
	Valid	1058	100	I have to spend more on necessary travel in a week than I can afford	0.798
	Excluded	0	0	I spend much more time travelling than I'd like	0.795
	Total	1058	100	There is always a transport option available to me at the times I need it	0.787
Reliability Statistics				I can reach all my regular destinations & activities	0.777
Cronbach's Alpha		*N of Items*		I feel safe while travelling to my regular destinations & activities	0.778
0.811		9		I can travel without negative consequences to my health	0.795
				I can travel in a way that is suited to my physical condition & Abilities	0.785
				'I am concerned about road safety while travelling to my regular destinations & activities	**0.827**

Table 12: Cronbach's Alpha for perceived transport adequacy, 9 items considered and Cronbach's alpha if item deleted.

With that, the new factor analysis was performed with a set of 8 items instead of 9. Factor analysis was performed again and the results of the factor loadings and communalities can be seen in table 13. The factor that resulted was "perceived transport adequacy".

Variables	*Factor loadings*	*Communalities (h2)*
I can reach all my regular destinations & activities	0.805	0.648
I feel safe while travelling to my regular destinations & activities	0.764	0.584
I am able to live my life as I want to	0.743	0.552
I can travel in a way that is suited to my physical condition & Abilities	0.720	0.518
There is always a transport option available to me at the times I need it	0.707	0.500
I can travel without negative consequences to my health	0.640	0.409
I spend much more time travelling than I'd like	0.567	0.322
I have to spend more on necessary travel in a week than I can afford	0.529	0.280

Table 13: variables, factor loadings and communalities related to perceived transport adequacy; 8 items considered, scores by size.

Internal consistency from the latent variable was checked again, with a set of 8 items. Table 14 shows the new value for Cronbach's Alpha when one of the items was removed and brings the values if there was another deletion in the items to improve Cronbach's Alpha value, which was not the case.

Cronbach's Alpha				*Item*	*Cronbach's Alpha if Item Deleted*
Cases		N	%	I am able to live my life as I want to	0.799
	Valid	1058	100	I have to spend more on necessary travel in a week than I can afford	0.827
	Excluded	0	0	I spend much more time travelling than I'd like	0.820
	Total	1058	100	There is always a transport option available to me at the times I need it	0.804
Reliability Statistics				I can reach all my regular destinations & activities	0.793
Cronbach's Alpha		*N of Items*		I feel safe while travelling to my regular destinations & activities	0.798
0.827		8		I can travel without negative consequences to my health	0.813
				I can travel in a way that is suited to my physical condition & Abilities	0.803

Table 14: Cronbach's Alpha for perceived transport adequacy, 8 items considered and Cronbach's alpha if item deleted.

The higher factor loadings were reaching regular destinations and activities is the most related to the latent construct of "perceived transport adequacy", followed by feeling safe while travelling to those regular destinations; able to live their life as they want to; travel in a way that is suitable to their physical condition and abilities; having transportation options available to them; travelling without consequences to their health; spending much time and finally money on travel. For transport adequacy, the resulting factor was also stored to be used in the other statistical and spatial analyses. Next, the last factor analysis was performed on perceived well-being.

7.1.3 Perceived Well-Being

Perceived well-being was measured by two different questions, both on a scale from 1=completely dissatisfied to 10=completely satisfied. Both questions are in the questionnaire in Appendix A and relate to the literature when it comes to personal evaluation of their life about emotional experiences such as contentment, happiness and satisfaction (Davern et al., 2007; Davern and Chen, 2010). The first question regarded how much the respondent was satisfied with their life as a whole, while the second related their satisfaction with:

- Personal travel options.
- Standard of living.
- Health.
- Achievements in life.
- Personal relationships.
- How safe they feel.
- Feeling part of their community.

- Their future security.

Factor analysis for perceived well-being was performed using the PCA method. Only one factor was extracted named “perceived well-being”, and the results from the factor loadings and the communalities are displayed following in Table 15. Factor loadings from all variables had a value above 0.3 and were considered to construct the latent variable perceived well-being.

Variables	*Factor loadings*	*Communalities (h2)*
satisfaction with what you are achieving in life	0.817	0.667
satisfaction with your life as a whole	0.812	0.660
satisfaction with your standard of living?	0.807	0.651
satisfaction with your future security	0.784	0.615
satisfaction with your personal relationships	0.750	0.563
satisfaction with how safe you feel	0.740	0.547
satisfaction with your health	0.698	0.487
satisfaction with feeling part of your community	0.694	0.481
satisfaction with your personal travel options	0.612	0.375

Table 15: variables, factor loadings and communalities related to perceived well-being; 9 items considered, scores by size.

Internal consistency of the model was checked with Cronbach’s Alpha and since deleting items would not improve the value, the model factor analysis took into consideration all 9 items mentioned before. The results from the internal consistency test and Cronbach’s Alpha if the item is deleted can be seen in the following table 16. The reliability statistics reached a value of 0.899 with 9 items (or the 9 questions) being part of the model.

Cronbach's Alpha				*Item*	*Cronbach's Alpha if Item Deleted*
Cases		N	%	satisfaction with your life as a whole	0.883
	Valid	1058	100	satisfaction with your personal travel options	0.898
	Excluded	0	0	satisfaction with your standard of living?	0.883
	Total	1058	100	satisfaction with your health	0.892
Reliability Statistics				satisfaction with what you are achieving in life	0.881
Cronbach's Alpha		*N of Items*		satisfaction with your personal relationships	0.887
0.899		9		satisfaction with how safe you feel	0.888
				satisfaction with feeling part of your community	0.892
				satisfaction with your future security	0.884

Table 16: Cronbach’s Alpha for perceived well-being, 9 items considered and Cronbach’s alpha if item deleted.

For perceived well-being, satisfaction with what they are achieving in life was the highest contributor, followed by satisfaction with life as a whole; standard of living; future security; personal relationships;

how safe they feel; their health; feeling part of their community and finally their personal travel options. The resulting factor was also stored to be used in further analysis.

7.2 T-tests and ANOVA Analyses

T-tests and ANOVA analysis were conducted in SPSS to investigate if the considered independent variables were statistically significantly related to the dependent variables. Independent variables were related to sociodemographic and mobility characteristics. Dependent variables were the three latent constructs from the factor analysis presented in previous section 7.1 (perceived accessibility, transport adequacy and well-being).

For the relationship to be significant, the p-value must be lower than 0.05. Each one of the following tables displays the independent variable that is being considered and its categories, and the three dependent variables. Dependent variables have p-values and mean values of t-tests and ANOVAs associated with each category of the independent variable. P-values represent the significance (sig.), or if the values are statistically significant or not. The threshold used is that sig < 0.05.

The first independent variable discussed is city. Table 17.1 presents the results, which do not show significance for any of the dependent variables.

Variable	***Category***	***Perceived Accessibility (mean values)***	***Perceived Transport Adequacy (mean values)***	***Perceived well-being (mean values)***
City	Rotterdam	-0.019	-0.032	-0.002
	Utrecht	0.019	0.031	0.001
	p-value	*0.538*	*0.306*	*0.961*

Table 17.1: Mean values of t-test for perceived accessibility, transport adequacy and well-being regarding the city.

Table 17.2 exhibits the results for age categories, results in green are the ones statistically significant. Age presents similar results for both perceived accessibility and transport adequacy, with the youngest cohort (18 to 25 years old) having a negative relation with the latent variables, while it improves as people get older.

Variable	***Category***	***Perceived Accessibility (mean values)***	***Perceived Transport Adequacy (mean values)***	***Perceived well-being (mean values)***
Age	18-25	-0.332	-0.410	-0.089
	26-35	0.088	0.035	0.006
	36-50	0.223	0.127	0.017
	51-70	0.041	0.281	0.074
	p-value	*0.000*	*0.000*	*0.308*

Table 17.2: Mean values of ANOVA for perceived accessibility, transport adequacy and well-being regarding age.

The same pattern can be seen for gender regarding perceived accessibility and transport adequacy, as displayed in Table 17.3. Men have a negative relation to these variables, while women have a positive relation. This was a surprising result, considering that, according to Hine and Grieco (2003) women tend to have a worse experience when it comes to the transport system compared to men because of poor public transport options and being less likely to own a driver's license.

Variable	***Category***	***Perceived Accessibility (mean values)***	***Perceived Transport Adequacy (mean values)***	***Perceived well-being (mean values)***
Gender	Female	0.136	0.132	0.033
	Male	-0.176	-0.172	-0.043
	p-value	*0.000*	*0.000*	*0.216*

Table 17.3: Mean values of t-test for perceived accessibility, transport adequacy and well-being regarding gender.

The household composition has a significant relation with perceived transport adequacy and well-being as shown in Table 17.4. Living alone has a negative relation with both while living with a partner can impact in a positive way transport adequacy and well-being. This result shows a relation with the fact that living with a partner could provide the opportunity to own a car. Living with children also impacts positively, although having a stronger relationship with perceived well-being. Positive relations with living with children and/or a partner might relate to achievements in life.

Variable	***Category***	***Perceived Accessibility (mean values)***	***Perceived Transport Adequacy (mean values)***	***Perceived well-being (mean values)***
Household	Living Alone	0.006	-0.005	-0.181
	Living with partner/spouse	0.016	0.166	0.140
	Living with children	0.104	0.036	0.209
	Other/Did not say	-0.113	-0.215	-0.137
	p-value	*0.125*	*0.000*	*0.000*

Table 17.4: Mean values of ANOVA for perceived accessibility, transport adequacy and well-being regarding household composition.

Income had an expected result of being significant to all the latent variables, including that the higher the income, the greater the relation as displayed in Table 17.5. This result was expected according to Martens et al. (2019) since people with higher incomes struggle less with paying for their transportation modes.

Variable	***Category***	***Perceived Accessibility (mean values)***	***Perceived Transport Adequacy (mean values)***	***Perceived well-being (mean values)***
Income	Less than 980	-0.159	-0.237	-0.268
	Between 980 and 1870	-0.139	-0.261	-0.194
	Between 1870 and 2680	0.032	0.099	-0.039
	Between 2680 and 3800	0.015	0.150	0.198

Variable	Category	Perceived Accessibility (mean values)	Perceived Transport Adequacy (mean values)	Perceived well-being (mean values)
	Between 3800 and 5460	0.346	0.475	0.382
	More than 5460	0.781	0.816	0.750
	Don't know/don't want to say	-0.028	0.023	0.101
	p-value	*0.000*	*0.000*	*0.000*

Table 17.5: Mean values of ANOVA for perceived accessibility, transport adequacy and well-being regarding income.

Education also presented relevance for all three perceived constructs as displayed in Table 17.6. Respondents that had either primary, secondary or tertiary MBO have a negative relation with the perception of accessibility, transport adequacy and well-being, while respondents that had either bachelor's or master/PhD have positive relationships.

Variable	Category	Perceived Accessibility (mean values)	Perceived Transport Adequacy (mean values)	Perceived well-being (mean values)
Education	Primary, secondary and other	-0.036	-0.093	-0.166
	Tertiary MBO	-0.121	-0.156	-0.044
	Tertiary Bachelor	0.039	0.088	0.086
	Tertiary Master or PhD	0.128	0.163	0.106
	p-value	*0.031*	*0.001*	*0.008*

Table 17.6: Mean values of ANOVA for perceived accessibility, transport adequacy and well-being regarding education.

Employment status was statistically significant to perceived well-being, with the results showing that having either a part-time or full-time job can affect it positively as shown in Table 17.7.

Variable	Category	Perceived Accessibility (mean values)	Perceived Transport Adequacy (mean values)	Perceived well-being (mean values)
Employment	Fulltime Job	-0.025	0.052	0.109
	Part-time Job	0.028	0.065	0.154
	Not paid/Other/Did not say	0.006	-0.047	-0.176
	p-value	*0.803*	*0.363*	*0.000*

Table 17.7: Mean values of ANOVA for perceived accessibility, transport adequacy and well-being regarding employment.

Respondents that spoke another language at home besides Dutch (which can indicate their migration background) were said to have a negative relation with both perceived accessibility and transport adequacy as significant results as Table 17.8 shows.

Variable	Category	Perceived Accessibility (mean values)	Perceived Transport Adequacy (mean values)	Perceived well-being (mean values)
Other languages spoken at home (besides Dutch)	No	0.047	0.122	0.042
	Yes	-0.079	-0.206	-0.071
	p-value	*0.048*	*0.000*	*0.076*

Table 17.8: Mean values of t-test for perceived accessibility, transport adequacy and well-being regarding other languages spoken at home (besides Dutch).

The following three independent variables in Tables 17.9, 17.10 and 17.11 had expected results related to perceived accessibility, transport adequacy and well-being: use of mobility aid, having a driver's license and owning a car showed to be statistically significant. The use of mobility aid restricts a person's accessibility, has a negative impact on their transport adequacy and negative influence on their well-being; having a driver's license and a car improves their perceived accessibility, transport adequacy and well-being. As discussed before in the literature overview, the society is highly car cultural so it was expected that owning a car or a driver's license would improve either perceived accessibility, transport adequacy and well-being.

Variable	Category	Perceived Accessibility (mean values)	Perceived Transport Adequacy (mean values)	Perceived well-being (mean values)
Mobility Aid	Yes	-0.673	-0.778	-0.123
	No	0.027	0.031	0.049
	p-value	*0.000*	*0.000*	*0.000*

Table 17.9: Mean values of t-test for perceived accessibility, transport adequacy and well-being regarding the use of mobility aid.

Variable	Category	Perceived Accessibility (mean values)	Perceived Transport Adequacy (mean values)	Perceived well-being (mean values)
Driver's licence	No	-0.384	-0.575	-0.273
	Yes	0.161	0.241	0.114
	p-value	*0.000*	*0.000*	*0.000*

Table 17.10: Mean values of t-test for perceived accessibility, transport adequacy and well-being regarding having a driver's license.

Variable	Category	Perceived Accessibility (mean values)	Perceived Transport Adequacy (mean values)	Perceived well-being (mean values)
Car Ownership	Yes	0.182	0.279	0.142
	No	-0.312	-0.478	-0.244
	p-value	*0.000*	*0.000*	*0.000*

Table 17.11: Mean values of t-test for perceived accessibility, transport adequacy and well-being regarding having a car.

The use of other transport modes presented some interesting results as shown in Table 17.12, having statistically significant results with all three latent variables. E-bike users have a positive relationship

with perceived accessibility, transport adequacy and well-being, while mopeds, speed pedelec, (electric) scooters and motorcycles have a negative impact on perceived accessibility and transport adequacy but a positive relation with perceived well-being.

Variable	*Category*	*Perceived Accessibility (mean values)*	*Perceived Transport Adequacy (mean values)*	*Perceived well-being (mean values)*
Other transport modes	Bicycle + cargo bike	0.039	0.038	-0.0004
	e-bike	0.143	0.376	0.191
	moped, speed pedelec (electric) scooter, motorcycle	-0.258	-0.288	0.048
	none or other	0.072	-0.033	-0.169
	p-value	*0.001*	*0.000*	*0.019*

Table 17.12: Mean values of ANOVA for perceived accessibility, transport adequacy and well-being regarding usage of other transport modes.

Users of public transport also had significant values related to perceived accessibility, transport adequacy and well-being as brought by Table 17.13. Interestingly, bus users have a negative perception of their accessibility and transport adequacy but a positive relation to well-being.

Variable	*Category*	*Perceived Accessibility (mean values)*	*Perceived Transport Adequacy (mean values)*	*Perceived well-being (mean values)*
Public transport	bus	-0.190	-0.089	0.142
	tram or metro	-0.156	-0.214	-0.087
	train	0.112	0.101	0.055
	other PT (regiotaxi, bellbus, etc)	0.033	0.071	-0.110
	p-value	*0.001*	*0.000*	*0.041*

Table 17.13: Mean values of t-tests and ANOVAs for perceived accessibility, transport adequacy and well-being regarding usage of public transport.

The significant results brought by the t-tests and ANOVAs were considered for the independent variables considered in the multiple regression models that are discussed in section 7.3.

7.3 Regression Models

After the preliminary results of the bivariate analyses, the six models presented in table 1 were tested as multiple linear regression models using the stepwise method. Stepwise includes the independent variable that has the most correlation with the dependent variable first and does it so on for the other independent variables (Tranmer et al., 2020). In addition, this method allows for the deletion of a previous variable that was significant before but is no longer after adding a new variable to the model (Tranmer et al., 2020). Each model considered independent variables that showed statistical relevance from t-tests and ANOVAs. So, for Model 1 where perceived accessibility was regressed, the

independent variables were: age, gender, income, educational level, other language spoken at home, use of mobility aid, driver's license, car ownership, other transport modes used and public transport.

Models 2.a and 2.b that regressed perceived transport adequacy considered age, gender, household formation, income, educational level, other language spoken at home, use of mobility aid, driver's license, car ownership, other transport modes used and public transport. In addition to all of these independent variables, Model 2.b also considers perceived accessibility as part of the independent variables.

Models 3.a, 3.b and 3.c regressed perceived well-being considering household formation, income, educational level, employment status, use of mobility aid, driver's license, car ownership, other transport modes used and public transport. Model 3.b considered perceived transport adequacy as an independent variable as well, while Model 3.c added perceived accessibility to the regression. The workflow for the regression models is displayed again in Figure 34 for easier consultation and illustration.

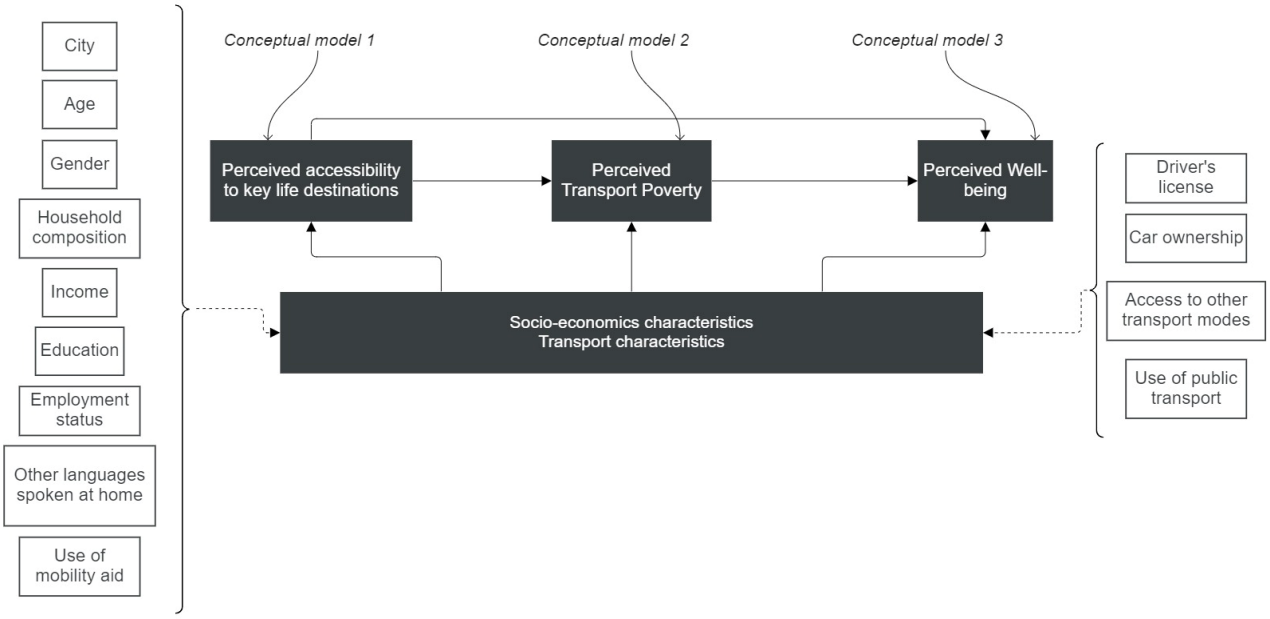

Figure 34: Workflow of the regression models.

The independent variables considered are the predictor variables, and for each one of them, dummy variables were created as new variables that represented the number of categories of that predictor minus 1, which was the category chosen to be the baseline group. Table 18 shows the dummies that were created for the variables that had more than 2 categories.

Variable	***Category***	***Dummy***
Age	18-25	x
	26-35	x
	36-50	x
	51-70	

Variable	*Category*	*Dummy*
Household	Living Alone	x
	Living with partner/spouse	x
	Living with children	x
	Other/Did not say	
Income	Less than 980	x
	Between 980 and 1870	x
	Between 1870 and 2680	x
	Between 2680 and 3800	x
	Between 3800 and 5460	x
	More than 5460	x
	Don't know/don't want to say	
Education	Primary, secondary, other	
	Tertiary MBO	x
	Tertiary Bachelor	x
	Tertiary Master or PhD	x
Employment	Fulltime Job	x
	Part-time Job	x
	Not paid/Other/Did not say	
Other transport modes	Bicycle + cargo bike	x
	e-bike	x
	moped, speed pedelec (electric) scooter, motorcycle	x
	none or other	
Public transport	bus	x
	tram or metro	x
	train	x
	other PT (regiotaxi, bellbus, etc)	

Table 18: Dummy variables created for each category of the independent variables.

The tables that display the results from the regression analysis that will be presented have the following results to interpret:

Unstandardized beta – These are the model parameters (Tranmer et al., 2020). They indicate the average increase or decrease in the dependent variable associated with a 1 unit increase in the predictor (or the independent variable considered). These betas cannot be used for comparison between them, since they are dependent on the scale of measurement of the exploratory variable (Tranmer et al., 2020).

Beta – are the standardized coefficients. The betas will be looked at since it allows for comparing the values of the coefficients because they relate to a version of the regression model that the variables have been standardized to a normal distribution, with a mean of 0 and standard deviation of 1 (Tranmer et al., 2020).

Significance – statistical significance from each variable. The rule of thumb of p-value < 0.05 also applies here.

Adjusted R squared – the variance explained adjusted for the model in the dependent variable.

Model 1 considered accessibility as the latent variable and resulted in having a driver's license, being female, using mobility aid, being the ages of 18-25 and 36-50 and using the train as significant variables, as shown by table 19.1.

Variable	***Category***	***Model 1***		
		Un. Beta	*Beta*	*p-value*
	Constant	-0.425		0.000
Age	18-25	-0.190	-0.083	0.013
	26-35			
	36-50	0.179	0.075	0.015
	51-70			
Gender	Female	0.202	0.100	0.001
	Male			
Household	Living Alone			
	Living with partner/spouse			
	Living with children			
	Other/Did not say			
Income	Less than 980			
	Between 980 and 1870			
	Between 1870 and 2680			
	Between 2680 and 3800			
	Between 3800 and 5460			
	More than 5460			
Employment	Fulltime Job			
	Part-time Job			
	Not paid/Other/Did not say			
Other languages spoken at home (besides Dutch)	No			
	Yes			
Mobility Aid	Yes	-0.539	-0.104	0.000
	No			
Driver's licence	No			
	Yes	0.398	0.182	0.000
Car Ownership	Yes			
	No			
Other transport modes	Bicycle + cargo bike			
	e-bike			
	moped, speed pedelec (electric) scooter, motorcycle			
	none or other			
Public transport	bus			
	tram or metro			
	train	0.126	0.063	0.035
	other PT (regiotaxi, bellbus, etc)			

Variable	*Category*	*Model 1*		
		Un. Beta	*Beta*	*p-value*
Perceived Accessibility				
Perceived Transport Adequacy				
	Adjusted R squared	*0.102*		

Table 19.1: regression model 1.

Model 1 shows significant relations with the ages of 18-25 and 36-50, where the first cohort perceives accessibility in a restricted way and the second cohort in a positive way. This is consistent with the literature, that explains that younger people are less likely to own a driver's license which results in a higher chance to experience accessibility disadvantages (Martens et al., 2019).

The effect on gender also presents an unexpected result, with women having a positive perception of their accessibility. This is presented differently in the literature, which affirms that women might face problems with accessibility (Martens et al., 2019).

Using mobility aid is negatively related to people's perceived accessibility, which is in line with the literature so far, since this group is presented as facing the highest limitations, due to road design, vehicles that are not adapted to them or high costs of travelling (Martens et al., 2019). Having a driver's license impacts positively on perceived accessibility, as expected and explained by the literature when it comes to low-income or young people that are less likely to have a driver's license and experience accessibility restrictions (Martens et al., 2019).

Also, model 1 showed similarities and differences from the literature. Young people are shown to be more dependent on public transport, cycling and walking and less likely to have a driver's license and for that matter present a higher probability to experience accessibility and transport restrictions (Martens et al., 2019). The results regarding age are limited when it comes to older cohorts. Jorristma et al. (2018) put in their study that age progression might lead to travelling less often and choosing locations close to their home due to physical limitations or lower income. Since the target group used in this study was between the ages of 18 and 70 years old, the impact on older people is not conclusive.

Model 2.a considered transport adequacy as the dependent variable and presented having a driver's license, using mobility aid, age between 18-25, speaking other languages at home besides Dutch, income between 3800 and 5460, using an e-bike, being female, having a car, using the tram or metro as public transport as significant for the model. Model 2.b also considered transport adequacy as the dependent variable, but in this case, accessibility was also used as an independent variable. Results are displayed in Table 19.2.

Variable	*Category*	*Model 2.a*			*Model 2.b*		
		Un. Beta	*Beta*	*p-value*	*Un. Beta*	*Beta*	*p-value*
	Constant	-0.407		0.000	-0.325		0.000
Age	18-25	-0.171	-0.075	0.014			

Variable	***Category***	***Model 2.a***			***Model 2.b***		
		Un. Beta	*Beta*	*p-value*	*Un. Beta*	*Beta*	*p-value*
	26-35						
	36-50						
	51-70						
Gender	Female	0.153	0.076	0.007			
	Male						
Household	Living Alone				0.127	0.057	0.018
	Living with partner/spouse						
	Living with children						
	Other/Did not say						
Income	Less than 980	0.332	0.087	0.002	0.184	0.048	0.046
	Between 980 and 1870						
	Between 1870 and 2680						
	Between 2680 and 3800						
	Between 3800 and 5460						
	More than 5460						
Employment	Fulltime Job						
	Part-time Job						
	Not paid/Other/Did not say						
Other languages spoken at home (besides Dutch)	No	-0.185	-0.090	0.001	-0.176	-0.085	0.000
	Yes						
Mobility Aid	Yes	-0.628	-0.121	0.000	-0.369	-0.071	0.003
	No						
Driver's licence	No	0.345	0.158	0.003	0.277	0.126	0.005
	Yes						
Car Ownership	Yes	0.311	0.150	0.004	0.210	0.101	0.024
	No						
Other transport modes	Bicycle + cargo bike	0.255	0.079	0.005	0.254	0.079	0.001
	e-bike						
	moped, speed pedelec (electric) scooter, motorcycle						
	none or other						
Public transport	bus	-0.149	-0.063	0.024			
	tram or metro						
	train						
	other PT (regiotaxi, bellbus, etc)						
Perceived Accessibility					0.495	0.495	0.000
Perceived Transport Adequacy							
	Adjusted R square	*0.199*			*0.411*		

Table 19.2: regression models 2.a and 2.b.

Model 2.a, as shown previously by the bivariate analyses, still presents the negative impact of the youngest cohort on transport adequacy and the positive perception of women on transport adequacy. In addition, people that earn between 3800 and 5460 euros also have a better experience of transport adequacy. People that speak other languages besides Dutch also appear as having lower perceived transport adequacy, together with people that use a mobility aid. Having a car and a driver's license contribute to the perception of transport adequacy. When other transport modes are considered, people that use an e-bike also have a positive perception of their transport adequacy, while when looking at the public transport categories, tram or metro users have a negative perception of their transport adequacy.

When model 2.b is analysed, the first differences noticed are the significance regarding age, gender and public transport that don't occur anymore. In this model, perceived accessibility has a high relation with perceived transport adequacy, meaning that people that have a positive perception of their accessibility will also have a positive perception when it comes to their transport adequacy. Also, adding perceived accessibility to the model presents an improvement in the value of adjusted R squared, from 0.199 to 0.411.

Transport poverty is said by the literature to be usually experienced by children, young people, the elderly, single-parent households, low-skilled workers, ethnic minorities, people that use mobility aid and women (Martens et al., 2019). Models 2 and 3 confirm some of these groups, such as young people, ethnic minorities (considering that the respondents that speak another language at home are part of this group) and people that use mobility aid. In addition, model 2.b shows that living with a partner contributes to transport adequacy, which also relates to the fact that single-parent households might face more transport restrictions.

Literature affirms that women might face transport poverty or disadvantage as a result of poor provision of public transport or because they are less likely to have a driver's license (Hine and Grieco, 2003). The present study, however, indicates that women have a positive perception of their accessibility and transport adequacy. This could be a bias from the sample, since it was an unexpected result or related to the fact that the Dutch have a strong cycling culture and compact cities, which reduces the experience of transport poverty (Jorritsma et al., 2018; Martens et al., 2011; Bastiaanssen et al., 2013; Martens, 2013). Perception of the transport system is a conversion factor of the individual according to the capabilities approach (Meijering et al., 2019) and in this case, it could represent that women and men have different levels of perception of the transport system.

Migration background was not measured explicitly but speaking another language at home was considered in this study as a trace to might have a migration background. From the models, speaking other languages at home showed to contribute negatively to transport adequacy, which has a relation to the literature that declares that people with a migration background are less likely to have and travel by car or bicycle (Jorritsma et al., 2018) and not having a car can limit the options and opportunities to participate in social life (Holder, 2010).

The strong cycling culture and the compact design of the Dutch cities (Martens et al., 2011; Bastiaanssen et al., 2013; Martens, 2013) are shown by the literature as a factor that can limit the experience of transport poverty. However, the regression models do not show a clear relevance from bike users to transport adequacy, but from e-bikes.

Model 3.a examines perceived well-being as the latent variable and results in using mobility aid, having a car, living alone, having a part-time job, earning less than 980 euro, between 980 and 1870 euro and between 1870 and 2680 euro as significant variables to the model. Model 3.b also analyses perceived well-being as the latent variable but adds transport adequacy as an independent variable. In this case, perceived transport adequacy, use of mobility aid, living alone, living with children, earning less than 980 euro, between 980 and 1870 euro, between 1870 and 2680, using moped, speed pedelec, (electric) scooter or motorcycle, having a parttime job or fulltime job and using the bus as public transport as relevant to the model. Finally, the last model 3.c examines perceived well-being taking into account perceived accessibility and transport adequacy as independent variables result in considering perceived accessibility, perceived transport adequacy, using mobility aid, living alone, earning less than 980 euro, using a moped, speed pedelec, (electric) scooter or motorcycle, having a parttime or fulltime job and using the bus as public transport as significant to the model. Results are displayed in Table 19.3.

Variable	***Category***	***Model 3.a***			***Model 3.b***			***Model 3.c***		
		Un. Beta	*Beta*	*p-value*	*Un. Beta*	*Beta*	*p-value*	*Un. Beta*	*Beta*	*p-value*
	Constant	*0.078*		*0.277*	*0.013*		*0.843*	*-0.059*		*0.260*
Age	18-25 26-35 36-50 51-70									
Gender	Female Male									
Household	Living Alone	-0.196	-0.087	0.003	-0.175	-0.078	0.006	-0.246	-0.109	0.000
	Living with partner/spouse									
	Living with children				0.137	0.056	0.052			
	Other/Did not say									
Income	Less than 980	-0.432	-0.153	0.000	-0.256	-0.090	0.004	-0.161	-0.057	0.043
	Between 980 and 1870	-0.305	-0.132	0.000	-0.203	-0.088	0.004			
	Between 1870 and 2680	-0.223	-0.092	0.004	-0.197	-0.082	0.006			
	Between 2680 and 3800									
	Between 3800 and 5460									
	More than 5460									
Employment	Fulltime Job				0.168	0.081	0.010	0.189	0.091	0.003
	Part-time Job	0.228	0.095	0.001	0.244	0.102	0.001	0.257	0.108	0.000

Variable	*Category*	*Model 3.a*			*Model 3.b*			*Model 3.c*		
		Un. Beta	*Beta*	*p-value*	*Un. Beta*	*Beta*	*p-value*	*Un. Beta*	*Beta*	*p-value*
	Not paid/Other/Did not say									
Other languages spoken at home (besides Dutch)	No Yes									
Mobility Aid	Yes No	-1.187	-0.229	0.000	-0.882	-0.170	0.000	-0.868	-0.168	0.000
Driver's licence	No Yes									
Car Ownership	Yes No	0.249	0.120	0.000						
Other transport modes	Bicycle + cargo bike e-bike moped, speed pedelec (electric) scooter, motorcycle none or other				0.194	0.076	0.005	0.183	0.072	0.008
Public transport	bus tram or metro train other PT (regiotaxi, bellbus, etc)				0.174	0.055	0.039	0.198	0.063	0.019
Perceived Accessibility								0.111	0.111	0.001
Perceived Transport Adequacy					0.402	0.402	0.000	0.351	0.351	0.000
	Adjusted R squared	*0.124*			*0.267*			*0.265*		

Table 19.3: regression models 3.a, 3.b and 3.c.

The variations of models 3.a, 3.b and 3.c regressed perceived well-being. Model 3.b also considers transport adequacy as an independent variable and model 3.c considers both transport adequacy and accessibility as independent variables. For model 3.a, when it comes to household formation, living alone has a negative impact on perceived well-being. When it comes to income categories, the lowest three present a negative relation with perceived well-being, gradually increasing with the increase of income as well. A part-time job is the employment category that still shows a positive relationship with perceived well-being. Mobility aid also keeps its negative impact on perceived well-being and car ownership a positive relation.

With the use of perceived transport adequacy in model 3.b, some variables change their significance to the model. First, when it comes to household formation, people that live with children show a positive relationship with their perceived well-being. Second, full-time employers gain positive significance in the model as well. Finally, the significance of different transport modes changes in the model: car

ownership loses its significance while other transport modes and public transport usage gain. When it comes to other transport modes, users of mopeds, speed pedelec, (electric) scooters and motorcycles have a positive relationship with perceived well-being. In addition, bus users also have a positive perception of their well-being. Perceived transport adequacy appears in the regression model as having a strong positive relationship with perceived well-being.

The last variation of the models about well-being, model 3.c, shows differences compared to model 3.b in household and income categories. Household shows a similar behaviour as model 3.a with negative relation only with people that live alone. Most income categories lose their relevance to the model, except the lowest one. Perceived accessibility also shows a positive relationship with the dependent variable and perceived transport adequacy keeps its strong relation with it. Another important remark related to the models is about the value of the adjusted R-square. There is an improvement from model 3.a to model 3.b when it comes to adjusted R-square value, from 0.124 to 0.267. However, model 3.c presents a lower value for it, 0.265.

Perceived well-being presented itself in the model affected by the lowest three categories of income, also, accessibility and transport adequacy have statistical significance to perceived well-being, as shown by the literature (Dolan et al., 2008; Awaworyi Churchill and Smyth, 2019). Considering a shift in transport planning towards enhancing people's well-being, income is also a socioeconomic characteristic to be looked at closely, even though for accessibility and transport adequacy the lower categories of income did not show statistical significance for the sample in this study that could be due to strong correlation with other variables used in the models.

The results from all the models confirmed that people that use mobility aid in fact face severe conditions when it comes to accessibility, transport adequacy and well-being. One of the concerns brought by Jorritsma et al. (2018) regarding this group is also the limitation that they face when it comes to social interaction. In the present study social exclusion was not treated as a measured variable but as a consequence of having a poor experience with accessibility and mobility options. Literature affirms that limited mobility can be related to low levels of subjective well-being and social exclusion (Ma et al., 2018; Lucas, 2012; Delbosc and Currie, 2011) and it can be taken into account for future study.

When it comes to other private transport modes and public transport, literature (Benenson et al., 2011, 2017; Golub and Martens, 2014) declares that there is a difference between the levels of accessibility that people can reach with them. The multiple regression models show similar and contrasting outcomes. Train impacts positively on accessibility, which contradicts the literature. E-bikers are more likely to experience higher transport adequacy, while tram and metro users have a negative relationship, which is in line with the literature. When it comes to well-being, the use of scooters, mopeds and motorcycles has a positive relationship with perceived well-being and so do bus users, which conflicts in parts with studies.

With the previous statistical analysis completed, section 7.4 brings the spatial analysis and the maps that were produced with perceived accessibility, transport adequacy and well-being.

7.4 Spatial Analysis

The spatial analyses performed in this study took into consideration the 3 latent variables that were built as the result of the factor analysis and socioeconomic and transport characteristics from the study area. This analysis visually supports the discussion in this chapter. The maps illustrating the average values of perceived accessibility, transport adequacy and well-being on a normalized scale from 0 to 10 in different areas of Rotterdam and Utrecht are presented. It is essential to acknowledge that the number of respondents per area differs. For consultation, the maps with the average number of respondents can be checked in Appendix B.

First, the maps regarding Rotterdam are discussed, followed by Utrecht. When it comes to perceived accessibility, Rotterdam achieves an average of 7.96 on a scale from 0 to 10. According to the map presented in figure 35, the higher averages are in general located on the east and north side of the city.

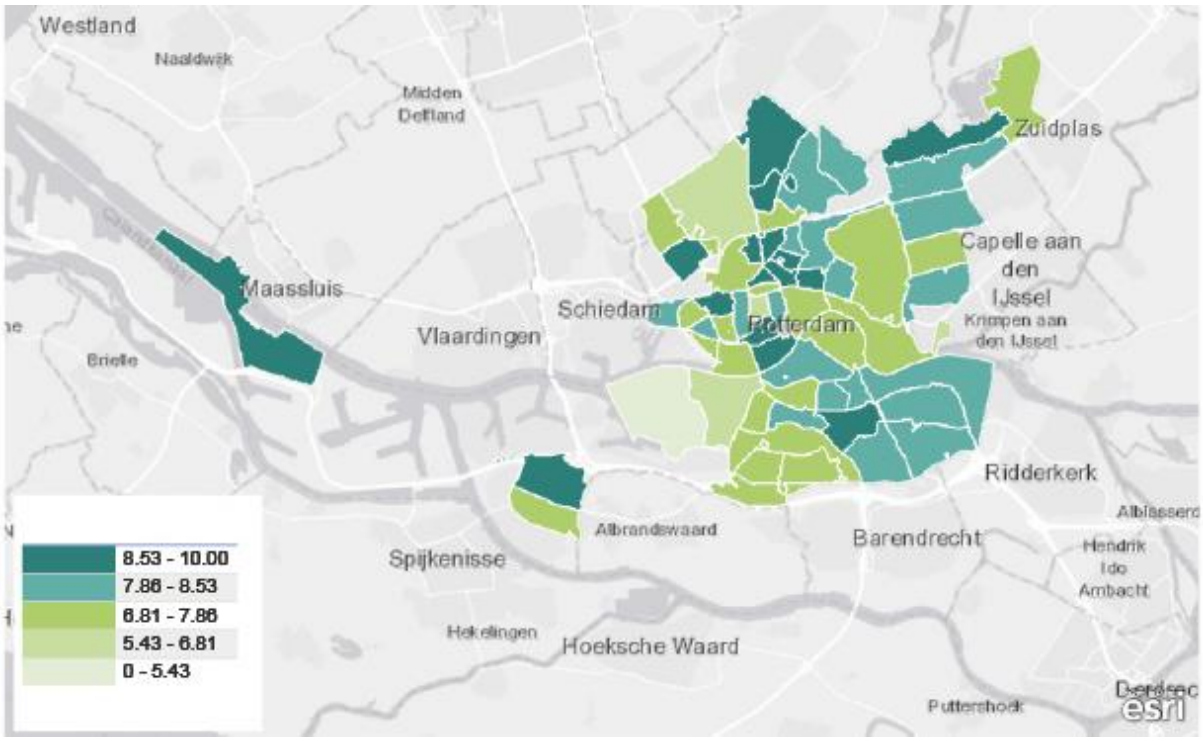

Figure 35: average value of perceived accessibility in Rotterdam – values per postal code.

Transport adequacy shows a similar trend to perceived accessibility when it comes to areas in the north and east parts of the city. However, transport adequacy achieves higher values in the southwest part of Rotterdam. In general, the average achieved is 7.16 on a scale from 0 to 10. Figure 36 brings the spatial distribution of perceived transport adequacy.

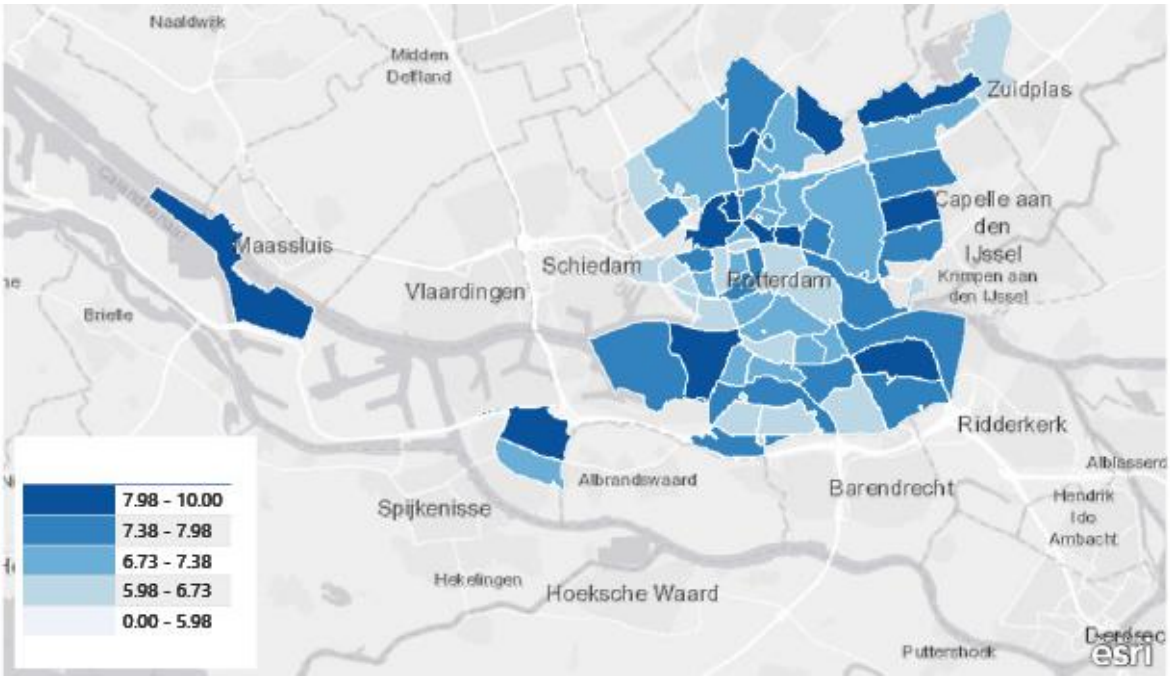

Figure 36: average value of perceived transport adequacy in Rotterdam – values per postal code.

Perceived well-being reaches an average of 6.73 in Rotterdam on a scale from 0 to 10. Similar patterns as displayed by perceived accessibility and transport adequacy are also observed for well-being: regions located to the east and north part of the city present higher values. The distribution is displayed in Figure 37.

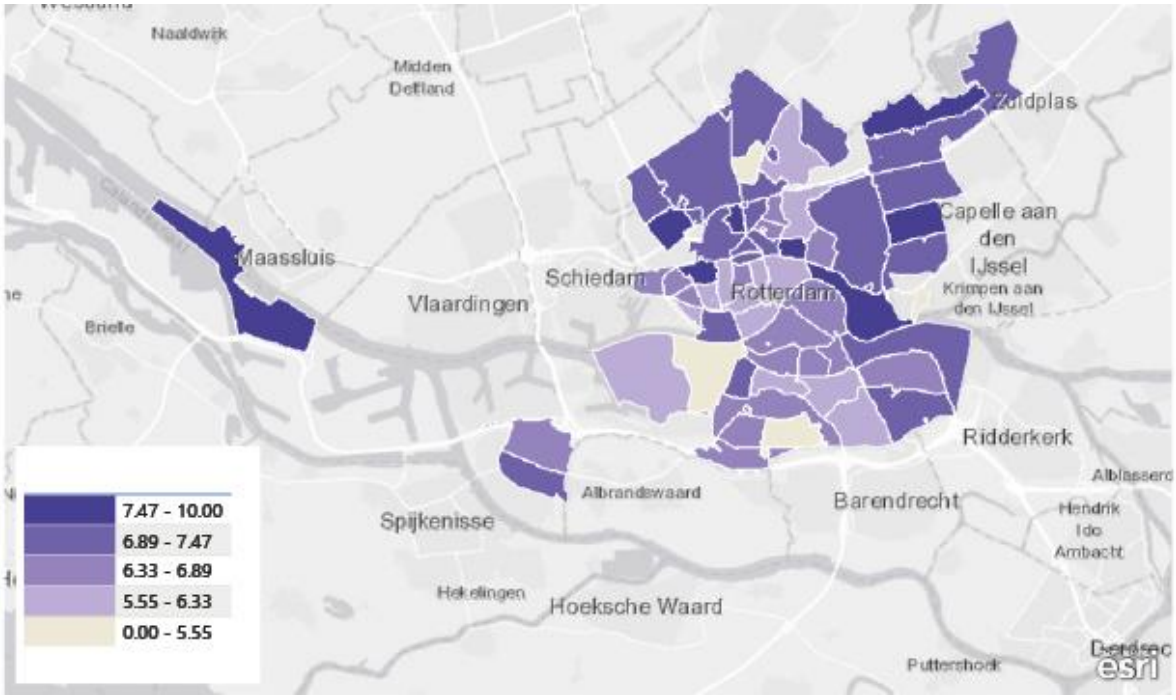

Figure 37: average value of perceived well-being in Rotterdam – values per postal code.

When examining Utrecht's perceived accessibility, the average value reaches 8.01, which is higher if compared to Rotterdam's. In this case, the highest values are observed in the central, southeast and some regions in the west and north part of the city.

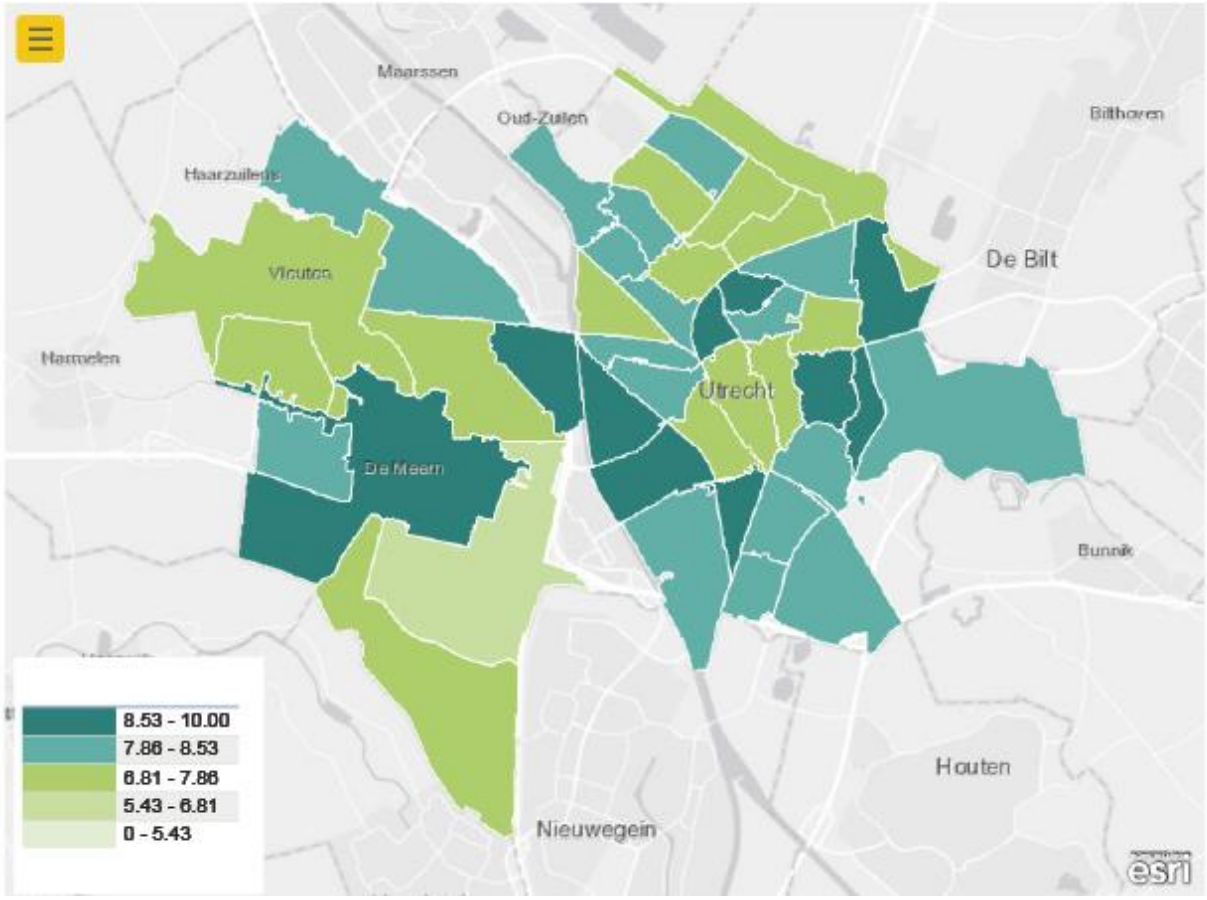

Figure 38: average value of perceived accessibility in Utrecht – values per postal code.

The average of perceived transport adequacy is also higher in Utrecht than in Rotterdam. In this case, the value reaches 7.31 on a scale from 0 to 10, and the same pattern is observed when it comes to its distribution: southeast and centre present the highest values, followed by some areas in the north and west. Southeast still endures as a region with a lower value of perceived transport adequacy if compared to the rest of the city. Figure 39 brings the spatial distribution of perceived transport adequacy.

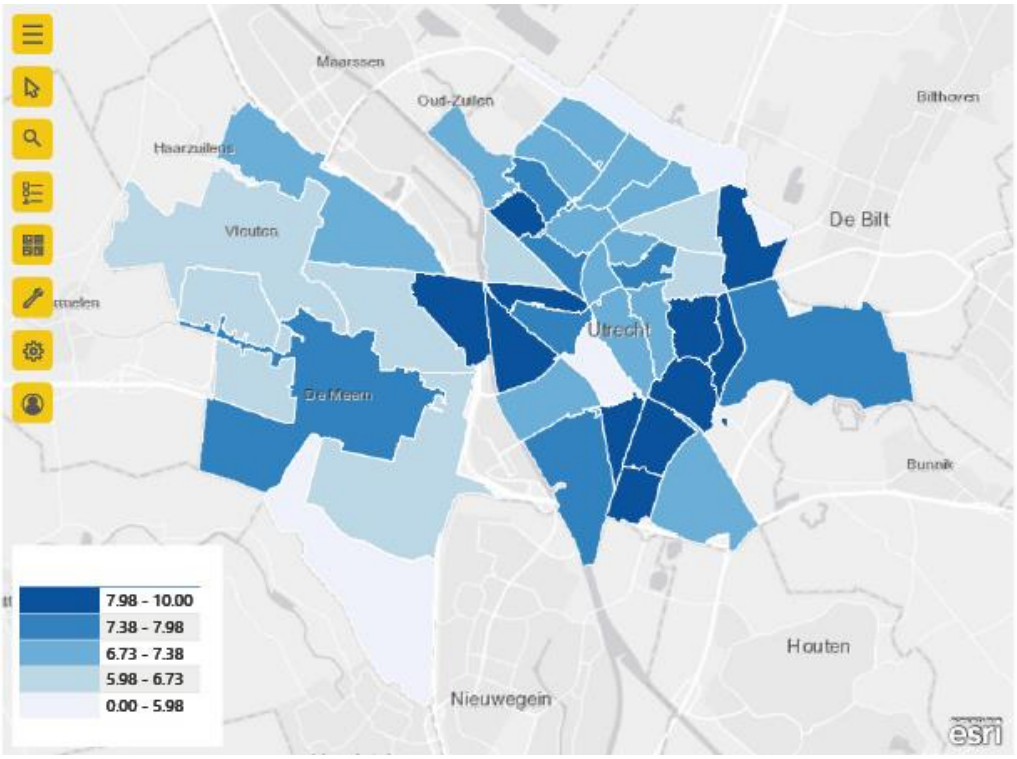

Figure 39: average value of perceived transport adequacy in Utrecht – values per postal code.

Perceived well-being in Utrecht reaches an average value of 6.80, higher compared to Rotterdam as well. As for perceived accessibility and transport adequacy, well-being offers the same spatial distribution, as presented in Figure 40.

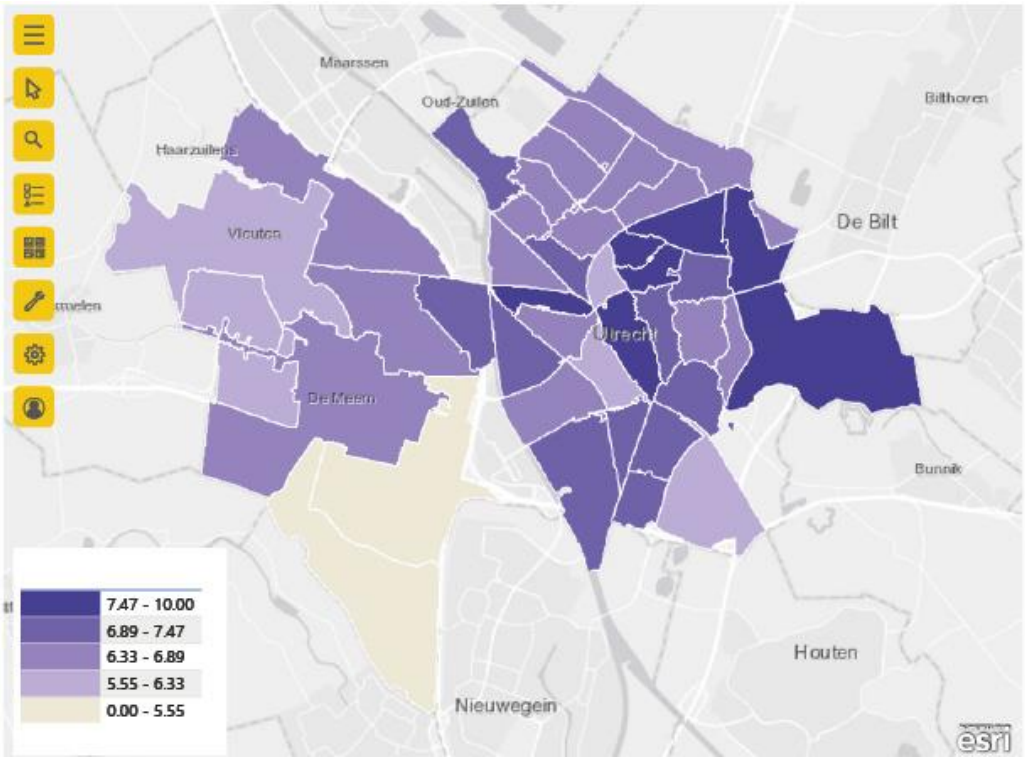

Figure 40: average value of perceived well-being in Utrecht – values per postal code.

An important remark to consider when checking the spatial patterns of the distribution in the previous maps from both cities is that they provide an aggregate measure of the variables, and it is not accurate when determining the resources and conversion factors that are associated with each individual, which agrees with the explanation by Martens et al (2019). Figures 41.1 and 41.2 present three scatter plots from Rotterdam and Utrecht, between perceived well-being and transport adequacy; perceived well-being and accessibility; perceived transport adequacy and accessibility. All the graphs exhibit the average measurements for each variable to help the reader to understand and visualize the gaps between the minimum and maximum levels in each city.

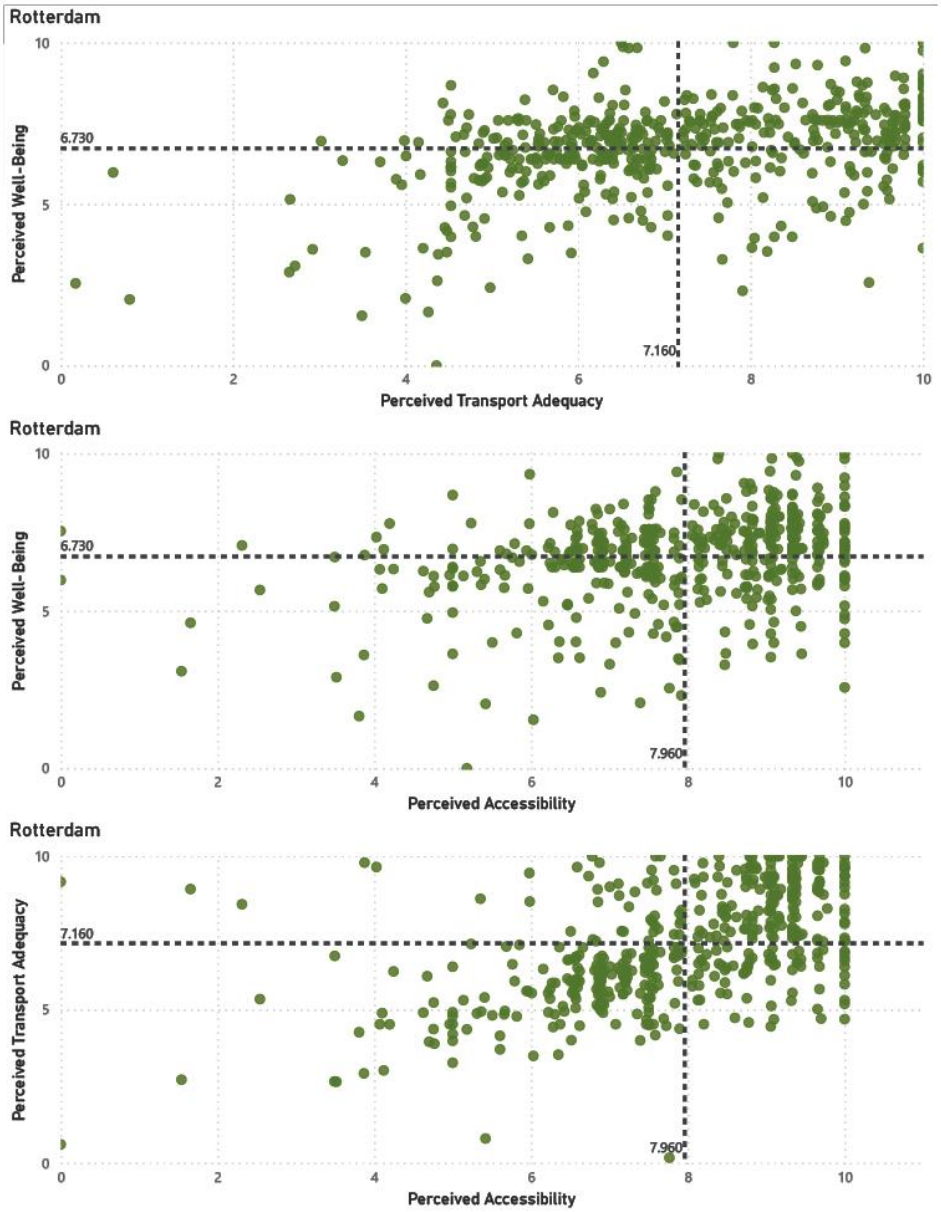

Figure 41.1: scatter plots for Rotterdam.

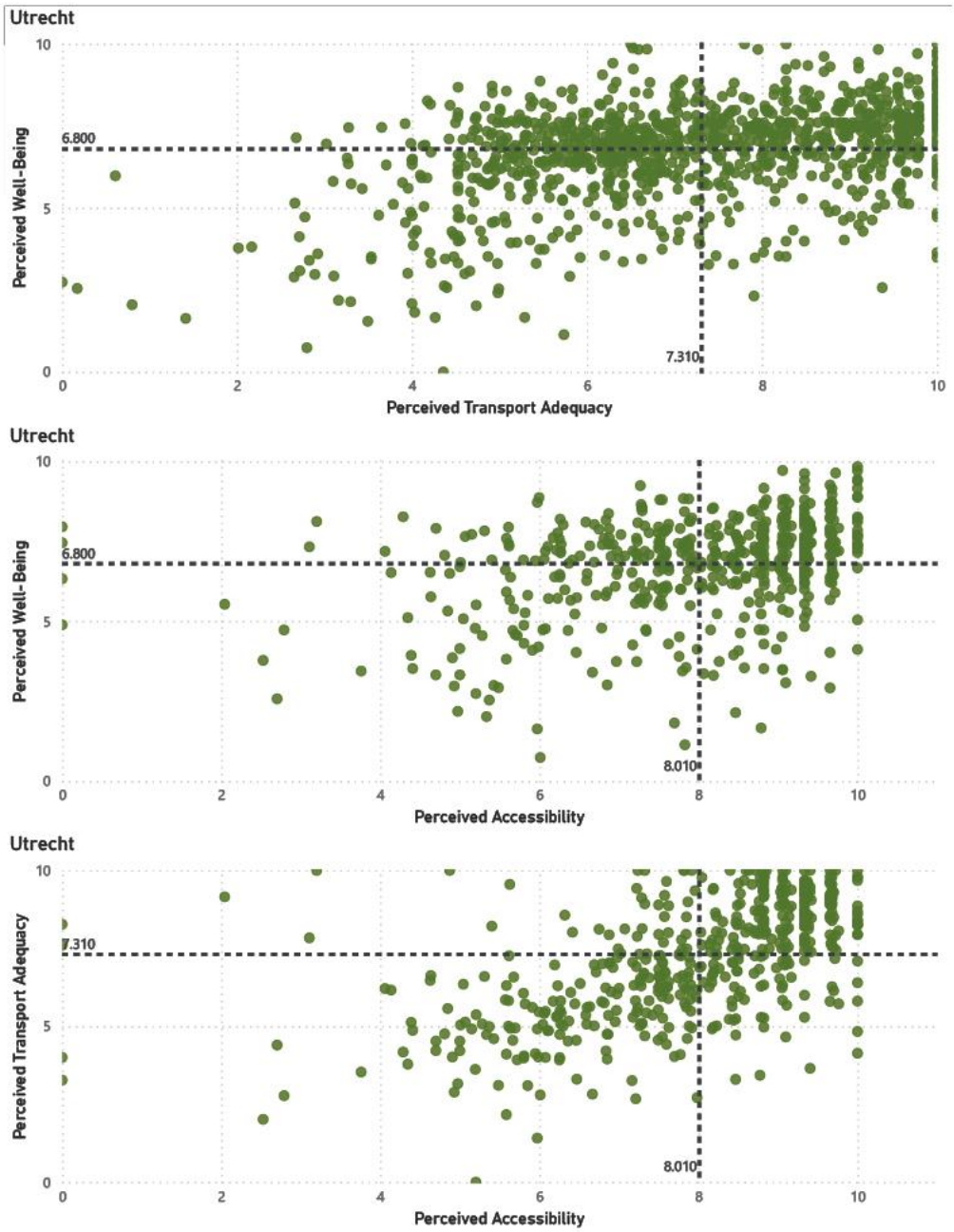

Figure 41.2: Scatter plots for Utrecht.

The measurements and indications of accessibility, transport adequacy and well-being in this research are meant to be indicative to enhance the benchmark of these topics in the Dutch context. Also, the goal is not to establish a minimum threshold, but to address accessibility using the capabilities framework, and how personal, mobility and economic characteristics can shape it [accessibility] and affect well-being, as put by the authors used as references in this study (Kuttler and Moragli, 2021c; Pereira et al., 2016; Vecchio and Martens, 2021). Overall, this study presents findings that contribute to the research that has been done so far on transport poverty, well-being and the capabilities approach applied to transportation.

7.5 Conclusion

In the present section, the general conclusions from chapter 7 are discussed. From the factor analysis, perceived accessibility was constructed by 8 variables and is firstly related to access to supermarket, local shopping area and followed by GP, pharmacy, health centre; hospital; friends and family at their home; work, volunteering and internship; gym, team or hobby; university, school or study location and finally children's school or daycare.

Perceived transport adequacy was composed of 8 items, and the factor loadings with higher value were: reaching regular destinations and activities, followed by feeling safe while travelling to those regular destinations; able to live their life as they want to; travel in a way that is suitable to their physical condition and abilities; having transportation options available to them; travelling without consequences to their health; spending much time and finally money on travel.

Finally, for the factor analysis on perceived well-being, 9 variables were considered, and the ranking was obtained as follows: satisfaction with what they are achieving in life; satisfaction with life as a whole; standard of living; future security; personal relationships; how safe they feel; their health; feeling part of their community and finally their personal travel options.

T-tests and ANOVAs brought the significance of the independent variables (resources and conversion factors) to the dependent variables (which are the latent variables resulting from the factor analysis). For perceived accessibility, significance appeared from age, gender, income, education, other languages spoken at home, use of mobility aid, driver's license, car ownership, other transport modes and public transport usage. Perceived transport adequacy indicated significance with age, gender, household formation, income, level of education, other languages spoken at home, mobility aid, driver's license, car ownership, other transport modes used and public transport. Finally, perceived well-being has significance with household formation, income, education, employment, mobility aid, driver's license, car ownership, other transport modes and public transport.

In the regression analysis, in terms of effect in size considering the unstandardized beta, accessibility is highly influenced negatively by the use of mobility aid (-0.539) and positively related to having a driver's license (0.398) in model 1. Models 2.a and 2.b regressed transport follow the same tendency, the most important effect in size is mobility aid (-0.628 for model a and -0.369 for model b) and driver's license (0.345 for model a and 0.495 for model b). Finally, models 3.a, 3.b and 3.c regressed well-being. In this case, the greater effects in size in model 3.a are seen in mobility aid (-1.187) and car ownership (0.249), which shows even higher effects than employment status. In model 3.b, mobility aid (-0.882) and transport adequacy (0.402). Effects of the lower incomes are also considerable for the first two model variations. Model 3.c shows the effects in size mostly related to mobility aid (-0.868) and transport adequacy (0.351). In general, for the models that regressed well-being, living alone effects are negatively associated with the dependent variable (-0.196/-0.175/-0.246 respectively for models 3.a, 3.b and 3.c).

Table 20 displays the overview and comparison of the independent variables considered in this study and what literature and the analysis resulted in taking into account accessibility, transport poverty and well-being.

	Literature	*Analysis*
Age	Younger people face issues with transport and accessibility, especially if they don't have a driver's license. Older people also face restrictions due to physical conditions or lower income	Confirms literature related to younger cohorts facing transport poverty. Results are not conclusive for older people.
Gender	Women are described as experiencing restrictions with accessibility and transport	Women have a positive experience when it comes to their accessibility and transport adequacy, contradicting what literature shows so far.
Household	Single-parent households have mobility restrictions	Living with a partner brings a positive impact on transport adequacy. Living alone relates negatively with perceived well-being and living with children relates positively with the same variable.
Income	Low incomers have restrictions with accessibility, transport and well-being.	Confirms literature, showing high cohorts have a positive relation with transport adequacy and lower cohorts have a negative relation with perceived well-being.
Employment	Low-skilled workers face transport poverty.	Demonstrates a positive relationship between having a job and perceived well-being.
Migration background	Less likely to have a car or to travel by bike. More likely to own a public transport subscription. Leading to higher chances of experiencing transport poverty.	Negative relation with transport adequacy from people that speak another language at home.
Mobility aid	Experience restrictions with accessibility, transport adequacy and well-being.	Confirms literature.
Driver's license	Positive relation with accessibility, transport adequacy and well-being.	Confirms literature.
Car ownership	Positive relation with accessibility, transport adequacy and well-being.	Confirms literature.
Other transport modes	Bicycle reduces the impact of experiencing transport poverty or mobility restrictions.	E-bikes are associated positively with perceived transport adequacy and scooters, motorcycle, and moped with perceived well-being.
Public transport	Public transport presents a limited experience when it comes to accessibility and transport adequacy compared to private vehicles.	Train users contribute to accessibility, metro and tram users restrict transport adequacy and bus users have a positive relationship with perceived well-being.
Accessibility	Low levels of accessibility result in experiencing transport poverty and affect well-being.	Confirms literature.
Transport Poverty	Transport poverty is a multidimensional concept and is related to well-being.	Confirms literature.

Table 20: general conclusions from the regression models according to the literature and the analysis (based on Awaworyi Churchill and Smyth, 2019; Bastiaanssen et al., 2013; Benenson et al., 2011, 2017; Delbosc and Currie, 2011; Dolan et al., 2008; Golub and Martens, 2014; Holder, 2010; Jorristma et al., 2018; Lucas, 2012; Ma et al., 2018; Martens, 2013; Martens et al., 2011, 2019; Meijering et al., 2019).

Most of the independent variables from the table have their relationship with accessibility, transport poverty and well-being confirmed by the analysis, although some results were unexpected (such as gender or train users when it comes to public transport).

With the statistical analysis complete, the spatial analysis displayed the results and patterns for perceived accessibility, transport adequacy and well-being in Rotterdam and Utrecht. The upcoming chapter 8, brings the discussion and limitations of the present study and recommendations for future practice.

8 Conclusion, Discussion and Recommendations

8.1 Conclusion and Discussion

This study first, investigated the underlying relations between accessibility, transport poverty, well-being and socio-economic and transport characteristics. To understand these relations, the following research question and sub-question(s) were addressed:

What relations can be identified between perceived well-being, transport poverty, accessibility, socio-economic and transport characteristics?

To answer the main research question from the study, a literature review was conducted, followed by statistical analysis to confirm the findings from other studies. The statistical analysis treated perceived transport poverty the other way around and analysed transport adequacy instead. Literature brought that different levels of well-being, transport poverty and accessibility can be influenced by age, gender, household formation, income, employment status, migration background, use of mobility aid, having a driver's license, owning a car, other transport modes used and public transport. All of these variables were considered for the statistical analyses to understand how they present themselves in the Dutch context.

In general, the outcomes from the socioeconomic characteristics considered in the statistical models show the relationships brought by the literature. However, the results from this study showed unexpected results when it came to gender since the sample analysed contradicts the literature by presenting that women have a positive relationship to accessibility and transport adequacy compared to men. Users of mobility aid are put by the literature as one of the groups that suffer more severely with accessibility, transport poverty and well-being, which is confirmed by the statistical analysis. In addition, literature brings that people that own a driver's license and have a car have a positive relation with accessibility, transport poverty and well-being, which is also confirmed by the statistical analysis.

When it comes to the usage of other private transport modes besides the car, literature in the Dutch context shows that the bicycle reduces the impact of experiencing transport poverty or mobility restrictions. However, when considering other modes such as e-bikes, scooters, motorcycles, and mopeds, e-bikes have a positive relationship with perceived transport adequacy, and scooters, motorcycles, and mopeds have a positive relationship with perceived well-being. Public transport is said to present a limited experience to accessibility and transport adequacy compared to private vehicles compared to the literature. According to the statistical analysis, train users contribute to accessibility, metro or tram users have a negative relation with transport adequacy and bus users positively perceive their well-being.

Low levels of accessibility result in transport poverty and affect a person's well-being, which is confirmed by the statistical analysis. Finally, transport poverty is described by the literature as being a multifaceted concept that affects well-being, which is also confirmed by the statistical analysis.

The six sub-questions that were acknowledged by the conceptual model were answered based on the statistical analysis from this study. The relations between *accessibility, socioeconomic and transport characteristics* could be seen when it comes to age, gender, use of mobility aid, having a driver's license and usage of public transport. When it comes to *transport poverty and accessibility* the relationship is measured by the relation between transport adequacy and accessibility. Statistical analysis shows that perceived accessibility has a positive relation with transport adequacy.

Transport poverty, socio-economic and transport characteristics show that age, gender, income, other languages spoken at home, use of mobility aid, having a driver's license, car ownership, use of other transport modes (e-bike) and public transport (tram or metro) influence transport adequacy. The relationship between *well-being and accessibility*, from the statistical analysis, perceived accessibility has a positive relationship with perceived well-being. The relation between *well-being and transport poverty* is measured by the relation of perceived well-being and perceived transport adequacy. It was possible to conclude that transport adequacy has a positive relation with well-being. Finally, when it comes to the relationship between *well-being, socioeconomic and transport characteristics*, the statistical analysis shows the significance of household formation, income, employment, use of mobility aid and car ownership.

The second aim of this study was to explore the spatial distribution of different levels of accessibility, transport adequacy and well-being in Rotterdam and Utrecht, by answering the following question:

How are the different levels of perceived accessibility, transport poverty and well-being distributed in Rotterdam and Utrecht?

The geographical analyses performed in this study took into consideration the 3 dependent variables that were built as the result of the factor analysis and socioeconomic and transport characteristics from the study area. First, the maps illustrating the average values of perceived accessibility, transport adequacy and well-being on a normalized scale from 0 to 10 in different areas of Rotterdam and Utrecht were presented. It is essential to acknowledge that the number of respondents per area differs. For consultation, the maps with the average number of respondents can be checked in Appendix B.

The maps display some patterns in the distribution of accessibility, transport adequacy and well-being that show that areas with lower levels of one of these variables usually also are the same areas that have lower levels of the other variable. In addition, Rotterdam showed itself with a lower average in accessibility, transport adequacy and well-being. Considering that the sociodemographic characteristics of both cities differ in the variables that have a relationship with accessibility, transport poverty and well-being, it is consistent that they would present different averages. One example is that Rotterdam has a

larger population with low income, which has a negative impact on accessibility, transport adequacy and well-being.

This study address accessibility, transport poverty and well-being by using some concepts of the capabilities approach, shedding a light on new mobility concepts that have been growing in the past years and presenting another perspective on the transport dilemmas for the urban environment. The findings from it can contribute to topics related to justice and fairness in the transport system. The next section discusses the limitations and recommendations of the study.

8.2 Limitations and Recommendations

Although this research shows several relevant findings about the underlying factors that relate accessibility to transport poverty and well-being presented in the previous section, there are some limitations as well.

Causal relations between the variables were not checked, using structural equation modelling. It is strongly advised for further analyses to understand their causal relations and even connect them to the capabilities approach framework applied to transportation. Even though the results regarding age show results that confirm the literature, this study has a clear limitation when it comes to younger or older individuals. Because the questionnaire was addressed to people from 18 to 70 years old, there are no conclusions to take from vulnerable groups such as people below or above those ages. Also, recommendations for future research are to address these groups, which are said by the literature to suffer from accessibility limitations.

Perceived accessibility does not take into account variations in the day (day or night) or weather conditions, which might affect how people perceive their transport options and affect accessibility as well. A recommendation for research is using incrementing data on these topics, which might refine the results and give an even more detailed overview of the accessibility of the population.

The study does not consider social exclusion as a measured variable in the survey. Although the literature shows implications of limited access to social participation, no conclusion from the data set can be taken. It is recommended for future research to explore the relationship between accessibility, transport poverty, well-being, and social exclusion as well.

Although the present study uses the capabilities approach that relates to a certain extent to the conceptual model, the capabilities framework can be further explored bringing another approach. One example is to compare the perceived accessibility from the questionnaire with achieved accessibility data, which might contrast the difference between the capability set and the functioning of an individual. Finally, the results contribute to the general literature on transport poverty, however, as Lucas et al (2016) discuss, it is highly associated with the local context, planning and culture. Local planners and policymakers need to acknowledge this so that the policies and legislation can be able to address the

local context. The two cities discussed in this study presented different levels of accessibility, transport adequacy and well-being, however, their averages were considerably close to each other. More context on the Dutch territory is still needed, in smaller cities or rural areas.

Examining the topic of transport equity, it is fundamental for policymakers to pay attention to which measurement is being used to determine if the distribution of a benefit or burden related to the transport system is fair. In this sense, the capabilities approach brings a focus more to the individual characteristic than aggregate geographical or household measures on transport inequalities, which supports the creation of policies that focus on the conversion factors of a person, such as perception and awareness of the transport system to enhance the confidence to use different types of transport means, such as shared mobilities or to become less car-centric societies.

Promoting accessibility in the policy scenario should consider its impact on individual and societal well-being. Practice recommendations are to focus on the well-being that can be improved by increasing accessibility for the population that lacks the most, diminishing the gap between the individuals that have high accessibility and the ones on the lowers levels of it. In this sense, the policies regarding bikeability, access to shared transportation or public transportation should be directed to the ones that nowadays experience low levels of accessibility affecting their well-being. In any case, based on the results, people that use mobility aid are strongly facing issues with accessibility, transport adequacy and well-being. Practice recommendations involve discussion in focus groups with this population to understand where are the gaps and what can be improved for them.

The results obtained from the regression models show that owning a car or having a driver's license is still very positively connected to accessibility, transport adequacy and well-being. Although the Netherlands has a strong cycling culture, these results show that the car culture is still strongly present, and for a shift to happen in the transport system, planners and policymakers will also have to address a shift in the car-centric culture. Although more Dutch research is needed on the topics of transport poverty, well-being and capabilities approach, this study provided useful research and practice-related findings.

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Appendix A: Questionnaire

Mobimon onderzoek Universiteit Utrecht

WELCOME TO THE MOBIMON STUDY!

This study is intended only for people living in Rotterdam or Utrecht who are between 18 and 70 years old. To thank you for participating in our study, we offer an online gift card to people who have completed the survey. If you would like to receive the gift card, you can enter your email address at the end of the survey.

About this study

This project studies how residents of large cities travel and what their experiences are with transportation. The Mobimon-project aims to learn more about who is at risk of transport poverty and how this is experienced in everyday life.

Transport poverty occurs when someone has reduced job opportunities or cannot fully participate in society because of a lack of (suitable) transportation options.

By filling out this survey, you help to increase scientific insight into the experience and causes of transport poverty in the Netherlands. This knowledge will be used to better understand where and how transportation in the Netherlands can be improved.

About this survey

The survey consists of 4 sections and will take approximately 20 minutes to complete.

The questions relate to the different means of transport you may use, the destinations that you travel to, your experience with various ways of traveling, your satisfaction with different areas of life and your personal circumstances.

PLEASE NOTE: For some of the questions, your answer might be (temporarily) different as a result of the ongoing Covid-19 restrictions. Please try to answer each question as you would in a situation without Covid-19.

There are 40 questions in this survey.

Collection & processing of your data

- The information you share with us will be used for research on transport poverty.
- Your data is stored in a secure environment that only the Mobimon research team can access.
- Your data will be stored and analysed in a way that ensures it cannot be directly traced back to individual persons (it will be depersonalized).
- After the end of the Mobimon-study, the depersonalized dataset will remain available for future research for up to 10 years.
- The depersonalized results from the study may be published in academic journals
- The depersonalized results from the study may be shared with other research and/or public institutions for further research or policy purposes.

Conditions for participation

- You can only participate in this study if you are between 18 to 70 years old and live in either Rotterdam or Utrecht.
- Participation in this study is completely voluntary and you can withdraw from the survey at any point without stating the reason.
- To thank you for participating in our study, we offer an online gift card to people who have completed the survey. If you would like to receive the gift card, you can enter your email address at the end of the survey. This is voluntary and your email address will be used for this purpose only. After the survey has ended all email addresses will be removed from our database.

Questions?

Any comments or questions regarding this study can be directed at mobimon@uu.nl. For inquiries about your rights & privacy, please contact the data protection officer at privacy@uu.nl.

☐ I have read the conditions and agree to participate in this study

>Start survey

PRELIMINARY QUESTIONS

Please answer the following two questions before continuing to the survey.

1. What year were you born?*
    - [Dropdown list years]
    - Don't know / Don't want to say

2. In which city do you live? **
    - Rotterdam
    - Utrecht
    - Other

**If answer is "Don't know / Don't want to say", jump to section "*NOT PART OF TARGET POPULATION"*

***If answer is "Other", jump to section "*NOT PART OF TARGET POPULATION"*

MEANS OF TRANSPORT

The first section of the survey is about the different types of transportation that you can use, and under which conditions you use these. We ask these questions to get a general overview of the transportation options that are available to you.

Means of transport [1/3]

The following set of questions is about the different types of vehicles that are available to you. Please answer these questions as you would for a situation without the Covid-19 virus.

1. Do you have a valid driver's license?
   - Yes
   - No*

* *If answer is "No", jump to section*

Means of transport [2/3]

2. How do you feel about driving?

	Completely disagree = 1	2	3	4	Completely agree =5
I feel comfortable driving a car					
I have a lot of experience driving a car					
I find it hard to drive under difficult conditions (at night, during rush hour, etc.)					
I prefer not to drive					

3. Do you own or have access to a car?
   Please choose **all** that apply:
   - Yes, a personal car
   - Yes, a leased car
   - Yes, a family/household car
   - Yes, the car of friends or acquaintances
   - Yes, through a car-share/rental plan (e.g. Greenwheels, Car2Go, ConnectCar)
   - No
   - Other:

4. How frequently do you drive a car?
   - Daily
   - A couple of times a week
   - A couple of times a month
   - A couple of times a year

- Less than once a year
- Never
- Other

5. What type of car do you normally drive or use?
   Please choose **all** that apply:
   - Diesel
   - Gasoline
   - Hybrid
   - Electric
   - Don't know
   - Other:

6. What type of parking facilities are available for the car(s) you use where you live?

	Yes	Sometimes	No
There is secure parking space available			
There is sufficient parking space available			
There is free or affordable parking space available			

• Means of transport [2/3]

7. Which of the vehicles listed below do you use?*
   Please choose **all** that apply:
   - Bicycle
   - E-bike
   - Moped or speed pedelec (up to 45 km/hr)
   - (Electric) scooter
   - Cargo bike (bakfiets)
   - Motorcycle
   - None
   - Other:

* *If answer is "None", jump to section*

Means of transport [3/3]

8. What type of parking facilities are available for bicycles, mopeds or motorcycles where you live?

	Yes	Sometimes	No
There is dry/indoor parking space available where I live			
There is secure parking space			

available where			
There is sufficient parking space available where I live			

Means of transport [3/3]

9. Are you a member of a paid car-share, bike-share, or other vehicle sharing service? *
   Please choose **all** that apply:
   - Yes, a car-share service (e.g. Greenwheels, Connect Car)
   - Yes, a bike-share service (e.g. OV-fiets, Donkey Republic)
   - No
   - Other:

**Note: This does not apply to borrowing a vehicle from family or friends.*

10. Which public transport options are available in your neighbourhood? *
    Please choose **all** that apply:
    - Bus
    - Tram
    - Metro
    - Train
    - Regiotaxi/belbus (dial-a-bus)
    - None of these
    - Other:

* *If answer is "None of these", jump to question 12 "*How do you usually pay for public transport?"

11. To what extent do you agree with the following statements?
The public transport options in my neighbourhood...

	Completely disagree = 1	2	3	4	Completely agree =5	Don't know
…are affordable to me						
…are easy to understand how to use						
…are accessible to people with reduced mobility						
…are available at times that are useful to me						
…reach destinations or activities that are important to me						

12. How do you usually pay for public transport?
    Please choose **all** that apply:
    - Personal OV-card (with photo) with subscription
    - Personal OV-card (with photo) without subscription

- Anonymous OV-card (no photo)
- Student travel product
- Single ticket
- Not applicable: I never use public transport
- Other:

13. How do you normally plan your trip?
Please choose **all** that apply:
- Using an online travel planner on my computer (9292.nl, Google Maps, etc.)
- Using a travel planner or map app on my phone
- Using the information boards provided at the stop or station
- Using an offline travel planner (timetables, bus schedule, etc.)
- Using an offline map
- I don't plan my trips
- Other:

TRAVEL BEHAVIOUR & TRANSPORTATION EXPERIENCE

The second section of the survey is about your travel behaviour and your motivations for travelling the way that you do. We ask these questions to better understand your experience with travel and transportation.

Travel behaviour & transportation experience [1/4]

The following set of questions is about the way you (normally) travel and the type of trips you take. Please answer these questions as you would for a situation without the Covid-19 virus.

14. How frequently do you travel using the following modes of transport?

	(Almost) daily	A few times a week	Once a week	A few times a month	Once a month	A few times per year	(Almost) never
Walking (incl. with walker, crutches, wheelchair, mobility scooter, etc.)							
cycling or e-bike							
(electrical) scooter							
cargo bike							
moped, motorcycle, or speed pedelec							
car (as the driver)							
car (as a passenger)							
bus							
tram							
metro							
train							
taxi or Uber							
regiotaxi/belbus (dial-a-bus)							

Travel behaviour & transportation experience [2/4]

Please answer these questions as you would for a situation without the Covid-19 virus.

15. Out of the previous options, what is your preferred way of travelling? *
    - o Walking (incl. walker, crutches, wheelchair, mobility scooter, etc.)
    - o Cycling or e-bike
    - o By (electrical) scooter
    - o By cargo bike (bakfiets)
    - o Moped, motorcycle, or speed pedelec
    - o Car (as the driver)
    - o Car (as a passenger)
    - o Bus
    - o Tram
    - o Metro
    - o Train
    - o Taxi or Uber
    - o Regiotaxi/Belbus (dial-a-bus)
    - o Other

16. What are your main motivations for choosing to travel this way? *
    Please select from 1 to 5 answers.
    Please choose **all** that apply:
    - o It is quick or quicker than other options
    - o It is inexpensive or free
    - o It is safe or safer than other options
    - o It is the most convenient option to use
    - o It is the option nearest to me/my house
    - o Only available option at the times I travel
    - o Only available option to reach my destination
    - o Only available option I'm capable of using
    - o To keep my flexibility and freedom
    - o To keep fit and healthy
    - o It is good for the environment
    - o To avoid crowding
    - o Other:

17. If your main travel mode were suddenly unavailable, would you still be able to reach all of your regular destinations at the time that you would want to? *
    - o I could reach all destinations
    - o I could reach most destinations
    - o I could reach some destinations
    - o I could reach very few destinations
    - o I could no longer reach any destinations

**For example: would you still be able to reach your job, family or the supermarket?*

Travel behaviour & transportation experience [3/4]

Please answer these questions as you would for a situation without the Covid-19 virus.

18. To what extent do you agree with the following statements?
With the transportation options available to me...

	Completely disagree= 1	2	3	4	Completely agree = 5	Not applicable
... I can easily reach my (volunteering) work or internship						
... I can easily reach my university, school or study location						
... I can easily reach the supermarket or local shopping areas						
... I can easily reach my family doctor (GP), pharmacy, or health centre						
... I can easily reach a hospital						
... I can easily visit my friends or relatives at their home						
…this is a control question. Please select "completely disagree"						
... I can easily reach my gym, team or (hobby)club						
... I can easily reach my children's school or daycare						

19. How long does it (approximately) take to travel from your home to your job? *
    - 5 minutes or less
    - Between 5 and 15 minutes
    - Between 15 and 30 minutes
    - Between 30 and 45 minutes
    - Between 45 and 60 minutes
    - Between 60 and 90 minutes
    - More than 90 minutes
    - Variable: my work location constantly changes
    - Not applicable: I work from home
    - Not applicable: I don't work
    - Other

20. Are there specific activities or important destinations in the Netherlands that you cannot access because of a lack of (suitable) transportation options?*
    **Please answer as you would for a situation without the Covid-19 virus*
    - No
    - Yes...
        - Make a comment on your choice here:

21. In the past year, have you turned down a job or decided not to apply to a job that you were interested in due to (potential) problems with transportation?*

**Please answer as you would for a situation without the Covid-19 virus.*

*Please choose **all** that apply:

- Yes, I had to turn down a job for this reason
- Yes, I decided not to apply for a job for this reason
- No
- Not applicable (not looking for a job)
- Other:

Travel behaviour & transportation experience [4/4]

Please answer these questions as you would for a situation without the Covid-19 virus.

22. When travelling, do you (sometimes) use mobility aids or devices?*

Please choose **all** that apply:

- Yes, a walking cane, crutches, or a white cane
- Yes, a walker
- Yes, a(n) (electric) mobility scooter
- Yes, a(n) (electric) wheelchair
- I'd rather not say (skip question)
- No
- Other:

**This question is asked to learn more about your health. If you do not want to share this information, select "I'd rather not say (skip question)".*

23. To what extent do you agree with the following statements?
With the transportation options available to me...

	Completely disagree = 1	2	3	4	Completely agree = 5
I am able to live my life as I want to					
I have to spend more on necessary travel in a week than I can afford					
I spend much more time travelling than I'd like					
There is always a transport option available to me at the times I need it					
I can reach all my regular destinations & activities					
I feel safe while travelling to my regular destinations & activities					
I am concerned about road safety while travelling to my regular destinations & activities					
I can travel without negative consequences to my health					
I can travel in a way that is suited to my physical condition & abilities					

WELLBEING

In the third section of the survey, you are asked to rate how satisfied you are with different areas of life. We ask these questions to get a general impression of your current situation.*

**Please answer as you would for a situation without the Covid-19 virus.*

Wellbeing [1/2]

The following set of questions is about your satisfaction regarding different areas of life.*
**Please answer as you would for a situation without the Covid-19 virus*

24. How satisfied are you with...?
1= completely dissatisfied and 10= completely satisfied *

	1	2	3	4	5	6	7	8	9	10
Your life as a whole?										

Wellbeing [2/2]

25. How satisfied are you with...?
1= completely dissatisfied and 10= completely satisfied

	1	2	3	4	5	6	7	8	9	10
Your personal travel options?										
Your standard of living?										
Your health?										
What you are achieving in life?										
Your personal relationships?										
How safe you feel?										
Feeling part of your community?										
Your future security?										

PERSONAL INFORMATION

The next section focuses on your background and personal circumstances. We use this information to compare your experiences with transportation with those of people from various backgrounds.* **Please answer as you would for a situation without the Covid-19 virus*

Personal information [1/3]

The following set of questions is about your personal circumstances.

26. What is your gender?
- Female
- Male
- Non-binary/Genderfluid/Other

27. What are the 4 numbers of your postal code?
Only numbers may be entered in this field (e.g. 1234) *
- Please write your answer here:

**This indicates the neighbourhood you live in, but does not reveal your personal address.*

Personal information [2/3]

The following set of questions is about your personal circumstances.

28. What best describes your living situation? *
Please choose **all** that apply:
- I live alone
- I live together with my partner/spouse

- I live together with my children
- I live together with other family members
- I live together with friends/housemates
- It varies (e.g. a few days per week with children)
- Other:

29. What is the primary language you speak at home? *
    - Arabic
    - Berber
    - Chinese
    - German
    - English
    - French
    - Dutch
    - Papiamento
    - Polish
    - Turkish
    - Other

30. Do you speak any other language at home? *
    - None / not applicable
    - Arabic
    - Berber
    - Chinese
    - German
    - English
    - French
    - Dutch
    - Papiamento
    - Polish
    - Turkish
    - Other

31. To what extent do you agree with the following statements?
I am satisfied with how often I have contact with...

	Completely disagree = 1	2	3	4	Completely agree = 5	Not applicable
…my family (that I do not live with)						
…my friends (that I do not live with)						
…this is a control question. Please select "completely agree"						
…my neighbours						

32. In the past year, have you been less/unable to reach your family or friends in the Netherlands due to problems with transportation? *
    - Yes, I could not reach my family or friends as well as I wanted to because of
    - problems with transportation
    - Yes, I was unable to reach my family or friends at all because of problems with
    - transportation
    - No
    - Other

Personal information [3/3]

The following set of questions is about your personal circumstances.

33. What is your highest completed level of education?
    - Primary education
    - Secondary education: vmbo, mulo, onderbouw havo/vwo
    - Secondary education: bovenbouw havo/vwo
    - Tertiary education: mbo1
    - Tertiary education: mbo2-4, hbs
    - Tertiary education: university of applied sciences / university bachelor
    - Tertiary education: university of applied sciences / university master / PhD
    - Other

34. What best describes your current employment situation?
    Please choose **all** that apply:
    - Full time job, permanent contract
    - Full time job, temporary contract
    - Part time job, permanent contract
    - Part time job, temporary contract
    - Seasonal job
    - Entrepreneur / self-employed
    - Retired
    - Student
    - Stay-at-home parent
    - Caregiver
    - Unemployed: looking for a job
    - Unemployed: (temporarily) unable to work
    - Other:

35. What is your (estimated) net* monthly household income?*

**This is the amount that is listed on your payslip.*

- Less than €980
- Between €980 and €1870
- Between €1870 and €2680
- Between €2680 and €3800
- Between €3800 and €5460
- More than €5460
- Don't know / don't want to say

END OF SURVEY

You have reached the end of the survey. As a token of our appreciation we would like to offer you an online gift card. In order to receive the gift card, you can enter your email address below.

Your email address will be used for this purpose only and will be removed once the study has ended. You can also opt out of the gift card if you rather not enter your email address.

Please note that it may take a couple of days before you receive the link to your voucher in your inbox.

Thank you for participating in our study!

36. Would you like to enter your email address to receive the gift card?
    - Yes
    - No*

**If answer is "No", jump to question 38*

37. Please enter your email address below:
    - Please write your answer here:

38. Do you have any comments or suggestions for us?
    - Please write your answer here:

NOT PART OF TARGET POPULATION

Unfortunately, you are not part of the target population for this study and cannot take part in the survey. Thank you for your time and interest!

END PAGE

You have reached the end of this survey. If you have any questions or remarks, please contact us at: mobimon@uu.nl.

Thank you for completing this survey.

>Submit your survey.

Appendix B: Maps perceived accessibility, transport adequacy and well-being with number of respondents per postal code

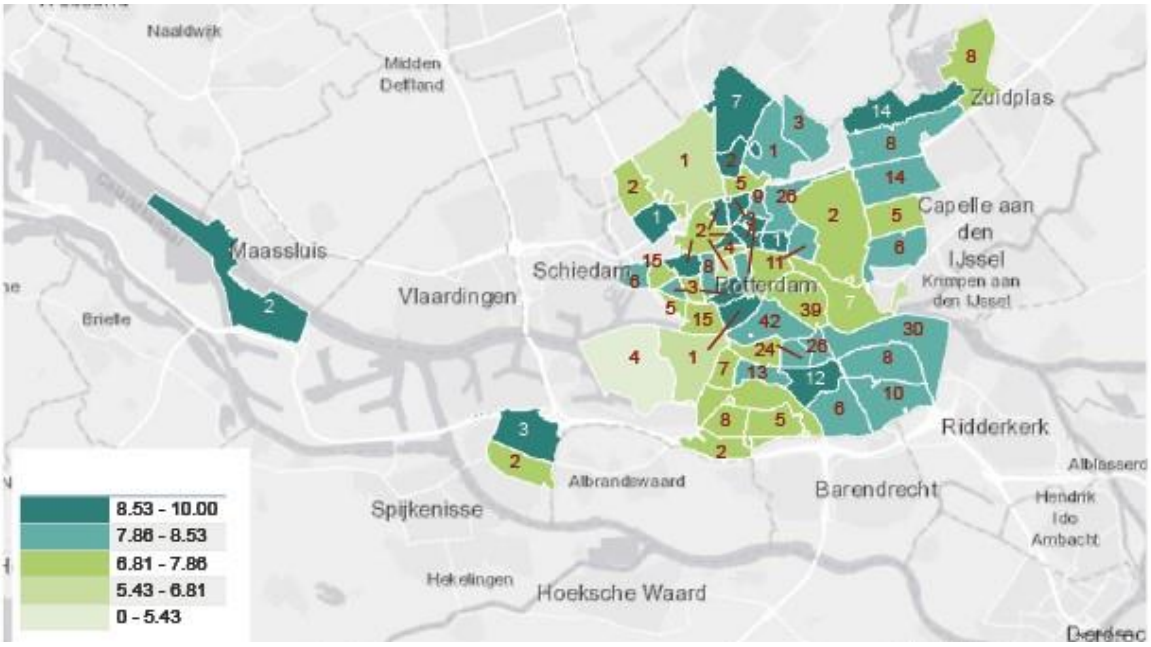

Figure 42.1: Perceived accessibility – Rotterdam with the number of answers per postal code.

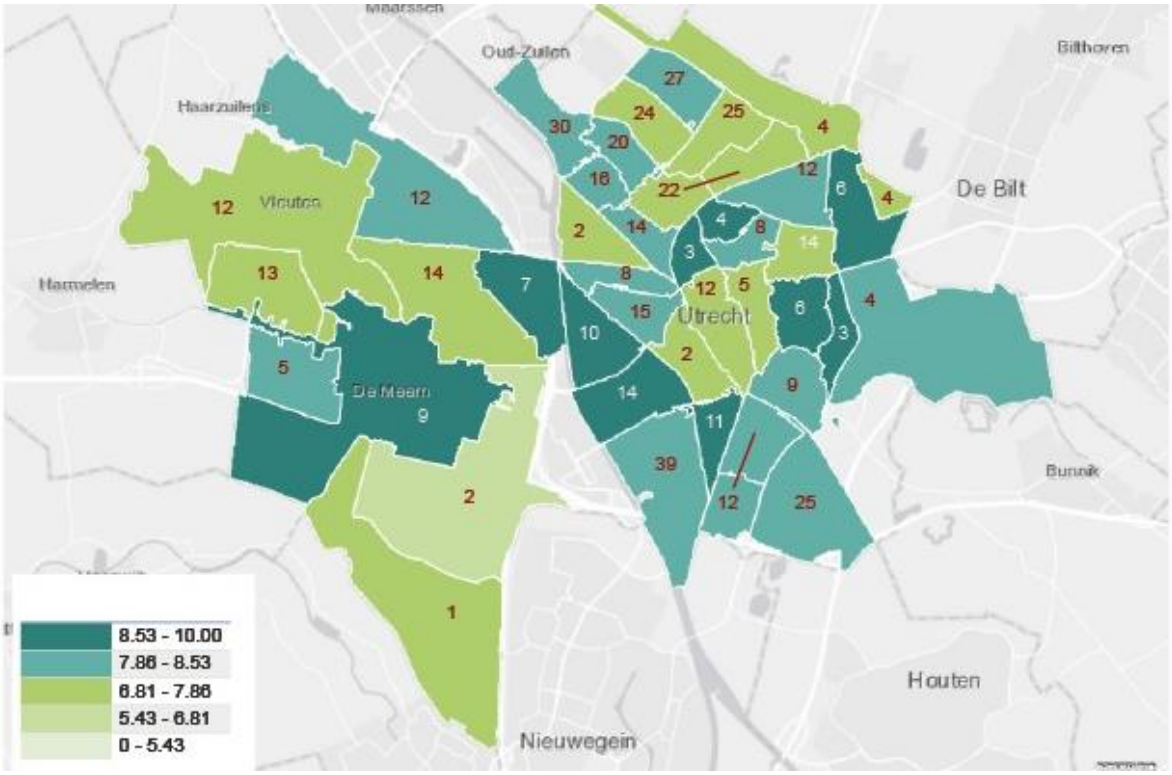

Figure 42.2: Perceived accessibility – Utrecht with the number of answers per postal code.

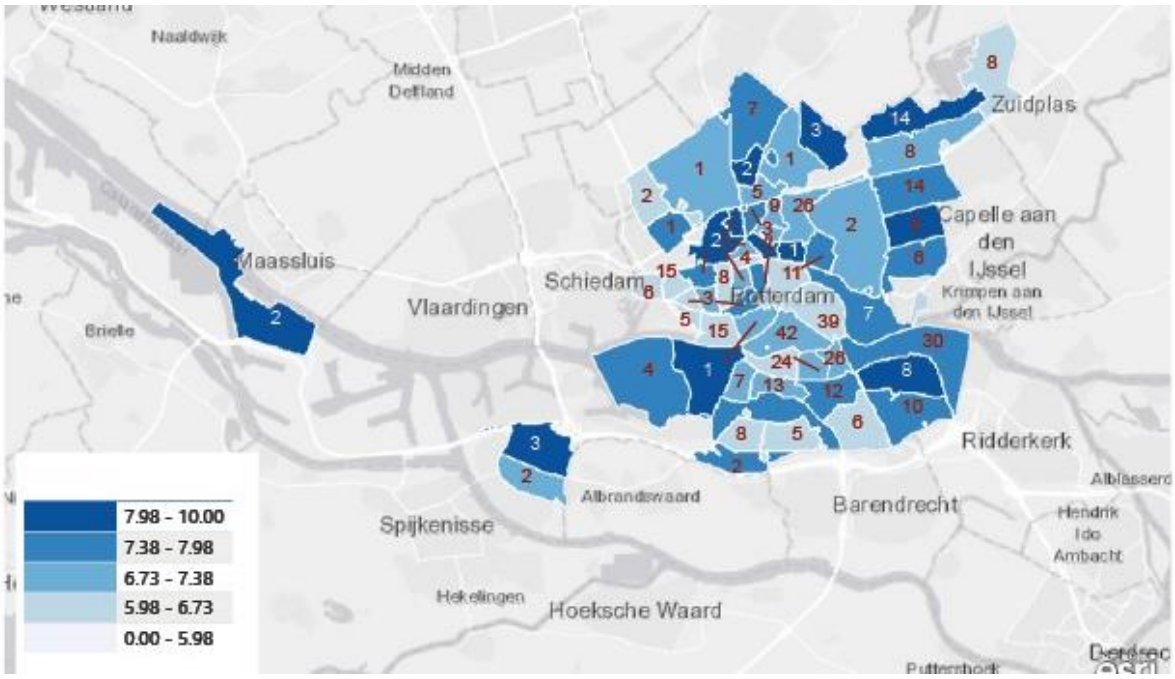

Figure 43.1: Perceived transport adequacy – Rotterdam with the number of answers per postal code.

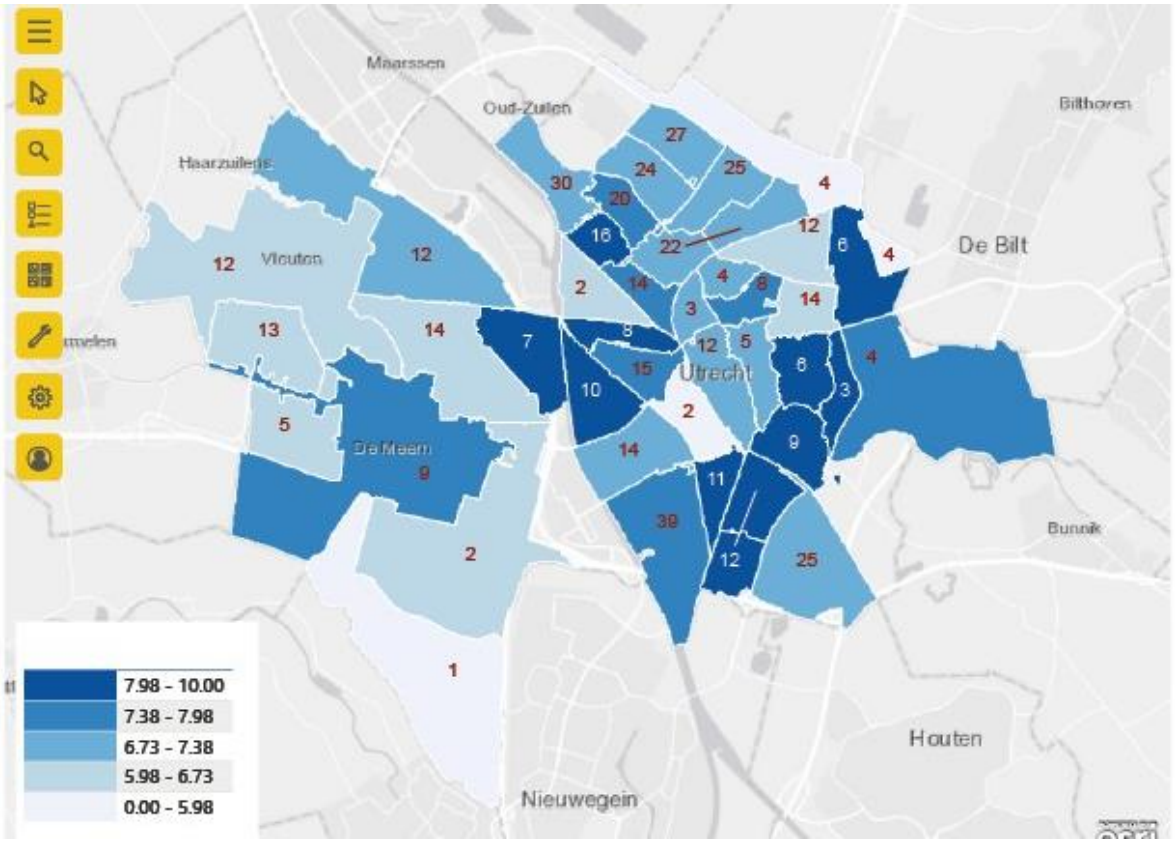

Figure 43.2: Perceived transport adequacy – Utrecht with the number of answers per postal code.

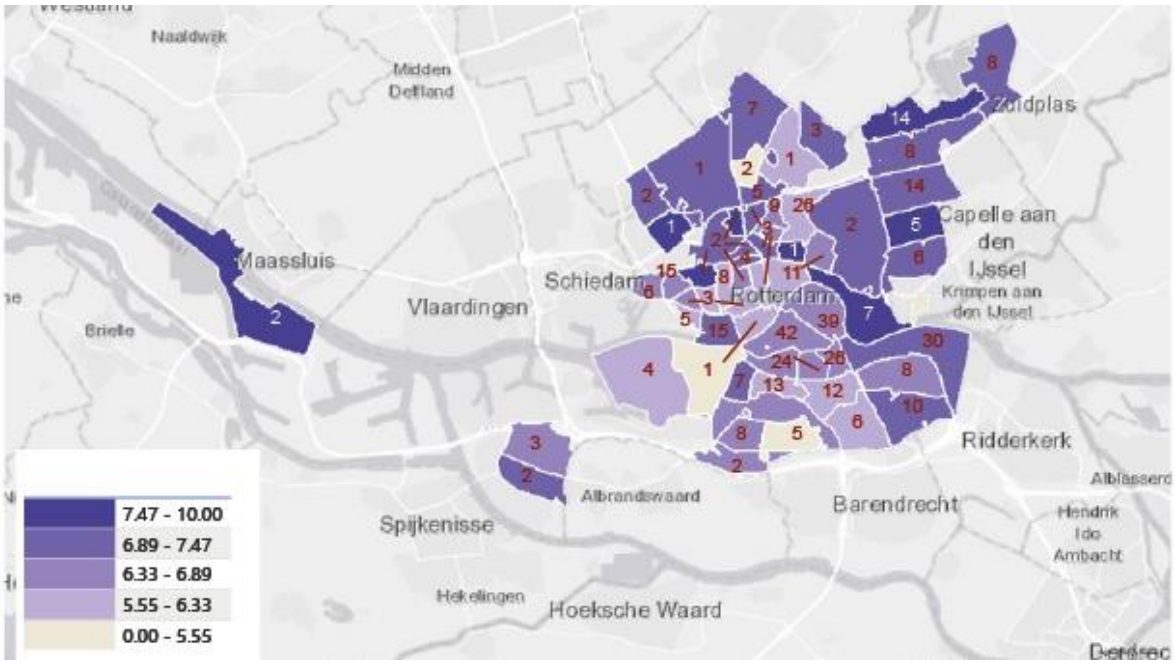

Figure 44.1: Perceived well-being – Rotterdam with the number of answers per postal code.

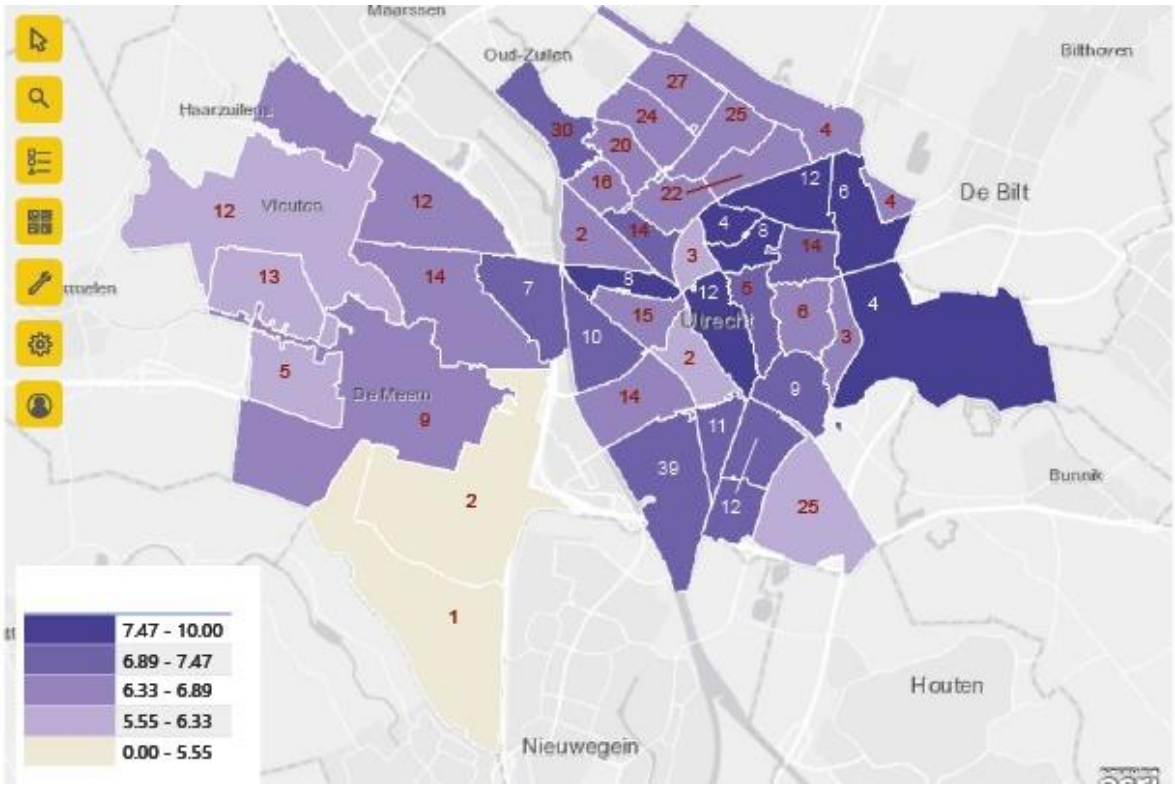

Figure 44.2: Perceived well-being – Utrecht with the number of answers per postal code.