Instance-based Transport Poverty

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INVESTIGATING THE EXISTENCE OF VARIATION IN THE INDIVIDUAL'S LEVEL OF TRANSPORT POVERTY WITH THE INTRODUCTION OF INSTANCE-BASED TRANSPORT POVERTY

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Preface

In the pages that follow, you will read the final product of my master's thesis, marking the culmination of my academic journey. This thesis is dedicated to the development of the concept of instance-based transport poverty, with the goal of constructing meaningful data to assist policy makers in creating effective policy interventions. The study presented here emerged from a profound desire to foster mobility opportunities for all members of our society. Understanding how transport poverty manifests in the lives of diverse individuals marks the beginning of a transformative journey within the mobility sector, with inclusivity at its core.

My inspiration for this study stemmed from numerous discussions with mobility experts, during which many ideas found their purpose under the expert supervision of Peter van der Waerden and Pauline van den Berg. I wish to express my heartfelt gratitude to them for their guidance throughout this process. The time and effort they invested in guiding me, exploring different perspectives, and challenging my decisions have significantly enhanced the quality of this study. I extend the same appreciation to Soora Rasouli for her guidance on the methodological aspects of this research.

A special thank you goes to Marcel Touset, who warmly welcomed me during my internship at APPM as my company supervisor. His candid feedback and fresh perspectives on transport poverty served as a guiding light, reminding me of the potential impact of this study on individuals' lives. Furthermore, his invitations to inspirational meetings and internal events provided me with the opportunity to build a valuable network for my future career.

Throughout the course of this thesis, I had the privilege of interviewing a diverse group of mobility experts, each contributing their unique perspectives and practical examples to enrich this research. I extend my thanks to Marc Seij from the Municipality of Rotterdam for his challenging questions and real-life examples, which guided my thought process. Similarly, I am grateful to Hans Jeekel from the 'Laberatorium voor Verantwoorde Mobiliteit' for shedding light on the broader implications of transport poverty and offering valuable insights that helped structure my thoughts through compelling examples.

As I reflect upon this thesis, I recognize it as a pivotal moment in my academic and professional journey. With a smile, I can proudly say that I have evolved over six years of dedicated study. Over time, I have developed a keen interest in applying social and behavioral sciences within the field of mobility, a passion I aspire to carry forward in my future career. This thesis marks the commencement of this journey, and I hope it serves as an inspiration to others, encouraging them to address the injustices inherent in today's mobility sectors.

With gratitude,

Michelle van Ardenne

Executive Summary

Mobility has been an enabler for individuals to participate in activities, playing an essential role in creating social inclusion and social exclusion. Although there is a consensus regarding the impact of inadequate mobility on social exclusion, the challenge is to devise measurement methods for exclusion due to inadequate mobility. Researchers have defined the inability to participate in activities due to inadequate mobility under the name of "transport poverty." The definition consists of five conditions that represent the causes of transport poverty. If an individual experiences at least one of these conditions, it is understood that the individual experiences transport poverty.

This assumption, however, neglects the multidimensionality of the concept of transport poverty, making it difficult to believe that the conditions of transport poverty can be experienced to varying degrees in different contexts. While the identification of transport-poor individuals is currently done with a 'yes' or 'no' label, there is a desire to identify the level of transport poverty per individual based on the context in which the problem occurs. Understanding the context of transport poverty levels is expected to provide details about where, when, and how transport poverty is experienced by the individual. This information is necessary to develop effective solutions to the problem.

To determine an accurate level of transport poverty, this study has developed a new measurement tool for transport poverty called "instance-based transport poverty." Instance-based transport poverty levels determine an individual's level of transport poverty in the context of one trip, making the level of transport poverty an accurate representation of the situation that the individual has encountered. The context of a trip is defined by a set of characteristics that represent the trip being evaluated. The aim of the study is to show that instance-based transport poverty can provide valuable insights into the effect of context on an individual's level of transport poverty by demonstrating that different contexts cause different levels of transport poverty. This method allows researchers to understand where, when, and how the problem of transport poverty occurs.

To determine whether instance-based transport poverty could successfully integrate the context into a level of transport poverty, it needed to be proven that different levels of instance-based transport poverty differ from each other when they relate to different contexts. If this hypothesis could be proven, it could be concluded that the concept of transport poverty is not constant, which requires an understanding of the factors that cause variation. This study decided to examine the differences between four levels of transport poverty, which were known to be collected from trips with different contexts. A second hypothesis was added to determine in what way the characteristics of the contexts affect the levels of transport poverty.

A survey was created in which the four levels of transport poverty were measured. These transport poverty levels were paired measurements from a within-subject study, as every participant was asked to state their level of transport poverty multiple times for different trips. Each transport poverty level was constructed using the Transport Adequacy Scale, calculating the average presence of the transport poverty conditions through nine transport poverty indicators. The first level of transport poverty was the overall transport poverty level, which was measured without the inclusion of any context as it reflected upon the daily life of the participant. The results showed a mean overall transport poverty level of 1.62, within a range of 1 to 4.25. After the questions regarding the overall transport poverty level, three instance-based transport poverty levels were determined by reflecting on the most recent trips for three different trip purposes: commuting, shopping, and leisure. The instance-based transport poverty levels showed lower mean values (1.49, 1.29, and 1.38) within a smaller range of values (1 to 3.625, 1 to 3.5, and 1 to 3.5).

A total of 280 participants between the ages of 18 and 85, residing in the Netherlands, successfully completed the survey, in which they were also asked to state their socio-demographic characteristics and available mobility resources. Twenty participants could not be taken into account due to missing values in the age and residential variables or extreme outliers within any other socio-demographic characteristic. Therefore, only 260 data points were used in the data analyses. Using Wilcoxon signed-rank tests, the study was able to conclude that significant differences exist between the different transport poverty levels. The results show

that, in general, the overall transport poverty levels contain a higher average value than the three instance-based transport poverty levels. These results suggest that an individual's level of transport poverty is not constant among trips with different trip purposes. Therefore, this study concludes that an overall level of transport poverty does not consistently represent the individual's level of transport poverty. The results highlight a desire to determine levels of transport poverty in reference to their context.

Further examination of the effects of the characteristics of the context was done with ordinal logistic regressions. The results of the regression models show that the performance of the models increases when more characteristics of the context are included in the model. Moreover, the results show that the significance of the characteristics is not constant between the different instance-based transport poverty levels. This outcome gives reason to assume that the importance of characteristics varies per trip purpose, which increases the need for an understanding of the context. However, it should be noted that the performance of the regression models was below the acceptable benchmark of the Pseudo R2.

The findings of the study demonstrate that the context of transport poverty creates a better understanding of where, when, and how variation in an individual's level of transport poverty occurs. The relationships of the characteristics with the levels of transport poverty explain the factors that increase or decrease an individual's level of transport poverty. These insights can be used to identify the situations in which the level of transport poverty is high or low and to pinpoint the causes of the degree of transport poverty.

The biggest challenge ahead is the social discussion on what level of transport poverty is acceptable and what level is not. To accomplish this, it is necessary to relate the level of transport poverty to a level of social exclusion that is generated by the level of transport poverty. The context can improve this process by providing clear use cases that can be used to create a benchmark for transport poverty, indicating which conditions are acceptable and which are not. For example, the inclusion of the context allows for a distinction between spontaneous increases in the level of transport poverty and a systematically high level of transport poverty. This distinction can help policymakers and transport engineers find effective solutions to reduce the level of transport poverty when improving the mobility system.

Contents

1 Introduction

Societies worldwide are experiencing an increase in their urban population, which is expected to rise to a worldwide urban population of 68 percent in 2050 (UN-Habitat, 2022). To accommodate the increasing population, cities need to grow, which often results in the expansion or redevelopment of urban areas. However, global challenges like climate change and scarce resources create barriers to realizing these expansions and developments. To ensure a high quality of life for all citizens living in these growing cities, all members of the United Nations have signed the 2030 agenda for Sustainable Development (United Nations, 2015). This global partnership strives to tackle global sustainability challenges with interventions that go hand-in-hand with the reduction of inequality while stimulating economic growth. Seventeen goals have been defined, with goal 11 dedicated to the creation of inclusive, safe, resilient, and sustainable cities. Creating these inclusive, safe, resilient, and sustainable cities is easier said than done. Citizens vary in their needs, desires, and resources, resulting in the fact that there is no one-size-fits-all solution that satisfies all citizens. As a result, many sustainable strategies and interventions have been created in line with SDG 11.

Especially within the mobility sector, multiple mobility solutions can be implemented to solve the challenges of sustainability and inclusivity. It has become clear that social and environmental factors influence travel behavior, which makes it necessary for solutions to be adjusted to the environment in which they are implemented (Asgari, Gauthier & Becker, 2013; Lucas et al., 2012). These adjustments make it challenging to find an acceptable solution for all users. In Western society, modern life is strongly related to being mobile (Jeekel, 2018; p. 3). This perspective justifies the making of an extensive number of trips to fulfil the daily needs of individuals, which has become a major social phenomenon in the last decade (Kaufmann & Viry, 2015). Therefore, spatial policies are often created with the assumption that citizens are highly mobile by car (Kenyon et al., 2002; & Kaufmann, 2015; Lucas et al., 2016). This has resulted in the car-dominant societies known today (Banister, 2019; Jeekel, 2019), which has created car-oriented land-use patterns and limited transport alternatives (Litman & Laube, 2002). Consequently, vulnerable citizens who cannot use a car are stuck with insufficient mobility opportunities that do not meet their travel needs (Banister, 2019). This creates inequalities and injustice in the mobility sector, which should be addressed on the political agenda to create more suitable sustainable policies that consider all citizens (Bastiaanssen & Breedijk, 2022).

In recent years, public authorities have given more attention to inclusivity within transport policy-making (Bastiaanssen & Breedijk, 2022). Attention has been paid to the social and economic consequences of insufficient mobility. However, many aspects of the relationship between mobility and social exclusion are still unknown (Lucas et al., 2016). Researchers have therefore tried to define the relationship between mobility and social exclusion in the name of “Transport Poverty (TP)”(Lucas et al., 2016) and “Transport Related Social Exclusion (TRSE)” (Luz & Portugal, 2021). The terms have been used interchangeably; however, a difference should exist according to the terminology. The term ‘social exclusion’ is seen as a multi-faceted issue, while the term ‘poverty’ is often only related to a lack of resources (Pritchard et al., 2014). Fortunately, in literature, the term ‘transport poverty’ also acknowledges the influence of more than just resources, which will be explained later in this chapter. Still, a difference in focus exists as transport-related social exclusion focuses more on defining the process that leads to social exclusion, while transport poverty focuses more on the factors that increase or decrease the risk of being socially excluded (Luz & Portugal, 2021).

1.1 Background

Social exclusion is considered as a key outcome of the lack of participation in activities (Khan et al., 2015). Mobility has been defined as an enabler for people to participate in activities, therefore playing an essential role in creating social inclusion and exclusion (Kamruzzaman & Hine, 2012). Researchers even argue that barriers in mobility can cause reduced subjective well-being through the mediation of social exclusion (Currie et al., 2010). Although there is a consensus regarding the impact of limited mobility on social exclusion, the challenge is to devise measurement methods that enable us to measure the impact of inadequate mobility on the lives of individuals. Lucas and colleagues (2016) highlight the following two challenges in the creation of transport poverty measurement tools:

- First, transport poverty relies on the individual perspective. The level of social exclusion can vary among individuals, even among members of the same household, as people develop different sets of capabilities and resources throughout their life. Also, people within the same household can have different activity patterns. While many other mobility-related concepts can be generalized on a household level, this is a more complex process for transport poverty.
- Second, the social, temporal, and geographical context of the area influence the benefits coming from the mobility system (Luz & Portugal, 2022). It is, therefore, challenging to point out a clear cause of social exclusion, as many aspects interact with each other within the concept of transport poverty.

Despite these two challenges, literature has tried to develop a definition for the concept of transport poverty. While there is consensus that it is difficult to agree upon one comprehensive definition, Lucas and colleagues have defined a lexicon that includes the conditions that cause the experience of transport poverty. These conditions can be experienced in isolation or in combination (Lucas et al., 2016), and are stated as follows:

“An individual is transport poor if, in order to satisfy their daily basic activity needs, at least one of the following conditions apply:

- The necessary weekly amount spent on transportation, leaves the household with a residual income below the official poverty line.
- There is no transport option available that is suited to the individual’s physical condition and capabilities.
- The existing transport options do not reach destinations where the individual can fulfil his/her daily activity needs, in order to maintain a reasonable quality of life.
- The individual needs to spend an excessive amount of time on travelling, leading to time poverty or social isolation.
- The prevailing travel conditions are dangerous, unsafe or unhealthy for the individual.”

1.2 Problem Analysis

Having identified the conditions of transport poverty, measuring the level of transport poverty should be possible. Lucas and colleagues (2016) have argued that measuring one of the conditions in the daily life of the individual is enough to get an understanding of whether that individual is likely to experience transport poverty. However, this assumption neglects the multidimensional aspects of the concept of transport poverty. Transport poverty is expected to vary in more dimensions than only being absent or present, as research has shown that transport poverty can vary in size and impact (Krabbenborg & Uitbeijerse, 2023). This observation makes it difficult to believe that the conditions of transport poverty can only be experienced as present or absent.

Still, measuring transport poverty according to Lucas's assumption would result in a 'yes' or 'no' label for transport poverty, because it is unknown where, when, or how transport poverty occurs. Using the conditions as the causes of transport poverty can provide insights into what phenomena are causing transport poverty, however, the lacking connection with the mobility system makes it impossible to conclude what is causing the conditions to occur. It is desired to understand which characteristics from the mobility system are causing the conditions to occur because the conditions themselves are hard to solve. For example, solving the condition of time poverty can only be done when knowing what is causing the time poverty to occur, as there are multiple characteristics in the mobility system that can cause time poverty.

Moreover, due to the multidimensionality of transport poverty, the conditions are expected to be experienced in a variety of ways as well. For example, time poverty can be experienced due to systematically long travel time with public transport, or due to occasional congestion on the highway due to an accident. Although the same condition is occurring, the effects of the condition on the life of the individual are expected to differ. Additionally, transport poverty can also differ within the life of one individual. For example, an individual can experience the condition of time poverty due to systematically long travel time with public transport to work, but no time poverty when walking to the supermarket around the corner.

1.3 Research Objectives and Questions

This study suggests introducing the concept of instance-based transport poverty to bridge the knowledge gap between transport poverty and the characteristics of the context in which transport poverty occurs. Instance-based transport poverty refers to the level of transport poverty determined for only one trip. Determining the level of transport poverty for only one trip makes it possible to quantify the context because the where, when, and how of the context can be directly related to the characteristics of the trip. Limiting the context to only one trip generates a level of transport poverty that is only valid for that one trip, instead of being valid for the whole lifestyle of the individual. With this approach, instance-based transport poverty levels can determine whether a trip and its characteristics contribute to the level of transport poverty or not.

Limited insights, however, have been published on how to operationalize the context in the concept of transport poverty (Lucas, 2018). This causes a lack of understanding of which characteristics of the trip should be defined as part of the context. According to Lucas and colleagues, the influential factors of transport poverty can vary from trip characteristics, like travel time and travel cost, to social and environmental factors like social norms and the landscape (Lucas et al., 2016). However, no universal framework has been developed on the concept of the context of transport poverty. This study, therefore, focuses on providing the first step in the definition of the context in transport poverty by deducing the influential factors of the context from the relation between instance-based transport poverty and travel behavior.

The aim of the research is to show that instance-based transport poverty can provide valuable insights about the effect of the context on the individual's level of transport poverty by showing that different contexts cause different levels of transport poverty. Examining variation is chosen as an objective because significant differences between different levels of instance-based transport poverty are a reason to believe that transport poverty cannot be generalized over multiple trips and show that the context should be taken into account when assessing an individual's level of transport poverty.

To achieve the aim and objectives, this study will have to determine which trip characteristics relate to the concept of transport poverty before it can measure instance-based transport poverty levels. Literature on travel behavior will, therefore, be used to determine the set of trip characteristics that will be included in the context, after which all trip characteristics will be combined in one theoretical framework to determine what the context of transport poverty entails. This theoretical framework will provide the base for this study, which tries to answer the following main research question:

How can the concept of instance-based transport poverty provide insights about the effect of the context on an individual’s level of transport poverty?

To answer this question, three sub questions have been formulated which need to be answered first. They are stated as followed:

- How can transport poverty be measured?
- How can the context of transport poverty be operationalized?
- How can variation within an individual’s level of transport poverty be defined and operationalized?
- To what extend does the inclusion of the context improve the estimation of an individual’s level of transport poverty?

1.4 Academic and Social Relevance

Mobility is a fundamental part of society, which's system provides access to activities. Making this system inclusive for all citizens requires knowledge about how mobility affects individual's participation in activities. The concept of transport poverty has been developed to understand which transport poverty conditions cause an individual to have the inability to access activities. The concept of instance-based transport poverty adds to this knowledge by specifying the context in which individuals have the inability to access activities.

Understanding how the context of transport poverty influences the level of transport poverty is relevant for the accuracy and precision of transport poverty measurements. The accuracy of the level of transport poverty increases when degrees can be defined within the level of transport poverty due to the connection with the context. Variation in the way an individual can be assigned a level of transport poverty makes that the identification of 'being transport poor' is closer to the true and accepted value of what society believes is transport poverty. Referring back to the example of the two individuals experiencing time poverty in section 1.2, society would put different labels on the two individuals. The person experiencing systematically long travel times fulfills the socially accepted label of being transport poor better than the person experiencing a long travel time due to occasional congestion.

The precision of the level of transport poverty increases because the context makes it possible to evaluate the transport poverty levels of similar mobility experiences with each other. By fixating a characteristic, like the purpose of the trip, two levels of transport poverty can be compared more precisely. For example, the levels of transport poverty of two commuting trips are expected to be closer to each other than the level of transport poverty of one commuting trip and one shopping trip. A precise determination of the level of transport poverty makes it possible to substantiate the relation between an influential factor and the level of transport poverty when this influential factor is being used as a constant.

The increase in accuracy and precision can be used by policymakers and transport engineers to create a better understanding of the concept of transport poverty. With the increase in accuracy, a more accurate definition of transport poverty can be enforced, which makes it easier to identify individuals who are experiencing transport poverty. The discussion on the social acceptance of social exclusion can benefit from a more accurate definition of transport poverty, as it allows policymakers and transport engineers to create a benchmark for what level of transport poverty is acceptable and which is not. With the increase in precision, these benchmarks can also be measured, which allows society to target the right vulnerable individuals with the right policy interventions coming from the right department.

2 Background

This chapter discusses the concept of transport poverty to define the indicators that determine the level of transport poverty. Accordingly, the trip characteristics of the context will be determined based on literature about travel behavior and their relation with the concept of transport poverty.

2.1 The Concept of Transport Poverty

2.1.1 The History of Transport Poverty

Transport poverty finds its history in the car-oriented urbanization of urban areas in this era (Bastiaanssen & Breedijk, 2022). Trip purposes like work and shopping destinations moved to the outskirts of the cities as those areas still consisted of enough public place to build new facilities. However, spatial designs based on urban sprawl have caused accessibility problems for those who do not have access to a car and have to reach destinations beyond walking distance because of the car dependency generated by the urban design. With the lack of suitable alternatives, individuals relying on public transport, walking, or the bike experienced exclusion of participation in the highly car-dependent urban areas (Lucas, 2012). The discovery of this relation between social exclusion and transportation was the starting point for the concept of transport poverty.

However, before the concept of transport poverty could be defined, it was important to understand the inter-relationships between mobility and social exclusion. A pioneer in this field of study was the Social Exclusion Unit (SEU) with their 2002-2003 study of transport and social exclusion in the UK (Social Exclusion Unit, 2003). This organization has examined how transport disadvantages influence social concerns, like unemployment, health inequalities, and poor education, by identifying the transport and social barriers that strengthen the consequences of social exclusion. The results showed that especially for job seekers, the absence of a car had a significant influence on their number of job opportunities. With the study, the SEU has changed the perspective on accessibility, which they defined as the concept of 'individuals being able to access key services at a reasonable cost, in reasonable time, and with reasonable ease.' Their definition showed to take into account both transport and social disadvantages when examining the adequacy of mobility.

Many countries created considerable academic interest in the relation between mobility and social exclusion after the publication of SEU (Lucas, 2012). However, this has also caused a worldwide discussion on the definition of social exclusion caused by inadequate mobility within the mobility sector. On the contrary, there is broad agreement that social exclusion reaches beyond just the description of poverty, recognizing its broader reach and implications (Luz & Portugal, 2021). Making a clear distinction between poverty and social exclusion enables researchers and policymakers to recognize that poverty does not automatically result in exclusion. Similarly, it acknowledges that an individual can experience exclusion without being in a state of poverty (Kenyon et al., 2002). Social exclusion has therefore been recognized as a multidimensional, multilayered, and dynamic concept of deprivation (Lucas, 2012). The integration of a social exclusion perspective into mobility policies has assisted policymakers in recognizing the following key aspects (Lucas, 2012):

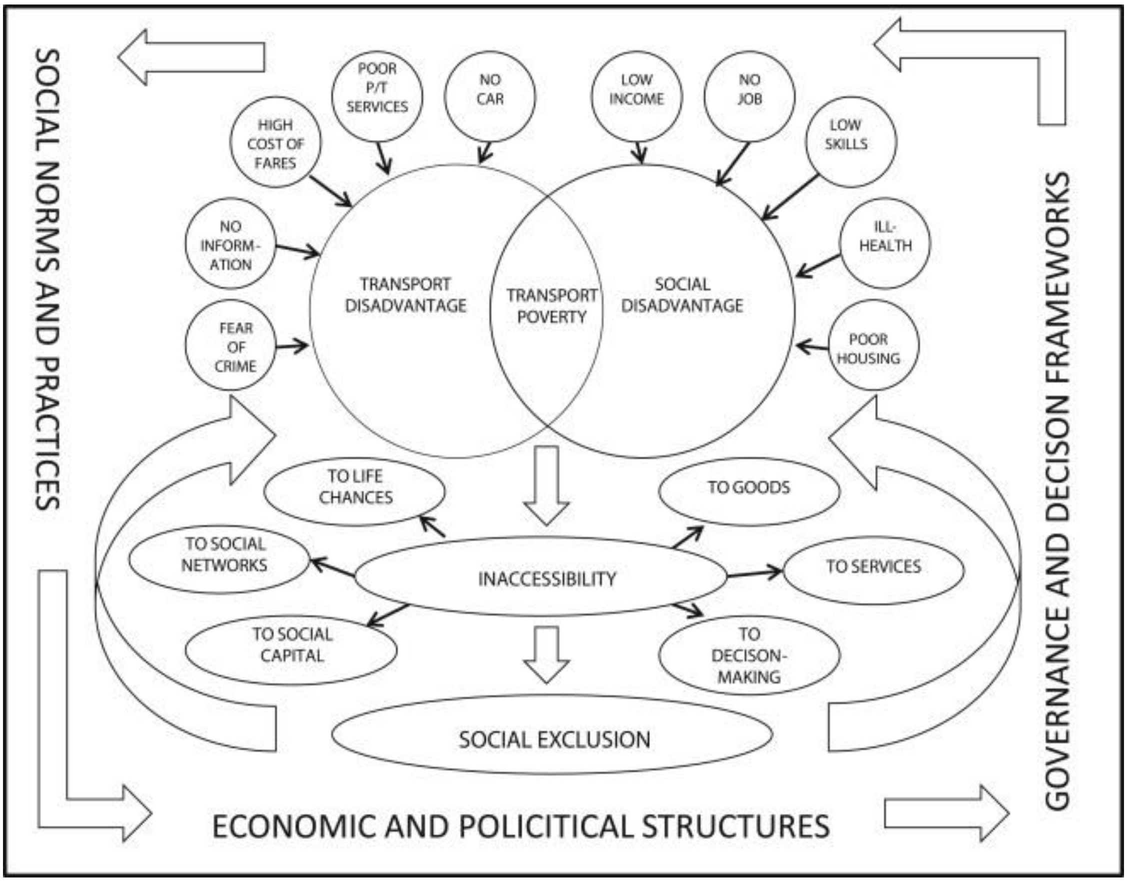
a) The issue of social exclusion is multi-dimensional (Levitas et al., 2007), involving both the circumstances faced by individuals and the underlying processes, institutions, and structures within society at large;
b) Social exclusion is inherently relational, as it involves a comparison between the disadvantaged individuals and the normal relationships and activities of the broader population;
c) Social exclusion is dynamic in nature, meaning it evolves over time and varies across different spatial contexts, as well as throughout an individual's lifetime.

However, finding a solution for eliminating or erasing social exclusion within the mobility sector has not been successful so far (Bastiaanssen & Breedijk, 2022). The correlation between social exclusion and the economic and social consequences of mobility has paved the way for the study of transport poverty, which aims to define the circumstances in which individuals face social exclusion due to inadequate mobility.

2.1.2 Defining transport poverty

Studies on transport poverty show that the concept of transport poverty cannot have one clear definition because of the multi-dimensionality in which the concept presents itself. The multi-dimensionality makes it difficult to define a person as transport poor. Still, in order to communicate what is meant with the concept, transport poverty is often referred to as "the compounded lack of ability to travel to important destinations and activities" (Allen and Farber, 2019). What literature does agree upon is the fact that transport poverty is the outcome of the direct and indirect interactions between transport disadvantage and social disadvantage, and can cause individuals to experience social exclusion (Lucas, 2012). However, it is not transport poverty itself that causes the social exclusion, it is the result of inaccessibility to essential goods and services, as well as the 'lock-out' from planning and decision-making processes that cause a person to experience social exclusion. These circumstances can result in more transport and social disadvantages which deprive individuals even more. These relations are clearly shown in figure 1 by Lucas (Lucas, 2012).

Figure 1: The framework of transport poverty (Lucas et al., 2012)



As social exclusion is multi-dimensional, transport poverty is expected to have a multi-dimensional perspective as well. This means that transport poverty can be operationalized in a variety of ways, which makes it hard to define the concept (Lucas et al., 2016). Researchers have therefore focused on defining the conditions of transport poverty, which represent the variety of operationalizations of the interactions between transport and social disadvantages that cause the individual to lack the ability to travel to important destinations and activities (Lucas et al., 2016).

A fundamental aspect in the creation of the transport poverty conditions is the acknowledgment of the social norms and rules in the mobility system. The way in which a society facilitates mobility determines how vulnerable individuals experience transport and social disadvantages. For example, in western countries which have car-dominant societies, the conditions of transport poverty will be related to the perspective of high mobility as this perspective determines how activities can be reached (Kenyon et al., 2002; Lucas, 2012). The priority that is given to cars causes alternative modes of transport like public transport to be underdeveloped, resulting in an inability to travel to every activity when a car is not available. Individuals can therefore be forced to own a car, even though they do not have the financial budget for that. Forced car ownership can, therefore, be interpreted as a transport poverty condition in western countries. This example shows how social norms and rules present in a mobility system determine what is defined as a transport poverty condition.

Research on transport poverty so far has focused mostly on Western countries. Therefore, the conditions of transport poverty are often created with the car-dependent societies in mind and only apply to western countries. This is also the case with the conditions defined by Lucas and colleagues (2016) which have defined the following transport poverty conditions:

"An individual is transport poor if, in order to satisfy their daily basic activity needs, at least one of the following conditions apply:

- The necessary weekly amount spent on transportation, leaves the household with a residual income below the official poverty line.
- There is no transport option available that is suited to the individual's physical condition and capabilities.
- The existing transport options do not reach destinations where the individual can fulfil his/her daily activity needs, in order to maintain a reasonable quality of life.
- The individual needs to spend an excessive amount of time on travelling, leading to time poverty or social isolation.
- The prevailing travel conditions are dangerous, unsafe or unhealthy for the individual."

As the scope of this study is focused on The Netherlands, the conditions of Lucas (2016) will be used as the operationalization of transport poverty.

2.1.3 The four components of transport poverty

Lucas et al. (2016) established the foundation of the conditions of transport poverty based on four key components coming from the interaction between transport and social disadvantages: transport affordability, mobility poverty, accessibility poverty, or transport externalities. The assumption made here is that the presence of at least one condition coming from one of the components can determine an understanding in who is experiencing transport poverty. Whether the individual is aware of this level of transport poverty is neglected in the definition. Examining the four components could help policymakers to shape their policy solutions dedicated to solving transport poverty.

Transport affordability

Transport affordability looks at the expenditure for transportation in relation to the total budget of the person (Lucas et al., 2016). Gleeson and Randolph (2002) state that people experience poverty "when a household is forced to consume more travel costs than it can reasonably afford, especially costs relating to car ownership and usage." A connection can, therefore, be made between affordability and the concept of forced car ownership, meaning that a household has to spend a large share of their income on owning a car, as this is the only suitable transport option in their environment (Currie & Delbosc, 2013). By integrating the notion of transport affordability into the concept of transport poverty, policymakers gain a deeper understanding of the financial constraints or possibilities faced by individuals and households. This understanding can inform the development of targeted policies and interventions aimed at improving affordability, and ensuring equitable access to essential services, opportunities, and activities.

Mobility poverty

Mobility poverty refers to the systematic lack of transportation and mobility options (Lucas et al., 2016). In cases where mobility poverty exists, adequate transportation infrastructure or services are lacking within the direct environment of the individual. An example is the lack of public transport services in rural areas where those services are not financially feasible to maintain. Important here is to acknowledge that structural transport disadvantages are less visible, as their appearances in society are subtle and often not directly related to the common root causes by the naked eye (Kuttler & Moraglio, 2021). The lack of public transport, for example, is often compensated by increased car use or by accepting longer walking and cycling distances.

Car dependency plays a substantial role in mobility poverty, particularly in the context of the Global North, where Western countries' reliance on cars as the primary mode of transportation leads to a lack of suitable alternatives. People who cannot or do not want to make use of the car could experience mobility poverty when there is no alternative mode of transport present in their direct environment. By recognizing mobility poverty within the broader framework of transport poverty, policymakers can develop policies and initiatives that prioritize equitable access to different transportation options, promote alternative modes of transport, and facilitate social inclusion.

Accessibility poverty
Accessibility poverty expands upon the notion of mobility poverty by taking into account whether individuals can access their essential daily activities within a reasonable timeframe, with convenience, and at an affordable cost (Lucas et al., 2016; SEU, 2003). The assumption here is that a mode of transport should not only be physically present, it should also meet the demand of the users. The concept of accessibility encompasses various dimensions of access because the demand can be determined by different needs. These dimensions make it challenging to define and evaluate 'access' as a single operationalization. Different perspectives and methodologies contribute to the existence of multiple definitions and levels of access (Martens & Bastiaanssen, 2019). This diversity in approaches allows for a more comprehensive understanding of accessibility, taking into account various factors such as spatial distribution, transport modes, cost, and time considerations.

The significance of examining accessibility poverty lies in its ability to shed light on the range of opportunities available to individuals (Martens & Bastiaanssen, 2019). By analyzing the mobility opportunities, research gains valuable insights into how a transportation system can either empower or constrain people's ability to participate fully in society, and what should be the threshold that is allowed in society regarding accessibility. It serves as a critical indicator of the level of freedom individuals have in accessing essential services, opportunities, and activities, ultimately influencing their quality of life and potential for social inclusion. By integrating accessibility poverty into the concept of transport poverty, mobility policies can be developed with a more holistic approach, considering the multifaceted nature of access barriers.

Transport externalities
Transportation produces externalities as a consequence of traveling. There are two perspectives on the risk of experiencing transport externalities, which are both related to the environmental aspects of transport poverty (Lucas et al., 2016). Traffic-related environmental externalities – air pollution, noise pollution, casualties, and deaths – and the various dis-amenities of transport infrastructure projects on the lives and livelihoods of the local communities like attraction of the neighborhood or dislocation of the local community. These include disruptions to their daily lives and economic activities. Additionally, these externalities often lead to the disbanding and dislocation of communities as a consequence of their construction. Including these externalities in transport poverty would help policymakers to capture the broader impacts of transportation on individuals and communities.

The interaction between the components.
In the context of the individual, the differentiation of these four components becomes considerably challenging. The interplay and interdependencies among the transport and social disadvantages lead to significant overlaps of the components, wherein each component can be considered a subset of the others (Lucas et al., 2016). Transport affordability, for example, relates to the experience of transport poverty when an individual is forced to use a car due to the lack of other mobility alternatives (mobility poverty). The relations with the experienced transport poverty, however, are unclear, as both an affordable car or an affordable alternative can reduce the level of transport poverty. Nonetheless, it remains imperative to address the distinct components through varied policy interventions, given that the components influence different facets of transport poverty.

2.1.4 Transport Poverty in Practise

Knowing the conditions of transport poverty and their origin should make it possible to measure the level of transport poverty for an individual. However, also here there have been different approaches regarding the operationalization of the conditions and components of transport poverty into a measurement tool. In the Netherlands, there are currently different tools in use to identify individuals who suffer from transport poverty. The tools differ in the choice of which direct and indirect relations between transport and social disadvantages to operationalize. Three measurement tools will be highlighted in the following section to display how different operationalization generates different transport poverty indications.

Central Statistical Office (CBS)

The 'Centraal Planbureau Statistiek' (CBS) developed the first known transport poverty measurement tool by operationalizing the presence or absence of socio-demographic characteristics and mobility resources to calculate the risk of transport poverty (Kampert et al., 2019). They established four risk indicators ranging from 'very low' to 'very high' based on the interactions between different transport and social disadvantages which have been proven to affect an individual's ability to travel. Every indicator was based on a range of scores which could be determined by the sum of the effects of the characteristics and resources. For example, an individual without a car would score two points because literature has shown that the lack of car ownership significantly reduces the ability to travel, whereas an individual with a car would score 0 points. In the end, the total sum of the score of an individual without a car would result in a higher transport poverty indication compared to the individual with a car.

The risk calculation tool of CBS was the first transport poverty tool in the Netherlands that succeeded in quantifying the level of transport poverty of an individual. However, due to their dependence on quantitative data, the tool only covers a limited gamut of transport poverty dimensions. The main focus of the tool is on quantifying transport affordability and mobility poverty-related conditions, while it provides less attention to conditions in line with accessibility poverty and transport externalities. Moreover, the social disadvantages mainly focus on the socio-economic characteristics, which leave out social factors related to the capabilities of the individual.

Environmental Assessment Agency (PBL)

The 'Planbureau voor de Leefomgeving' (PBL) extended CBS's approach by connecting transport poverty indicators to revealed travel time data in their study called 'Accessibility for All' (Bastiaanssen & Breedijk, 2022). Their aim was to create an accessibility index that provides insights into access to basic facilities like healthcare, education, and work based on different modes of transport. This connection was made possible by using open-source data regarding travel time to destinations, social demographics, and land-use patterns. This study revealed how specific socio-demographic characteristics affect the accessibility to essential facilities in terms of travel time, with car-less individuals experiencing lower accessibility compared to those with access to a car. This information enables policymakers to understand who is at risk of transport poverty due to inadequate access to vital facilities in certain residential locations.

With the integration of the accessibility-oriented social and transport disadvantages, the tool is able to measure conditions related to accessibility poverty. This is an improvement in comparison with the tool of CBS. Still, transport externalities and capabilities are not taken into account, which leaves room for improvement.

Goudappel

Another recent transport poverty indicator is the "Integral Perspective on Accessibility" (IKOB-method) by Goudappel (Goudappel, 2022). This method not only analyzes the availability of facilities and individuals' ability to utilize opportunities but also incorporates personal preferences regarding mobility resources. This results in additional weightings applied to mobility resources and destinations in traffic models, reflecting the ease of use of different transportation options. The resulting level of accessibility allows for comparisons of different social groups' accessibility at various locations.

With the integration of personal preferences, the measurement tool of Goudappel is able to add a new dimension to the concept of transport poverty, namely preference. However, it is uncertain whether these preferences can be translated into accurate transport poverty conditions that are socially acceptable to use to define a person with transport poverty. For example, it is debatable whether a condition like ‘a person is transport poor when his/her desired mode of transport is unavailable’ is accurate and precise.

As shown by the examples, there is currently no universally accepted measurement tool for transport poverty which covers conditions from all four transport poverty components. According to Lucas et al. (2016), this lack of a unified tool can be characterized by the fact that mobility is highly influenced by complex factors like an individual's geographic location, social environment, and timeframe. Moreover, every individual can experience different dimensions of social exclusion in different situations (Church et al., 2000; Luz & Portugal, 2022). These situations, due to their complex context, create obstacles in developing a single measurement tool that can capture the complexity of transport poverty in a quantitative way. More appropriate would be a measurement tool that allows benchmarking between individuals based on the subjective assessment of transport poverty. By operationalizing the five conditions of transport poverty into a subjective scale, a measurement tool can be developed which compares individual perspectives on transport poverty.

Transport Adequate Scale

A subjective scale for transport poverty has been created by Ettema and colleagues with the Transport Adequate Scale (Ettema et al., 2023). The scale levels the level to which a person would agree with experiencing transport poverty. The levels are created by reflecting on the conditions of transport poverty (Lucas et al., 2016), on the travel conditions that have been experienced, and on the extent to which important destinations can be reached (Currie and Delbosc, 2011). The reflection is done by reflecting upon trips that have happened in the past. For example, when reflecting upon the impact of travel time, the individual reflects upon the trips they have made in the past and judge whether they think they have spent more time traveling during these trips than they would have liked.

Table 1: The nine indicators of transport poverty according to the Transport Adequate Scale of Ettema et al. (2023)

The Transport Adequacy Scale (Ettema et al., 2023)	
Indicator	Statement
Life satisfaction	I am able to live my life as I want to
Transport Affordability	I spend more money on necessary travel in a week than I could afford
Time Poverty	I spend much more time travelling than I would like
Availability	There is always a transport option available to me at the times I need it
Accessibility	I can reach all my regular destinations and activities
Security	I feel safe while travelling to my regular destinations and activities
Road Safety	I have concerns about road safety while travelling to my regular destinations and activities
Health Impact	I can travel without any negative consequences to my health
Physical Condition	I can travel in a way that is suitable to my physical condition and abilities

2.2 The Context of Transport Poverty

The previous section introduced the concept of transport poverty and explained how transport poverty conditions are formed. With the Transport Adequate Scale, the indicators of transport poverty have been defined for the construction of a transport poverty measurement tool. This section explains the influence of the context on transport poverty and defines the characteristics that need to be known in order to include the context in the measurement of a transport poverty level.

2.2.1 The Definition of the Context

Before the context is applied to the concept of transport poverty, it is essential to understand what the context consists of. So far, when literature has spoken about the context of transport poverty, the context was often referred to as the geographical or spatial context. The geographical context refers to the human and physical characteristics of places and environments (National Geographic Society, 2023). However, according to the Cambridge Dictionary, the word context refers to “the situation within which something exists or happens, and that can help explain it” (Cambridge Dictionary, 2023). The human and physical characteristics mentioned under the name of the geographical context do not refer to the situation in which transport poverty occurs, as transport poverty is about mobility and not about the urban environment. Rather, the geographic context relates to the resources that are available to the individual in a certain environment (Luz & Portugal). This is the reason why this study sees the need to define the context of transport poverty.

Applying the definition of the word context to transport poverty would mean that the context of transport poverty refers to the situation in which transport poverty exists or happens and helps to explain the concept of transport poverty. Transport poverty is known to exist within mobility, which in itself represents the movements of individuals and goods from one place to another (Oxford University Press, 2023). This study therefore argues that trips are good representatives of the context of transport poverty.

To define the context of transport poverty, it is necessary to define the characteristics of trips, just like the geographical context defines the characteristics of an environment. The characteristics of trips can consist of many different characteristics, and therefore it is desired to structure the characteristics. Geurs and Van Wee (2004) have developed a framework for the concept of accessibility which clusters the characteristics of accessibility into four components. Accessibility to them refers to “the components that provide opportunities for individuals to participate in activities in different locations” (Geurs & Van Wee, 2004). This definition overlaps with the common understanding of transport poverty in the way that both accessibility and transport poverty require an understanding of the characteristics that facilitate or constrain participation in activities, which is what trips facilitate. Therefore, this study has decided to cluster the characteristics of trips according to the four components of accessibility. This choice results in the context of transport poverty consisting of four components as well..

2.2.2 The components of the context

According to the accessibility framework of Geurs and Van Wee (2004), accessibility has four types of components, each containing different trip characteristics: the land-use component, the transportation component, the temporal component, and the individual component. In order to place a trip characteristic in a component, it is necessary to understand what defines the component. Therefore, this section will define the accessibility components.

Land-use component

The land-use component within the accessibility framework established by Geurs and Van Wee refers to the spatial allocation of opportunities, as well as the corresponding demand for these opportunities from the origin locations of individuals (Geurs & Van Wee, 2004). This demand for opportunities is rooted in the concept of mobility as derived demand, whereby the assumption is made that trips are undertaken with the explicit aim of reaching a specific destination where the individual can participate in an activity (Mokhtarian & Salomon, 2001). The perspective that views mobility as derived demand presupposes that every journey serves a trip purpose, frequently tied to the activity intended to be carried out at the destination of the trip. In the context of the Netherlands, the Central Bureau of Statistics (CBS) has defined eight distinct trip purposes based on the range of activities individuals engage in. These designated trip purposes encompass commuting to workplaces, visiting others, engaging in leisure activities, conducting shopping endeavors, pursuing business-related engagements, seeking educational opportunities, embarking on tours, and tending to personal care requirements.

The choice of a destination to fulfill the trip purpose is influenced by the land-use system that is present. According to Geurs and Van Wee (2004), the land-use component, therefore, reflects upon the amount, quality, and spatial distribution of activities. Incorporating the land-use component into the context of transport poverty would necessitate an understanding of the underlying trip purpose and the influence of the land-use system on the characteristics of the trip.

Transportation component

The transportation component refers to “the transport system, expressed as the disutility for an individual to cover the distance between an origin and a destination using a specific mode” (Geurs & Van Wee, 2004). Every individual is constrained in their ability to move due to the spatial and temporal constraints of the lifestyle of the individual and the transport system. A framework that describes the interaction between the spatial and temporal constraints of mobility is the space-time prism of Hägerstrand (1970). The space-time prism framework enables researchers to map out the available opportunities by creating postulated prism-shaped structures that represent the areas from a specific starting point in which an individual can participate in activities given the time budget. The areas often contain multiple potential travel options, which represent different routes per mode of transport that can be evaluated based on their trip characteristics. Knowing the travel options and comparing these options with the actual chosen option makes it possible to understand the choices that people make based on the spatial and temporal constraints that are provided (Liao, 2018).

Incorporating the transportation component into the context of transport poverty would require the spatial and temporal constraints to be translated into characteristics of the trip. According to Geurs and Van Wee (2004), the spatial and temporal constraints can be expressed in the amounts of time and effort that are needed to make the trip.

Temporal component

The temporal component refers to “the availability of activities at different times of the day, and the time available for the individual to participate in certain activities” (Geurs & Van Wee, 2004). As activities often cannot be performed all day long, individuals are bound by time schedules of the activity. These timeslots create the need to reach the destination in time to be able to participate.

Incorporating the temporal component into the context of transport poverty would require an understanding of the temporal constraints of the trip. According to Geurs and Van Wee (2004), it can be necessary to introduce time restrictions as a characteristic of a trip.

Individual component

The Individual component refers to “the needs, abilities, and opportunities of individuals” (Geurs & Van Wee, 2004). These characteristics of an individual influence the individual's ability to access transport services present in the transport system. According to the capability approach, individuals convert their mobility resources and skills into revealed travel behavior with the use of capabilities (Vecchio & Martens, 2021). The framework of the capability approach consists of four notions that enable the classification of different factors that play a role in the utilization of mobility opportunities. The four notions are resources, conversion factors, functioning, and capabilities (Luz & Portugal, 2022).

- Resources refer to the characteristics of the transport system available.
- Conversion factors refer to the skills that determine the possibility of converting mobility resources into capabilities.
- Capabilities refer to the activities that the individual is able to access and participate in through the mobility opportunities that are available.
- Functionings refer to the actual travel behavior and participation in activities.

Incorporating the individual component into the context of transport poverty requires an understanding of the characteristics of the individual making the trip. According to the capability approach, these characteristics can range from socio-demographics and socio-economic characteristics to mobility resources and skills (Luz & Portugal, 2022).

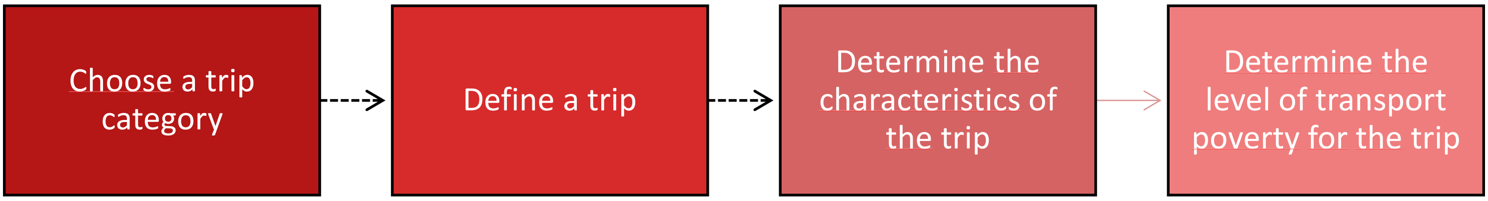
3 Theoretical Framework

This chapter introduces the concept of instance-based transport poverty. The aim of the framework is to explain the relationships between the indicators of transport poverty and the context in which transport poverty exists. First, the components of the concept of instance-based transport poverty will be explained, after which the relationship between the different components is explained. Lastly, the components are applied to this study.

3.1 The Components of Instance-based Transport Poverty

Instance-based transport poverty has been introduced with the aim of determining a level of transport poverty that can be connected to the context in which it exists. In order for this connection to be defined, it is necessary to understand what needs to be measured and how this can be measured. Figure [Insert Figure Number] introduces the four components of instance-based transport poverty and shows the steps that need to be taken to construct a level of instance-based transport poverty. After the introduction of the workflow, the sections in 3.2 will focus on how the different steps in the components of instance-based transport poverty can be measured using this study as an example.

Figure 2: Workflow of the four components of instance-based transport poverty



3.1.1 Choosing a trip category

Before a level of instance-based transport poverty can be measured, the purpose of the measurement needs to be defined. The purpose of measuring instance-based transport poverty in this study is defined as the need to understand the situation in which transport poverty exists. Trips can occur in many different forms, which is why it is desired to place trips into categories when clustering and/or comparing them. Within literature, trip categories often refer to the purpose of the trip (Hook et al., 2023). Examples of categories are commuting, shopping, and leisure. Making use of this categorization would mean that the purpose of measuring instance-based transport poverty is to understand for which trip purposes transport poverty exists. However, it can also be that the purpose of the measurement is to understand for which modes of transport poverty exists. In that case, the category of the trips depends on the mode of transport that is used for the trip, like the car or the bike (Schneider et al., 2020).

Choosing a trip category can, therefore, be done by fixing a characteristic of the trip at the start of the measurement. The choice of the characteristic must make it possible to distinguish between trips, which can be difficult for individuals to do. For example, it is assumed that trip purposes and modes of transport have easy-to-distinguish categories, while travel times or travel distances do not. For this reason, trip purposes and modes of transport are recommended as trip categories, while travel times and travel distances are not.

3.1.2 Define a trip

When the trip category has been chosen, it is necessary to define a trip that falls into that trip category. Individuals make many different trips throughout their life, which makes it hard to pick one. However, the definition of the trip can influence the results, as the way in which the trip is defined influences how the level of transport poverty for the trip can be measured and interpreted. For example, when determining the level of transport poverty for a trip that has happened in the past, it is possible to reflect upon the revealed characteristics of the trip. However, it could be that a researcher desires to determine the level of transport poverty for a trip that has not taken place in real life yet. In this case, a hypothetical trip can be defined.

Compared to the revealed trip characteristics, the characteristics defined in the hypothetical trip are uncertain, as there is no certainty that these characteristics will occur in real life. Therefore, it is recommended to choose the strategy for the definition of the trip that fits the purpose of the research. In this way, the benefits and constraints of the definition can be taken into account when interpreting the results. There are multiple possible strategies that can be applied. Examples are:

- The most recent trip made.
- The most frequent trip made.
- The next trip that will be made.
- A hypothetical trip.

3.1.3 Determining trip characteristics

Next, when a trip has been defined, the characteristics of the trip can be determined to get a complete overview of the context. The characteristics often function as a description of the trip, which makes the characteristics determinable by observing the trip. As explained in 2.2.2, the characteristics of trips can be clustered into four components: the land-use component, the transportation component, the temporal component, and the individual component. To get a good overview of the context, it is desired to define characteristics from all four components. Which characteristics can be defined depends on the data that is available about the trip. The more characteristics are known, the more detailed the context will be. It is, therefore, possible for the quality of the context to vary between trips, as trips cannot always guarantee the same level of detail.

The determination of the trip characteristics needs to be done sophistically, as small differences in the context can have a big impact on the interpretation of the level of transport poverty. The lack of an important characteristic can result in a wrongful determination of a person being transport poor. For example, when the characteristic of congestion is missing in the context, the long travel time can be interpreted as normal, while in real life, the long travel time was an exception. Examples like this give reason to expect that high levels of detail make it easier to distinguish trips.

3.1.4 Determining level of transport poverty

The last step in the construction of instance-based transport poverty levels is the determination of the level of transport poverty for the defined trip. What distinguishes the instance-based transport poverty levels from overall transport poverty levels is the fact that the level of transport poverty within the concept of instance-based transport poverty levels can be applied to a unique context, which allows for an understanding of where, when, and how the level of transport poverty occurred. Crucial in this process is to determine the level of transport poverty with the context in mind, which can be achieved by referring to the characteristics of the context it applies to.

The level of transport poverty for the instance-based transport poverty can be determined with the use of a transport poverty scale. As there is no clear definition of transport poverty, it is possible that multiple different scales can measure transport poverty. However, the requirement for the scale to be applicable for instance-based transport poverty is to produce quantitative data, interval or ordinal, which can be analyzed with statistical analyses. This requirement is needed to test the effects of the characteristics on the level of transport poverty and to determine the cause of the level of transport poverty within the context..

3.2 Interpretating Instance-based Transport Poverty

By bringing together the level of transport poverty with the context in which the level of transport poverty exists, instance-based transport poverty is able to interpret the effects of the characteristics of the context on the level of transport poverty. The effects of the characteristics on the level of transport poverty can be positive or negative. The direction is based on the relation that the characteristic has with the condition(s) of transport poverty that are represented in the transport poverty scale that is applied. The following sections will explain how the context is related to the level of transport poverty through the characteristics of the context and the conditions of transport poverty.

3.2.1 The relation between transport poverty and the context

A level of transport poverty depends on the presence of the conditions of transport poverty in a situation and their effect on the individual's ability to participate in activities (Allen and Farber, 2019). When a level of transport poverty is high, the presence of one or more transport poverty conditions is strong, and it is suggested that the presence of these conditions reduces the individual's ability to travel to important destinations and activities. A low level of transport poverty refers to the opposite situation, which means that the presence of the transport poverty conditions is weak, or even absent if possible. In these situations, individuals have the ability to travel to important destinations and activities.

Where the characteristics do not have a direct effect on participation, they do influence the presence and absence of transport poverty conditions. For example, the trip characteristic travel distance can increase the experience of time poverty when the distance is long, due to its correlation with travel time. On the other hand, the characteristic of car ownership can improve the experience of accessibility, as a car enables the individual to reach a lot of destinations. Every characteristic of the context in this way has their influence on the level of transport

3.2.2 Interpreting the level of instance-based transport poverty

The interpretation of a high and low level of transport poverty, however, is more complex than expected due to the lack of a clear definition. There is no benchmark for transport poverty that can indicate what is a high level of transport poverty and what is a low level of transport poverty. This study has, therefore, decided to reduce the risk of misinterpreting the level of transport poverty by having a strict benchmark for low levels of transport poverty. In this study, a low level of transport poverty can only be confirmed when all transport poverty conditions are absent. A high level of transport poverty, on the other hand, can already be confirmed by the strong presence of one transport poverty condition.

The consequence of this benchmark is that it makes it hard to determine the real effects of the characteristics, as the positive effects can have a bigger impact in this study than negative effects. The presence of one condition would already define the individual as being transport poor, where the effects in real life do not have to be that severe. A solution to this problem could be to use categories of transport poverty, which can all have their own definition. With the use of an ordinal scale, these categories can provide insights into the impact that transport poverty has on the life of the individual. The scale could, for example, refer to the effect of a transport poverty level on the social exclusion that the individual might experience. However, it is not part of this study to define the relationship between transport poverty and social exclusion in detail.

3.3 An example of instance-based transport poverty

To show how the concept of instance-based transport poverty can be measured, the next sections will use this study as an example to explain the decisions that have to be made. The sections follow the same steps as the workflow in figure 2. An overview of the decisions will be given in figure 3, which illustrates the theoretical framework for this study.

3.3.1 Choosing a trip category: trip purpose

To be able to compare the levels of transport poverty, this study has chosen to define and cluster trips based on their trip purpose. The choice for this trip category is inspired by literature on activity-based modelling, which argues that knowing the trip purpose helps in understanding the characteristics from the land-use and temporal components of the context (Dong et al., 2006). Three different trip purposes will be used to cluster and compare levels of transport poverty, which are commuting, shopping, and leisure

3.3.2 Define a trip: Most recent trip

To define trips, this study has chosen to make use of the most recent trips that have been made for every trip purpose. This choice has been made to ensure that the contexts of the trips were randomly generated, which is expected to generate a variety of contexts. A variety of contexts is desired in this study because the aim of the study is to show that instance-based transport poverty can provide valuable insights about the effect of the context on the individual's level of transport poverty, by showing that different contexts cause different levels of transport poverty. Because of the aim, the study focused on the collection of a variety of contexts, which was expected to be achieved with the choice for the definition.

3.3.3 Determining trip characteristics

The trip characteristics of the context in this study have been determined by literature. Only characteristics from which their relation with the conditions of transport poverty had been studied were allowed to be part of the context in this study. This resulted in the inclusion of ten characteristics. The following sections will explain why these ten characteristics have been chosen by showing their relation with the conditions of transport poverty.

Travel Cost

The transport poverty condition of transport affordability looks at the expenditure for transportation in relation to the total budget of the person (Lucas et al., 2016). When the cost to make a trip exceeds the financial budget of the individual, then the individual is considered as transport poor due to the condition of transport affordability. The travel cost of a trip, therefore, has an impact on the transport poverty condition of transport affordability. Travel costs themselves are influenced by the mode of transport and the distance which is traveled with that mode of transport (Rodrigue, 2020). The travel cost can differ per mode of transport due to the different fixed and operating costs that are in place per mode of transport.

By knowing the travel cost of the trip, the context of the instance-based transport poverty level can clarify the level of transport poverty related to transport affordability. Therefore, the characteristic of travel cost is included in the context. Linking this travel cost characteristic to other trip characteristics present within the context can determine why the high travel cost has occurred.

Travel Time

Time poverty refers to the condition in which the travel time used for transportation exceeds the time budget of the individual. When long travel times occur, the individual is considered as transport poor due to the condition of time poverty. The travel time of a trip, therefore, has an impact on the transport poverty condition of time poverty. Travel time, just like travel cost, is determined by the mode of transport and the distance that is covered with that mode of transport. Travel time can, however, be more complex than travel cost due to the different types of travel times that exist within the concept (Viergutz & Krajzewicz, 2019).

By knowing the travel time of the trip, the context of the instance-based transport poverty level can clarify the level of transport poverty related to time poverty. Therefore, the characteristic of travel time is included in the context. Linking the travel time characteristic to other trip characteristics present within the context can determine why the high travel time has occurred.

Travel Distance and Mode Choice

As stated before, the variables travel distance and mode choice influence the spatial and temporal constrains of trips. However, their effects on transport poverty are not direct, as the characteristics function as a mediator for the relations of travel time and travel cost with transport poverty. Still, travel distance and mode choice can provide valuable information regarding the context when analyzing the cause of transport poverty. Therefore, both travel distance and mode choice will be included in the context as characteristics.

Starting Time

Availability refers to the time schedule at which an activity can be performed (Geurs & Van Wee, 2004). Social norms and rules in societies, like opening hours and work schedules, influence the time schedules at which an individual can participate in an activity. The availability of a mobility opportunity at the right time becomes essential to be able to participate in an activity. The starting time of a trip, therefore, has an impact on the transport poverty condition of availability.

By knowing the starting time of the trip, the context of the instance-based transport poverty level can clarify the level of transport poverty related to the lack of availability. Therefore, the characteristic of starting time is included in the context. Linking the starting time to the other trip characteristics present within the context can determine why a certain starting time was necessary.

Trip Purpose
Accessibility refers to “the components that provide opportunities for individuals to participate in activities in different locations” (Geurs & Van Wee, 2004). The spatial distribution of activities, captured within the land-use patterns of an area, require individuals to travel between destinations. An activity is accessible when it is located within the spatial and temporal range of the individual. Reflecting upon a trip that has been made, therefore assumes that the location of the activity is accessible. To understand which activities are accessible, it is beneficial to study the purpose of the trip, as they reflect the activity that has been performed.

By knowing the trip purpose, the context of the instance-based transport poverty level can clarify the level of transport poverty for a certain activity. Therefore, the characteristic of trip purpose is included in the context. Linking the trip purpose to the other trip characteristics present within the context can determine which activities contain a high level of transport poverty and which do not.

Capabilities
The capabilities of an individual refer to the activities that enable the individual to access and participate in through the mobility opportunities that are available (Vecchio & Martens, 2021). Activities refer to travel behaviors like driving, walking, or taking public transport. Capabilities are determined by the utilization of mobility resources, which is influenced by the social demographics of the individual. Therefore, also the characteristics of mobility resources and social demographics should be included in the context.

Social demographics
The social demographics of the individuals contain multiple factors which influence the utilization of mobility resources. For example, the capability of walking can depend on the age of the individual. Moreover, the gender or sexuality of the individual can influence the sense of security when taking public transport. The characteristics age and gender show that the cluster of social demographic characteristics can relate to the transport poverty conditions of physical condition and sense of security. These abilities can be determined by the socio-demographic characteristics of the individual.

By knowing the socio-demographic characteristics of an individual, the context of the instance-based transport poverty level can clarify the level of transport poverty related to an inability to physically move. Therefore, the characteristics of the social demographics are included in the context. Linking the socio-demographic characteristics to other trip characteristics present within the context can determine whether specific groups in society experience specific transport poverty conditions more than other groups.

Mobility resources
Road safety refers to the risk of experiencing road traffic injuries and death (Pan American Health Organization, 2011). Different modes of transport provide different senses of safety on the road. When a trip is unsafe due to a high risk of experiencing road traffic injuries or death, an individual can decide not to participate in an activity (Vecchio & Martens, 2021). The availability of safe mobility resources, therefore, has an impact on the transport poverty condition of road safety.

By knowing the mobility resources, the context of the instance-based transport poverty level can clarify the level of transport poverty related to concerns about road safety. Linking the concern of road safety to other trip attitudes present within the context can determine which characteristics are causing the road safety concern.

Mobility Opportunities
The impact of mobility on the health of an individual refers to the transport externalities that a transport system can cause (Lucas et al., 2016). Transport externalities, like air pollution and noise pollution, can impact the health of individuals that travel through the polluted area. If the impact is very severe, the individual can decide to cancel its participation in the activity. Changing the route could provide a solution, however, this is

not always in favor of the other transport poverty conditions. Therefore, the availability of healthy mobility opportunities has an impact on the transport poverty condition of health impact.

By knowing the transport externalities, the context of the instance-based transport poverty level can clarify the level of transport poverty related to the health impact. Linking the transport externalities to other trip characteristics present within the context can determine which groups in society are most affected by transport poverty due to the presence of transport externalities.

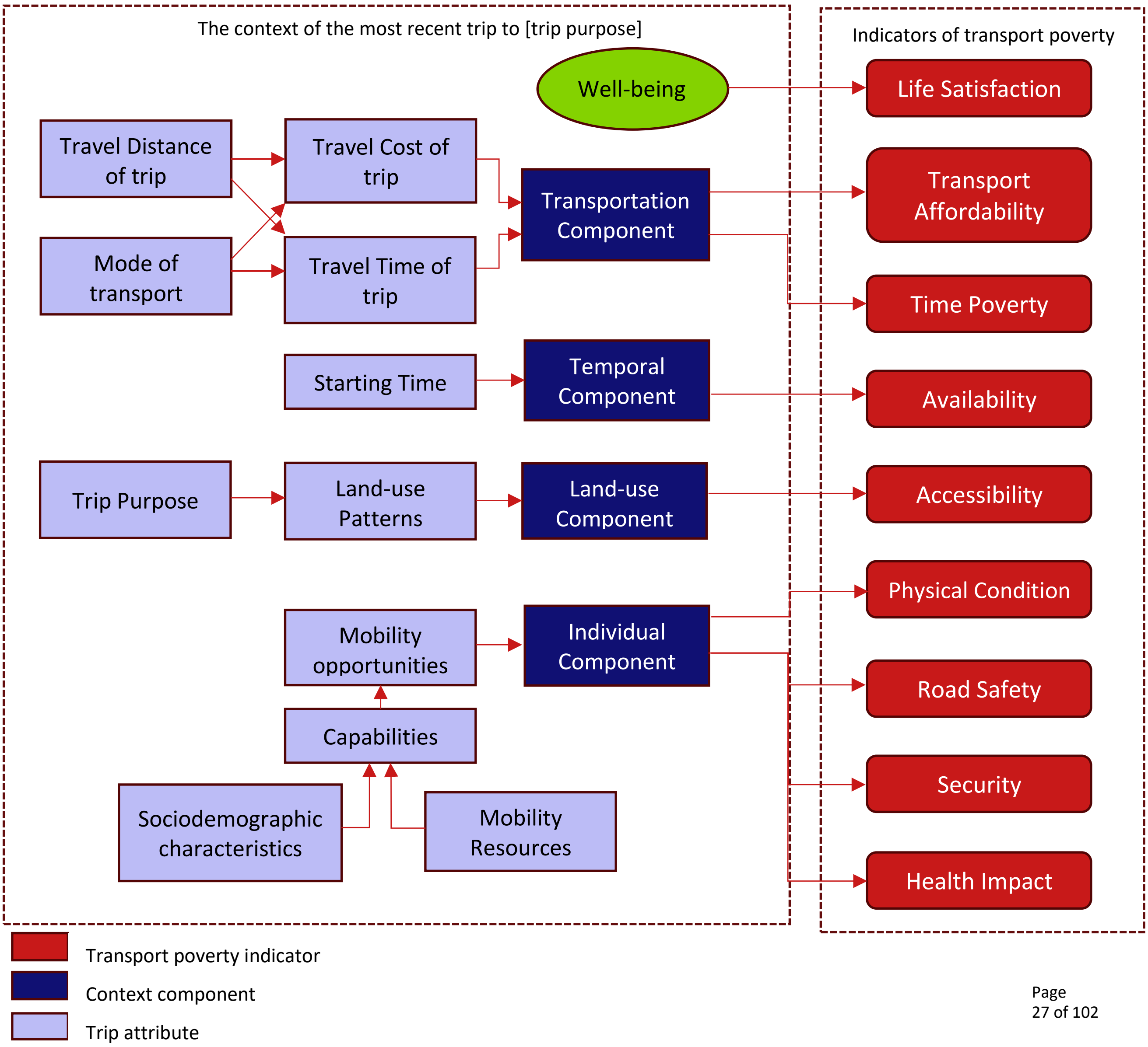
3.3.4 Determining the level of transport poverty

The level of transport poverty in this study is determined by the Transport Adequacy Scale (Ettema et al., 2023). The scale is a derivative of the five transport poverty conditions and includes nine indicators that represent these five conditions. These nine indicators have been explained in 2.1.4. A value for the level of transport poverty consists of the average value over the nine indicators. Every transport poverty indicator consists of a score based on a 5-point Likert scale ranging from "Strongly agree" to "Strongly disagree."

3.3.5 Overview

Figure 3 displays the choices that have been made regarding the concept of instance-based transport poverty in this study. One transport poverty indicator, life satisfaction, has no relation with the context in this study. The life satisfaction indicator shows no direct relation with the conditions of transport poverty, which is why it's hard to assign characteristics to the indicator. This study expects that the answer can be found in the concept of well-being; however, this concept is outside of the scope of this study. The figure summarizes the choices in the theoretical framework for this study.

Figure 3: The theoretical framework of the context of transport poverty as applied in this study



4 Methodology

This chapter explains the methodology of the study. The chapter starts with repeating the objectives of the study and continues with explaining the aim of the methodology. The data analysis methods that follow explain which analyses are used to answer the research questions of this study.

4.1 Research objectives

The aim of the research is to show that instance-based transport poverty can provide valuable insights about the effect of the context on the individual's level of transport poverty, by showing that different contexts cause different levels of transport poverty. To compare different levels of instance-based transport poverty, this study had to create multiple levels of instance-based transport poverty for one individual. The objective was that the instance-based transport poverty levels could be distinguished based on their context.

To accomplish this objective, the study fixed the trip purpose for every instance-based transport poverty level. By ensuring that every instance-based transport poverty level was reflecting upon a different trip purpose, variation in the trip characteristics of the context was inevitable due to the differences in destinations and time of participation. To ensure the differences in the context, the trip purposes of the instance-based transport poverty levels were chosen based on their variation in frequency. The assumption made here was that trips that have been made frequently to the same trip purpose would contain habitual behavior, which causes the trip characteristics to be optimized (Van Acker, Van Wee & Witlox, 2010). Less frequent trips, on the other hand, were expected to contain less optimal trip characteristics due to a lack of experience with the trip purpose.

In the end, three types of trip purposes were chosen. Commuting to work or study activities represented the trip purpose with the highest expected frequency and therefore the most expected habitual behavior. Leisure trips to different types of activities were chosen to represent the less frequent trips. In between the two, the trip purpose of shopping was chosen to represent a frequent trip purpose which can still vary in its destinations. What makes shopping trips interesting is the fact that there is a need to move humans and goods, instead of only humans as is often the case with commuting and leisure trips. This is expected to influence the choice of trip characteristics, which changes the context of the trip.

4.2 Methodology & Data Analysis Methods

To obtain an answer to the research questions, different levels of transport poverty had to be analyzed. While literature could provide the answers to the questions regarding the theoretical framework, not all questions could be answered by literature. Analyzing to what extent variation exists within an individual's level of transport poverty, and how the characteristics of the context explain the variation between the different instance-based transport poverty levels, required a quantitative study. Statistical tests should prove that significant differences exist between an overall level of transport poverty and multiple instance-based transport poverty levels. Proving that this difference is significant provides evidence to believe that including the context in the concept of transport poverty is necessary to understand any level of transport poverty. Moreover, statistical tests are also needed to determine the significance of the relations between the level of instance-based transport poverty and the characteristics of the context. The figures… show the different steps within the methodology that have been taken to conduct the study.

The data analyses will be conducted in Stata/SE 17.0. This software consists of a large variety of pre-programmed statistical tests, including the tests that are needed for this study. Moreover, the software allows modifying data so that it can be applied to the statistical tests.

4.2.1 The Creation of the Transport Poverty Variables

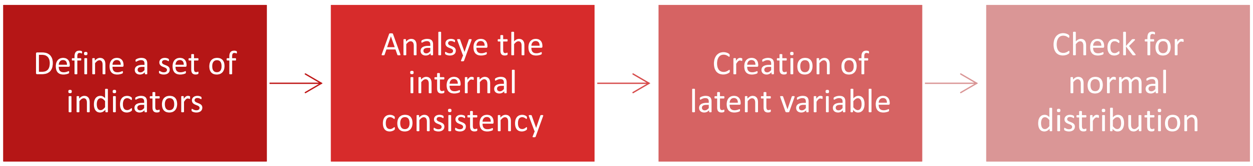
Examining variation in the individual's level of transport poverty required the creation of multiple latent variables, one for overall transport poverty and three for the instance-based transport poverty of transport poverty based on the three trip categories that have been chosen. A latent variable refers to a variable that represents a concept that cannot be observed directly, but rather is a derivative of multiple directly observable variables. The concept of transport poverty is a derivative of the nine transport poverty indicators, making use of the average value over the nine indicators. Every transport poverty indicator consists of a score based on a 5-point Likert scale ranging from "Strongly agree" to "Strongly disagree." As the statistical tests required one value per level of transport poverty instead of 9 individual ones, the nine indicators of transport poverty were combined into latent variables, each dedicated to one of the four transport poverty levels.

Figure 3 describes the workflow for the creation of the latent variables. To test the quality of the latent variables, the internal consistency was tested with the Cronbach's Alpha test. Cronbach's alpha is a hypothetical value index that would be obtained if all potential items constituting a given scale were available and randomly combined into a large number of equally sized tests (Cronbach, 1951). By randomly dividing a scale into two sets of items, the interrelatedness of the items can be measured according to the split-half reliability. The Cronbach's alpha optimized this strategy by calculating the average correlations of all possible split-half tests possible, and summarizes the outcome in the coefficient alpha (Cronbach, 1951).

If the items of the scale are highly interrelated, the alpha coefficient will be high. With a range from 0.00 to 1.00, the internal consistency is acceptable when the alpha coefficient is above 0.70. However, lower values are also accepted when the research is willing to tolerate a larger error rate. The number of items significantly influences the reliability of the scale. When items are highly interrelated and all other things being equal, the alpha coefficient will increase when the number of items increases. However, the purpose of the high alpha coefficient is not for the items to be mere clones of one another. The items should share a common factor which is the indicator of the latent variable. When this is the case, the total set of items will provide a better level of the concept than any single item.

To determine which statistical tests could be used to analyze the presence of variation within an individual's level of transport poverty, the normality of the data needed to be tested. Parametric tests like the t-test and the linear regression are recommended data analysis methods for comparison tests (Bevans, 2020). However, these tests assume that the data of the dependent variable is normally distributed and contains homogeneity of variance. These assumptions can be tested with the skewness and kurtosis test of D'Agostino, Belanger & D'Agostino, 1990). When these assumptions are not met, non-parametric tests should be used.

Figure 4: The workflow for the construction of the latent variables representing the different levels of transport poverty



4.2.2 Signed-rank test

In this study, the Wilcoxon matched-pairs signed-rank test (Wilcoxon, 1945) will be used to determine whether variation within the individual's level of transport poverty exists. With the test, it can be determined whether there is a significant difference between two matched-pairs of observations by looking at the difference in distribution. The null hypothesis of this study is that the distributions of the two variables are the same.

The signed-rank test makes the assumption that both variables have identical distributions, which would result in a median of zero. To prove that two variables are significantly different from each other, the absolute differences between the two variables are ranked. The ranking procedure is structured as follows:

First, the difference between the two variables is calculated for every individual in the dataset. This results in a list with positive and negative values resulted from the following formula:

$$D_j = X_{1j} - X_{2j}$$

Where D_j is the difference for any matched-pair of observations
X_1 is the first set of observations from the matched-pair
X_2 is the second set of observations from the matched-pair
j is the number of the observation (j= 1,2, …, n)

Second, the values of Dj are transformed into absolute values and ranked from 1 to n based on their absolute value. The values with a difference of zero are left out of the ranking, which reduces the value of n compared to the n of the sample size. After the ranking has been completed, the sign of the initial difference is given back to the rank. This means that all initial negative differences are multiplied by -1. This results in signed-rank values according to the following formula:

$$R_j = \text{sign}(D_j)\ \text{rank}(|D_j|)$$

Where R_j is the observed signed rank
D_j is the difference for any matched-pair of observations
j is the number of the observation (j= 1,2, …, n)

Third, to test whether the two matched-pairs of observations have identical distributions, the total sum of positive ranks is assumed to be identical to the total sum of the negative ranks. This would result in a value of zero within the following formula:

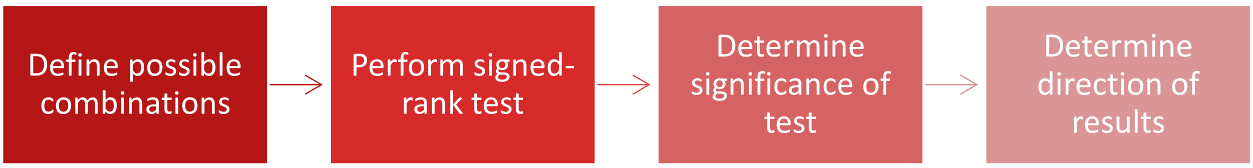
$$T_{obs} = \sum_{j=1}^{n} R_j = (\text{sum of ranks for } + \text{ signs}) - (\text{sum of ranks for } - \text{ signs})$$

Where T_{obs} is the distribution of the difference between the two matched-pair of observation
R_j is the observed signed rank
n is the sample size
j is the number of the observation (j= 1,2, …, n)

The signed-rank test shows a significant difference between two variables when the distribution Tobs shows a value significantly different from zero. The significance can be calculated with the Z-score based on the difference between the observed Tobs and the expected Tobs when the two matched-pair observations were identical.

Data analysis process
The signed-rank test had to be conducted six times in this study, as there are six possible combinations of matched-pair observations possible between the four transport poverty variables. Figure 4 shows how the tests have been divided into two sets of matched-pairs. The first set is based on calculating the differences between the overall transport poverty level and the different instance-based transport poverty levels, while the second set is based on the differences between the instance-based transport poverty levels themselves.

Figure 5: The workflow for Wilcoxon signed-rank test between the different levels of transport poverty



4.2.3 Ordinal Logistic Regression
The ordinal logistic regression is used in this study to estimate the relations between the level of transport poverty and the characteristics of the context. The transport poverty variables in this study represent an average of nine indicators that consist of a 5-point Likert scale score. Likert scores should be interpreted as ordered categorical scales according to the literature, as they have an even rank but often do not have an even distribution (Wu & Leung, 2017). This allows the variables of transport poverty to be interpreted as ordinal variables as well. However, translating the unique values of the scale into unique categories could result in a high number of categories. Therefore, the values will be aggregated into 5 categories, similar to the

5-point Likert scale. For category 1, all values equal to or larger than 1 and the values smaller than 1.5 were labelled as 1. For category 2, all values equal to or larger than 1.5 and smaller than 2.5 were labelled as category 2. This clustering process continued for five categories until all transport poverty values have been placed in a category.

With an ordinal dependent variable, the ordinal logistic regression is capable of estimating the potential relations between the trip characteristics and the levels of transport poverty. The ordinal logistic regression is a variation of the multinomial logistic regression model in which the order of the categories is taken into account (Cameron & Trivedi, 2005). The order of the categories can be defined within the regression by unique intercepts for every category. The output of an ordinal logistic model is the logarithmic output for the probability of falling in or below a certain category of the scale (UCLA, 2021). The lowest category is used as the baseline, as the baseline requires no lower categories. The logarithmic output can be calculated with the following formula:

$$logit\left(P(Y \leq j)\right) = \beta_{j0} + \beta_{j1} * x_1 + \cdots + \beta_{jp} * x_p$$

Where $logit\left(P(Y \leq j)\right)$ is the logarithmic output of the ordinal logistic regression
$P(Y \leq j)$ is the cumulative probability of Y being less than or equal to a specific category of j
Y is the predicted placement in a category of transport poverty
β_{j0} is the intercept depending on the category of the scale
β_{j1} is the odd ratio for category j in independent variable 1
X_1 is the value of independent variable 1.
j is the number of the category (j= 1, 2, …, n)

Calculating the cumulative probability for any combination of independent variables can be done with the following formula:

$$P(Y \leq j) = \frac{\exp\left(logit\left(P(Y \leq j)\right)\right)}{\left(1 + \exp\left(logit\left(P(Y \leq j)\right)\right)\right)}$$

Where $P(Y \leq j)$ is the cumulative probability of Y being less than or equal to a specific category of j
Y is the predicted placement in a category of transport poverty
j is the number of the category (j= 1, 2, …, n)

Different linear functions can be made per category. An assumption made in ordinal logistic regressions is that although the intercepts differ between the categories, the slopes of the regressions stay constant across the categories. This would result in linear lines when the values of the different categories are plotted. To check this, the parallel line test can be conducted. If the regressions for different categories are not parallel to each other, this means that the slopes are not constant. It is then required to revise the categories of the dependent variable before continuing with the ordinal logistic regression model.

Bivariate analyses

The logarithmic output of the regression model depends on the independent variables that are included in the model. It is therefore desirable that the independent variables have a correlation with the dependent variable. To determine the independent variables that will be added to the regression models, bivariate analyses are conducted between the four levels of transport poverty and all possible independent variables derived from the socio-demographic characteristics and mobility resources.

Wilcoxon rank-sum test

When an independent variable has only two categories, the Wilcoxon rank-sum test has been conducted. The Wilcoxon rank-sum test, also known as the Mann-Whitney U test, is a non-parametric statistical test used to determine whether there are statistically significant differences between two independent groups or conditions (Wilcoxon, 1945). It is used when the assumptions of normality and homogeneity of variances required for parametric tests like the t-test are not met.

The formula for the Wilcoxon rank-sum test statistic is as follows:

$$U = R_{min} - \frac{n * (n+1)}{2}$$

Where U is the difference between the observed ranksum and the expected ranksum
R_{min} is the lowest Ranksum value of the two groups of observations.
n is the number of observations

The standard deviation of the results is needed to determine the z-value of the test. The standard deviation can be calculated as follows:

$$\sigma = \frac{1}{n-1} \sum_{i=1}^{n} (r_i - r)^2$$

Where σ is the standard deviation of the Wilcoxon ranksum test
r_i-r is difference between the rank sums of the two groups of observations
n is the number of observations

The z-score can be calculated with the following formula:

$$Z = \frac{U}{\sigma}$$

With the z-score, the probability of the test can be determined. When the Wilcoxon rank-sum test can be rejected, it can be concluded that there is a significant difference in the levels of transport poverty over the two categories of the independent variable. The significant independent variables will be added to the ordinal logistic regression to determine whether the effect of the categories on the level of transport poverty can be estimated.

Kruskal –Wallis test

For categorical independent variables with more than 2 categories, the Kruskal-Wallis test was conducted to determine whether the medians of the transport poverty levels are the same over the different categories of the independent variable (Kruskal & Wallis, 1952). The Kruskal-Wallis test is a non-parametric statistical test used to determine whether there are statistically significant differences between three or more independent groups or conditions. It is an extension of the Mann-Whitney U test (Wilcoxon rank-sum test) for more than two groups.

$$H = \frac{1}{S^2} \left\{ \sum_{j=1}^{m} \frac{R_j^2}{n_j} - \frac{n(n+1)^2}{4} \right\}$$

Where H is the result of the Kruskal –Wallis one-way analysis-of-variance test
S^2 is the standard deviation
R_j is the sum of the ranks for the jth sample
n is the number of observations

The standard deviation is calculated with the following formula:

$$S^2 = \frac{1}{n-1} \left\{ \sum_{\text{all ranks}} R(X_{ji})^2 - \frac{n(n+1)^2}{4} \right\}$$

Where S^2 is the standard deviation
$R(X_{ji})^2$ is the squared rank for the ith observation in the jth sample
n is the number of observations

With these variables, the chi-squared values can be calculated to determine the probability of the results. When the Kruskal-Wallis test is rejected, it can be concluded that there are significant differences between the different categories of the independent variable. The significant independent variables will be added to the ordinal logistic regression to determine whether the effect of the categories on the level of transport poverty can be estimated.

Pairwise correlations
For interval variables, the pairwise correlations test was used to determine if the levels of transport poverty were correlated with the interval independent variables. When the pairwise correlations were significant, it could be concluded that the independent variable affects the level of transport poverty.

The bivariate analyses were only conducted for the independent variables coming from the individual component of the context, to verify the correlations in this sample with the general knowledge on transport poverty in the literature. Many different independent variables can be derived from the individual component of the context, as there are many different resources, conversion skills, and capabilities that can relate to transport poverty (Vecchio & Martens, 2021; Luz & Portugal, 2022). The independent variables coming from the land-use, transportation, and temporal component, on the other hand, are more straightforward as there are no alternative independent variables that can represent the components of the context.

Effect sizes
Important for ordinal logistic regressions is that there is no multicollinearity present among the independent variables of the model. Therefore, the correlations between the independent variables have been tested with the same tests as the bivariate analyses between the dependent and independent variables. Because the independent variables have different scales, categorical, ordinal, and interval, multiple types of effect sizes were used to determine the correlations between the independent variables.

For the effect size between two categorical variables, a chi-squared test was used to determine the significance of the correlation, while Cramer's V was used to determine the size of the correlation. The chi-squared value was calculated with the following formula (Pearson 1900):

$$X^2 = \sum_i \sum_j \frac{(n_{ij} - m_{ij})^2}{m_{ij}}$$

Where X^2 is the Pearson chi-squares statistics
$\sum_i \sum_j$ is the overall sum of the row and column margins
n_{ij} is the number of observations in row I and column j
m_{ij} is the results of $(n_{i.} - n_{.j})/n$
$n_{i.}$ is the row marginal of row i
$n_{.j}$ is the column marginal of column j
n is the sample size

Cramer's V was measured with the following formula (Cramer, 1946):

$$V = \left\{(X^2/n)/\min(I-1, J-1)\right\}^{1/2}$$

Where V is the Cramer's V effect size
X^2 is the Pearson chi-squares statistics
n is the sample size
(I-1,J-1) is the degree of freedom

The effect size between an interval and a categorical variable was calculated with Spearman's rho (Spearman, 1904). The significance was determined by the results of the Wilcoxon rank-sum test. Spearman's rho was measured with the following formula:

$$\rho = 1 - \frac{6\Sigma\, d_i^2}{n(n^2-1)}$$

Where p is the Spearman's rank correlation coefficient (rho)

d_i is the difference between two ranks of each observation
n is the number of observations

The effect size of two interval variables was calculated with the pairwise correlation test. The effect size was calculated with the correlation coefficient of Pearson, which consists of the following formula:

$$\widehat{\rho} = \frac{\sum_{i=1}^{n} w_i(x_i - \overline{x})(y_i - \overline{y})}{\sqrt{\sum_{i=1}^{n} w_i(x_i - \overline{x})^2} \sqrt{\sum_{i=1}^{n} w_i(y_i - \overline{y})^2}}$$

Where p is the correlation coefficient
n is the number of observations
w_i is the weight, which is w=1 when not specified
x_i is the observed value of x
y_i is the observed value of y
x is the mean value of x
y is the mean value of y

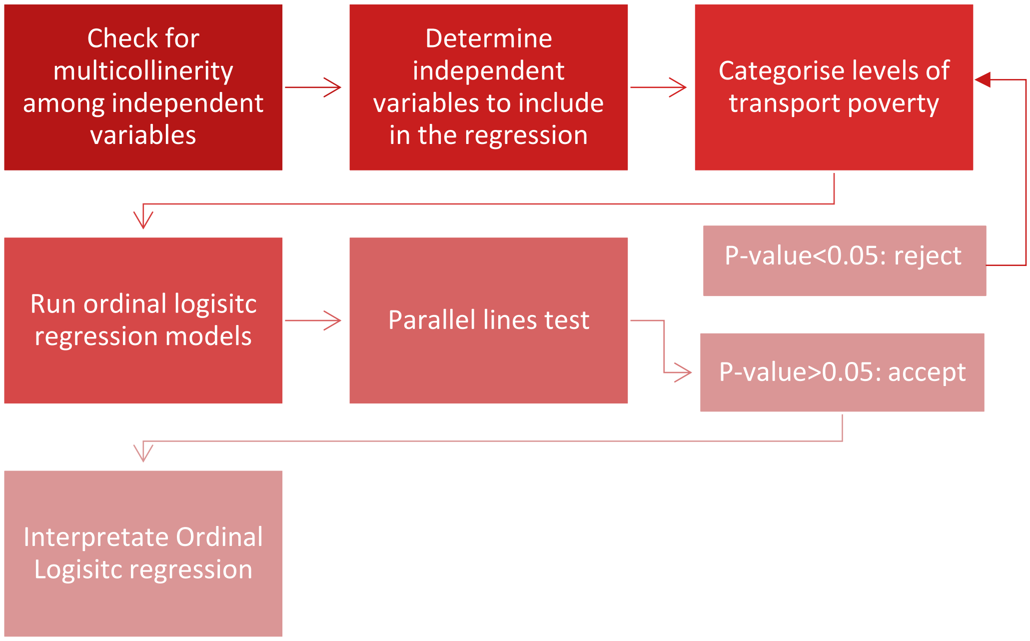
Data analysis process

To run the ordinal regression models, the study needs to follow multiple steps in a certain order, as shown in figure 6. First, among all the possible independent variables, it is necessary to check for multicollinearity. When a high correlation exists between two independent variables, one of the two variables needs to be excluded from the models. The second step is to determine which independent variables could be added to the model. Only promising variables that show a significant relation with the level of transport poverty will be added to avoid overfitting. Next, the categories of the transport poverty variable need to be determined. These categories need to meet the assumption of parallel lines to interpret the ordinal logistic regression model. Therefore, a parallel lines test is conducted after the regression has been modeled to check this assumption. When the p-value is significant, the assumption is not met, and the categories of the transport poverty variable should be adjusted. When the p-value is not significant, the parallel lines test shows that there is no difference in between the slopes of the different categories. When this is the case, the results of the regression can be interpreted.

Two sets of ordinal logistic regressions were conducted. The first set of regressions focused on the comparison of the characteristics of the overall transport poverty model with the three instance-based transport poverty models. As the overall transport poverty levels are not connected to the transportation or temporal component of the context, only the individual and land-use component of the context can be taken into account. To determine the effect of the context on the understanding of transport poverty levels, a second set of regression models has been conducted in which all components of the context are included as independent variables. However, in this set of regressions, only the instance-based transport poverty levels can be modeled, as the overall transport poverty levels do not contain any knowledge about the land-use, transportation, or temporal component of the context.

By comparing the performances of the three instance-based transport poverty models of the second set with the models of the first set, the effect of the context can be determined. When the performance of the models of the second set improves compared to the performance of the first set, it can be assumed that the coefficients of the better-performing models are more accurate than the parameters of the models that do not include all components of the context.

Figure 6: The workflow for ordinal logistic regression models with characteristics of the context



5 Research Design

This chapter describes the research design of the study. The chapter starts with a description of the data collection approach. After this, the different sections of the survey are described to show how the different characteristics of the context and the levels of transport poverty have been operationalized in this study.

5.1 Data collection

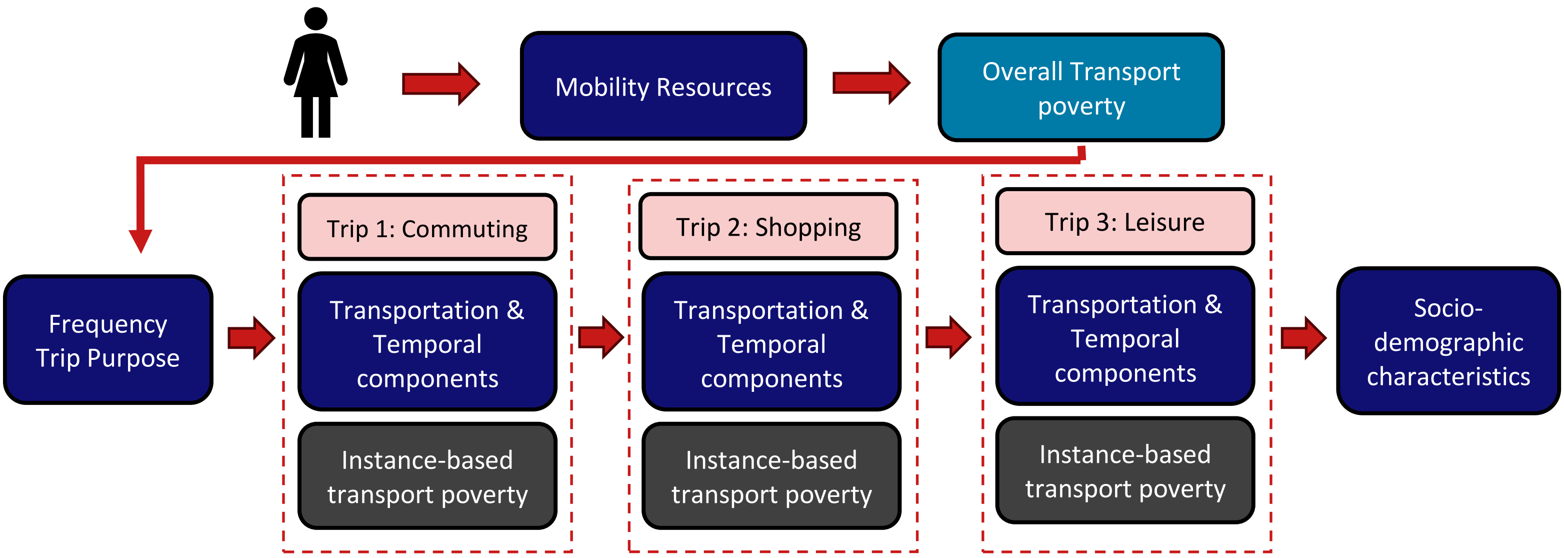
To reach the aim of this research, a quantitative approach was deemed the most suitable research strategy. A nonexperimental study with a cross-sectional survey has been employed in this study, which enables gathering data from a population at one specific point in time. Correlations between variables can be examined; however, causality in relations cannot be demonstrated (Baarda et al., 2012).

The survey has been distributed among people residing in the Netherlands from the 24th of May to the 16th of June. To increase the response rate, the web-based survey was shared within various networks of the student via different channels. A link to the online survey was distributed among different networks of the student via different social media channels like LinkedIn, Facebook, and Instagram. Additionally, to improve the variation in socio-demographic characteristics of the participants, the student distributed postcards with QR codes to the survey. These postcards were spread in both regions of Rotterdam and Eindhoven. The aim was to collect responses from all regions in the Netherlands, with an emphasis on a good representation of both urban and rural areas. In total, 500 participants filled in the survey, of which 280 successfully completed it. Unfinished surveys could unfortunately not be used as the data would not be able to guarantee the connection between the level of transport poverty and the components of the context.

5.2 Design of the Survey

For this study, an online survey with 72 questions has been developed. The questions of the survey were divided into seven sections based on the topic of the questions, as shown by figure 7. The topics concerned the collection of data regarding the different components of the context and the four levels of transport poverty. The sections were structured in an order that ensures the connection of the context to the level of instance-based transport poverty. The structure was based on the assumption that characteristics coming from the individual component would stay the same, whereas the characteristics coming from the land-use, transportation, and temporal component of the context are assumed to change per instance-based transport poverty level. Therefore, the characteristics regarding the individual component of the context were only asked once, while the characteristics of the land-use, transportation, and temporal components were defined per level of instance-based transport poverty. The complete questionnaire in English can be found in Appendix D.

Figure 7: The set-up of the survey



5.3 The Sections of the Survey

5.3.1 Mobility resources

The first section of the survey represents the mobility resources as independent variables representing the individual components of the context. The survey has included the most important resources and conversion factors according to the literature on the capability approach (Vecchio & Martens, 2021; Luz & Portugal, 2022). The resources adopted in the study are access to a car, access to modes of transport, presence of public transport within the residential area, and presence of shared mobility concepts within the residential area. The conversion factors included in the survey are driver's license, public transport payment method, and mobility aid.

The answers to the questions were pre-defined, requiring participants to select an answer from one or multiple pre-defined categories. All of the categories are self-explanatory and based on the most common answers to the question. The options representing modes of transportation draw inspiration from the conventional commuting categories outlined by CBS (CBS, 2023). Nearly all questions include an 'Other' option, allowing participants to indicate a different answer if none of the pre-defined categories apply to their situation. This approach ensures that all participants are able to provide an accurate response. An overview of the variables and their categories can be found in Appendix A.

5.3.2 Overall transport poverty

The second section of the survey represents the questions regarding overall transport poverty. The questions are formulated based on the transport poverty conditions outlined by Lucas and colleagues (2016), while adopting the scale from the transport adequacy scale developed by Ettema et al. (2023). In this particular study, the indicators from table 1 have been tailored to suit the target audience.

Notably, the main distinction between the statements used in this study and the statements of Ettema was the inclusion of one additional condition aimed at specifying the requirements for experiencing transport poverty. The revised statement was formulated as follows: "I face limitations in attending various activities due to transportation problems." This reframing of the original statement, "I am able to live my life as I want to," placed a greater emphasis on the detrimental effects of transport poverty by measuring the extent of its impact rather than assessing transport adequacy. The objective of this reframing was to incorporate the influence of a lack of opportunities on the participants' quality of life, thereby providing a more precise portrayal of transport poverty. In the results section, the accuracy of the scale will be discussed further.

Ultimately, the transport poverty scale consists of nine statements. The participants were asked to indicate how much they (dis)agreed with the statement on a 5-point Likert scale, ranging from ‘strongly agree’ to ‘strongly disagree’. The following statements were used:

- I need to spend more money on my transportation than I can afford
- I spend much more time travelling than I’d like
- There is a suitable travel option available when I want to travel
- I can easily reach my destinations
- I feel safe when travelling
- I worry about my road safety when I travel
- I can travel without experiencing negative health consequences
- I can travel in a way that is suited to my physical condition & abilities
- I am limited in the number of activities I can attend due to problems with my transportation

The level of overall transport poverty is based on the average presence of the nine transport poverty indicators. For every indicator, participants had to agree or disagree with the presence of transport poverty indicators at the reference points. This resulted in nine scores that could be averaged to get one score for the level of transport poverty.

5.3.3 Frequency of trip purpose

Throughout the survey, participants are asked to reflect upon trips that have been made in the past. To make sure only relevant questions were displayed to the participants, three questions about the frequency of activity participation have been added. These questions ask how often the participant travels to a certain activity. Trips could be added up when they fall into the same trip purpose category. As the three main trip purposes discussed in this study are commuting, shopping, and leisure, the same three activities are used for the questions related to the activity patterns. The questions are stated as follows:

- How often do you travel to work or study?
- How often do you go shopping outside of your home?
- How often do you travel to your sport, hobby or social contacts?

The questions contain multiple pre-defined answer options, ranging from ‘Every day’ to ‘Never’. The goal of these questions is to target participants with the right questions. For example, when a participant never commutes, there is no purpose for them in recalling their last commuting trip. The same counts for shopping and leisure trips. When those activities are not part of the participants’ activity patterns, then those questions are not relevant. Conditions have been added to the survey to avoid showing irrelevant questions to participants. When a participant states that they ‘Never’ travel to a certain activity, then the questions related to that activity will not be shown.

5.3.4 Instance-based transport poverty

The next section is dedicated to the estimation of the three instance-based transport poverty levels. In this section, participants were asked to recall a maximum of recent trips, all of which fell into one of the three trip purpose categories: commuting, shopping, and leisure. The participants were informed about the trip purpose by an explanation at the start of the section. Moreover, to help participants remain focused on their most recent trip, the activity was highlighted in the questions and transport poverty statements. The context of every trip was represented by the characteristics of the four components, from which the transportation and temporal components were questioned specifically for every trip. The questions regarding the context were followed by an estimation of the level of instance-based transport poverty with the transport adequacy scale (Ettema et al., 2023).

Transportation and temporal components of the context

Every recollection started with five questions that described the characteristics of the transportation and temporal components of the context for the most recent trip with the pre-defined trip purpose. The questions were based on the characteristics as defined in the theoretical framework in chapter 3. Travel cost has been left out, as literature shows that people systematically underestimate the actual travel cost of a mode of transport (Gössling et al., 2022). It is more beneficial to ask participants to state their perception upon the travel costs in terms of it being cheap or being expensive. This is done by the transport poverty indicator of transport affordability itself, which undermines the reason for adopting travel cost as a question in the characteristics. The questions were stated as follows:

- What was the distance of your most recent X trip?
- What was the starting time of your most recent X trip?
- What was the travel time of your most recent X trip?
- Which mode of transport did you use during your most recent X trip?

Level of instance-based transport poverty

After the context-related questions, the participants were asked to immediately determine the level of instance-based transport poverty for the trip they just described. Similar to overall transport poverty, the level of instance-based transport poverty was assessed with nine statements. However, this time the statements were framed towards the recollected trip and its trip purpose. This resulted in additional conditions added to the statements, stating that the participant had to evaluate the statement ‘for that trip specifically’. In this way, the participants evaluate the statements in the context of the trip, which makes the level of transport poverty instance-based and dedicated to one trip only. Again, the participants were asked to indicate how much they (dis)agreed with the statement on a 5-point Likert scale, ranging from ‘strongly agree’ to ‘strongly disagree’. The following statements were used:

- I needed to spend more money on the transport of my most recent X trip than i could afford
- The travel time of my most recent commuting trip I was longer than i liked There is a suitable travel option available for my most recent X trip
- There was a suitable travel option available for me for my most recent commuting trip
- I can easily reach the destination of my most recent X trip
- I felt safe when to my most recent X trip
- I worried about my road safety during my most recent X trip
- I could travel without experiencing negative health consequences during my most recent X trip
- My physical condition was suited for making my most recent X trip
- My most recent X trip caused problems which made me limit the number of activities i could attend

5.3.5 Social-demographic characteristics

The social-demographic characteristics have been added to this survey as part of the individual component of the context. The variables adopted in this study are gender, age, education level, ethnicity, employment, individual monthly net income, size of the household, and zip code. Most of them contained pre-defined answer options, which can be found in appendix A. Many categories are self-explanatory, such as gender and age; however, other categories make use of standardized categories. In the Netherlands, the Central Bureau of Statistics (CBS) is responsible for the benchmarking of statistical categories. Therefore, the standardized categories of income (CBS, 2023b), education (CBS, 2019), and employment (CBS, 2021) make use of CBS’s literature.

5.4 Data preparation

5.4.1 Privacy

The survey contained multiple questions that could be labelled as privacy-sensitive information. Participants, therefore, had to agree with the informed consent before they could start with the survey. In this informed consent, participants were informed about the purpose of the study, their rights as participants, and the types of sensitive data that would be collected within the survey. All data has been anonymized according to the rules stated in the informed consent, so that participants cannot be traced according to their personal data. Moreover, participants could answer a question with “I don’t know” or “I don’t want to share this information” when they did not want to specify their personal data. The ethical review board of the Technical University of Eindhoven has approved the survey on May 24, 2023.

5.4.2 Data cleaning

Before the analysis could start, the raw data needed cleaning. 500 participants filled in the survey, of which 280 successfully completed it. The study consisted of two requirements: the residential place and the age gap. All participants who were younger than 18 years old, older than 85 years old, or participants who did not want to share their age were eliminated from the dataset. Moreover, the people who did not fill in their zip code were removed as well, as residential placement in the Netherlands needed to be verified. Errors, missing values, and outliers were also identified and removed when necessary. Two participants were deleted because they filled in a household number of 42 and 2661. Also, to reduce the number of missing values in the dataset, the participants with missing values for employment were removed. This resulted in a total dataset of 260 participants.

6 Descriptive Analyses

This chapter describes the results of the survey, with a focus on identifying the characteristics of the participants. The chapter starts with a descriptive analysis of the results of the independent variables, followed by the discussion of the results of the dependent variables.

6.1 Social-Demographic Characteristics

This section provides an overview of the socio-demographic characteristics associated with the obtained sample (N=260). The distribution of these characteristics will be described and compared to the national standards of the Netherlands. An overview of the results can be found in Appendix B.

6.1.1 Age distribution

The first socio-demographic variable was age, which showed a distribution ranging from 18 to 85 years old. The mean category of the age variable is 36-45 years old, with the median falling into the category of 46-55 years old. The smallest group was the age group of 76-85 years old, representing only 1% of the sample. It's worth mentioning the lacking representation of the 36-45 age group (9%) compared to the other age groups. The cause could be attributed to the distribution strategy of the survey. According to the national age distribution in the Netherlands, it is normal to have a decrease in frequency for the age group of 36-45 (CBS, 2022), but the data from this sample differs substantially.

For the data analysis, the age categories have been clustered into three groups: 35-, 36-65, and above 65+. These clusters have been made based on the assumption that individuals are affected by their stage of life, which is often related to their age. Moreover, these age clusters have a high probability of representing different generations. The distribution of the age clusters is shown in figure 8.

6.1.2 Gender distribution

The gender distribution for the sample is 61% female and 39% male. The question also included an option for "Non-binary," however, no participant identified themselves as such. Compared to the national gender division, which is 49% male and 51% female (CBS, 2022), this sample has an overrepresentation of females, with male participants being underrepresented. Still, both groups contain a sufficient number of participants.

Figure 8: Distribution of the age categories in the sample

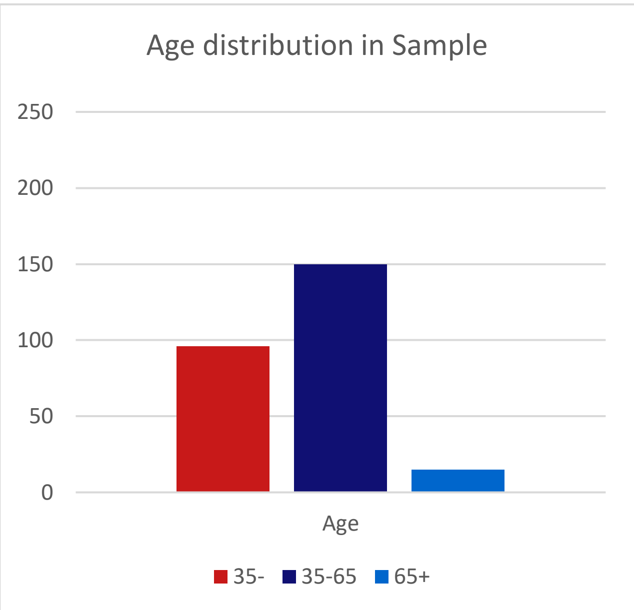
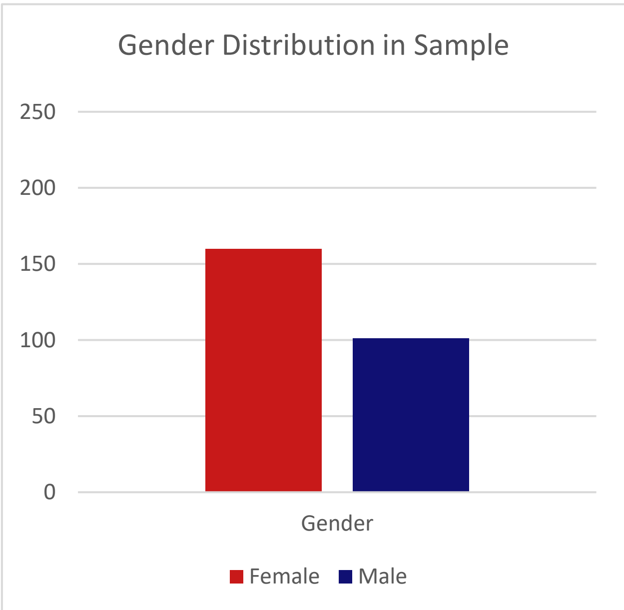


Figure 9: Distribution of the gender categories in the sample



6.1.3 Ethnicity distribution

Out of the eight pre-defined ethnicity categories, 95% of the participants stated that they had a western ethnicity. The Netherlands, however, has a large variation in the ethnicity of its inhabitants, especially with Arabic and Netherlands Antilles ethnicities (CBS, 2016). This sample does not reflect the presence of these ethnicities, so no statements can be made regarding ethnicity in this study.

6.1.4 Education distribution

The answers of the participants represent all five categories of education. The participants who didn't want to share their education level were added to the national average, HAVO/VWO – MBO2/4 category. HBO/WO Bachelor has the highest representation (30%); however, there is no big difference with HAVO/VWO – MBO2/4, which represents 29% of the sample. Compared to the national average (CBS, 2019), the sample overrepresents the high education categories HBO/WO bachelor and WO Master – PhD. Fortunately, the low and middle education categories also consist of a sufficient number of participants.

For the data analysis, the education categories have been clustered into three groups: primary education, secondary education, and tertiary education. These clusters have been created based on the Dutch educational system (CBS, 2019). The distribution of the education clusters is shown in figure 11.

Figure 10: Distribution of the ethnicity categories in the sample

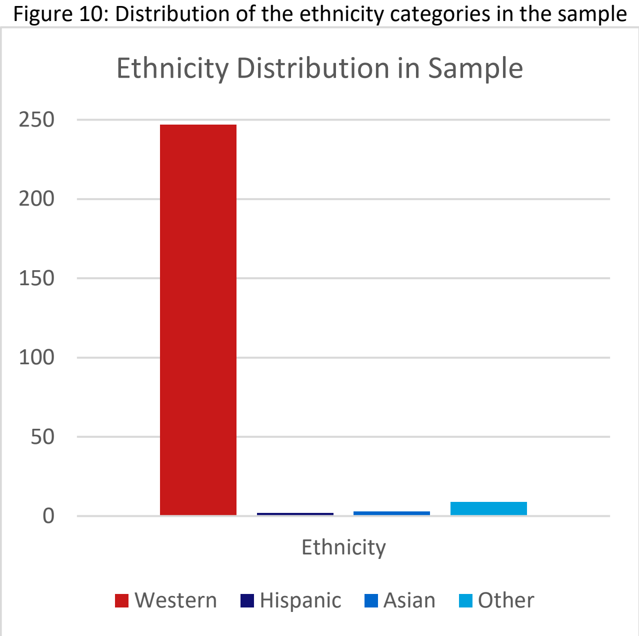
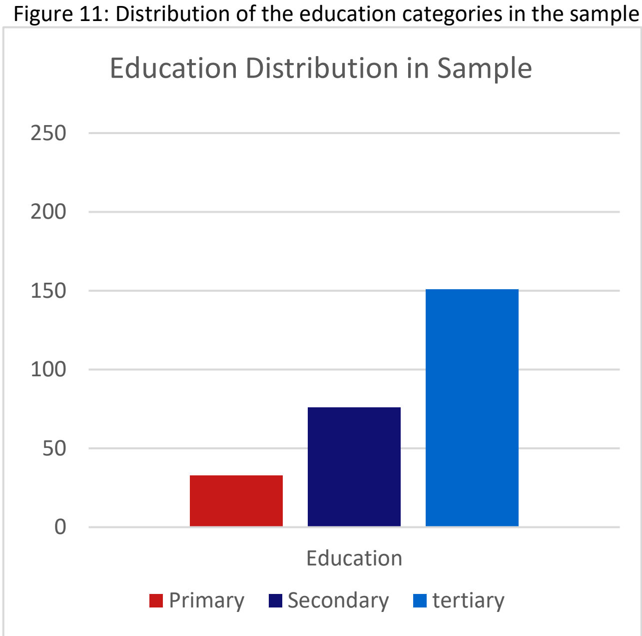


Figure 11: Distribution of the education categories in the sample



6.1.5 Income distribution

Income consisted of 8 categories, which were based on the income classification used by the CBS (CBS, 2023b). The most frequent income group is 1660-2500, which is in line with the national median income. The other categories also show similarities with the national average, meaning that the sample is a good representation. The variable shows 36 missing cases, 32 of which participants didn't want to share their income, and 4 participants who did not know their income.

For the data analysis, the income categories have been clustered into four groups: low income, middle income, high income, and no indication. These clusters have been created based on the benchmarks of the CBS for low, middle, and high income (CBS, 2023b), and the missing values under the name ‘no interest’. The distribution of the income clusters is shown in figure 12.

6.1.6 Employment distribution

The employment status "Fulltime job" was the most frequently answered category (44%). When adding up the percentages of the other categories that refer to a job (part-time and self-employed), 86% of the participants indicated that they are working. In 2023, 3.6% of the Dutch citizens were unemployed, when considering the working ages (CBS, 2023). The sample also shows a low representation of unemployment; however, in this case, the participants with special status are also added to the 'not working' group. For the data analysis, the employment categories have been clustered into two groups: working and not working. These clusters have been created based on the social status that is given to the type of employment. The distribution of the employment clusters is showed in figure 13.

Figure 12: Distribution of the income categories in the sample

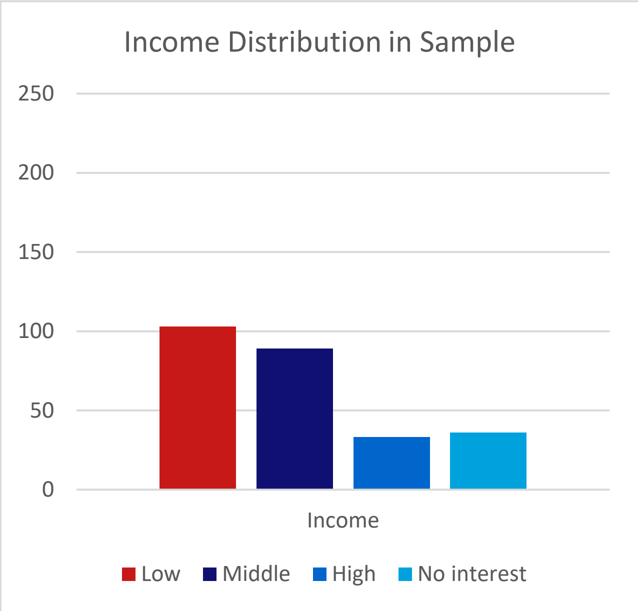
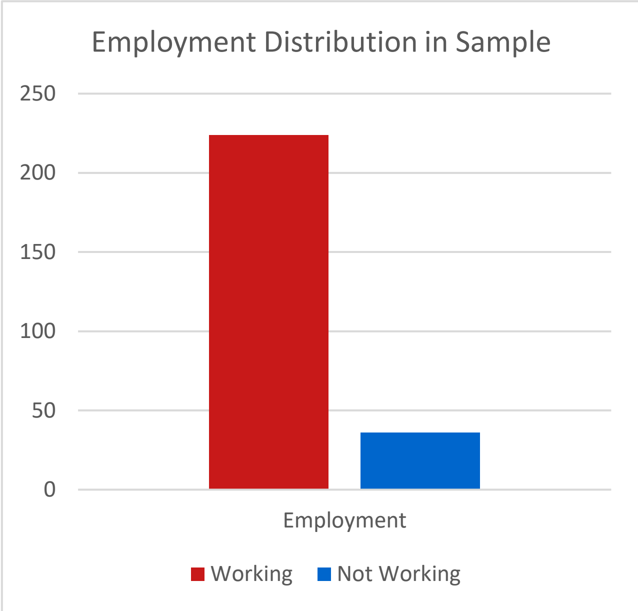


Figure 13: Distribution of the employment categories in the sample



6.1.7 Household distribution

The sample shows a mean household size of 2.9. This is slightly above the national average, which is 2.13 (CBS, 2022b). Looking at the single households, the sample shows a representation of 8%, whereas the national average is 18%. The national average for 2-person households is 50%, meaning also here the sample has an underrepresentation of that group.

6.1.8 Urban Density distribution

The sample shows that the participants come from 129 unique zip codes throughout the country. The aim of the zip code variable, however, is not the exact living location of the participant, but rather the understanding of the urban density of the residential area. The CBS has developed a categorical scale for urban density, ranging from very high urban density (1) to no urban density (5) (CBS, 2023c).

For the data analysis, every participant has been given a value from the urban density scale of the CBS, based on the zip code provided in the survey. The distribution of the urban density is shown in figure 15.

Figure 14: Distribution of the household categories in the sample

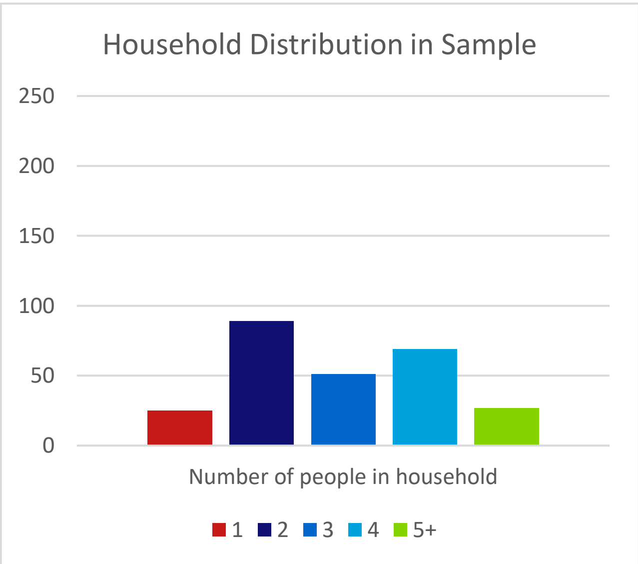
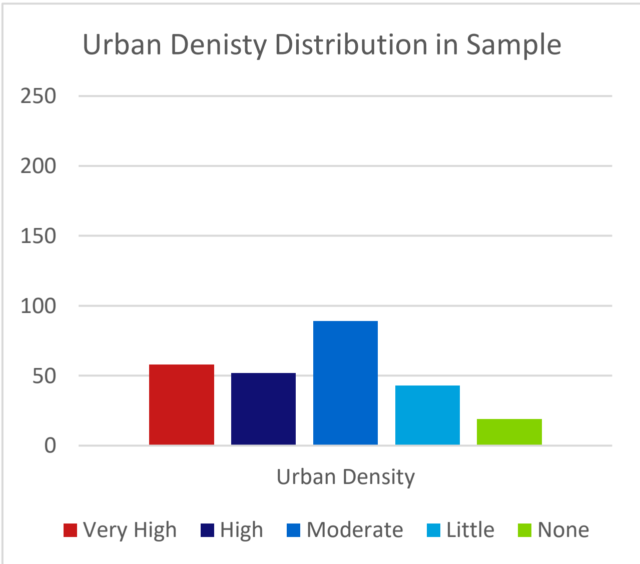


Figure 15: Distribution of the urban density categories in the sample



6.2 Mobility Resources

This section provides an overview of the mobility resources associated with the obtained sample (N=260). The distribution of these characteristics will be described and compared to the national standards of the Netherlands. An overview of the results can be found in Appendix B.

6.2.1 Driver's license distribution

95% of the participants stated to have a driver's license. The average of the Netherlands states that 80% of the citizens between the 18 and 85 years old has a driver's licenses (CBS, 2019b). This shows that the group with a driver's license is overrepresented in this sample. However, the observation is still in line with the fact that the big majority possesses a driver's license.

6.2.2 Car access distribution

When looking at access to cars, the sample shows that 73% of the participants have direct access to a car (Private + Lease), and 24% have indirect access to a car (Shared + Family/Friends + Household + Other). This leaves 3% with no access to a car. These numbers are in line with the national average, which states that 74% of households in the Netherlands consist of 1 or more cars (Witte et al, 2022).

For the data analysis, the car access answers have been clustered into three categories: Private car, Borrowed car, and No car. These categories are based on the difficulty of having access to a car. The distribution of car access is shown in Figure 17.

Figure 16: Distribution of the drivers license categories in the sample

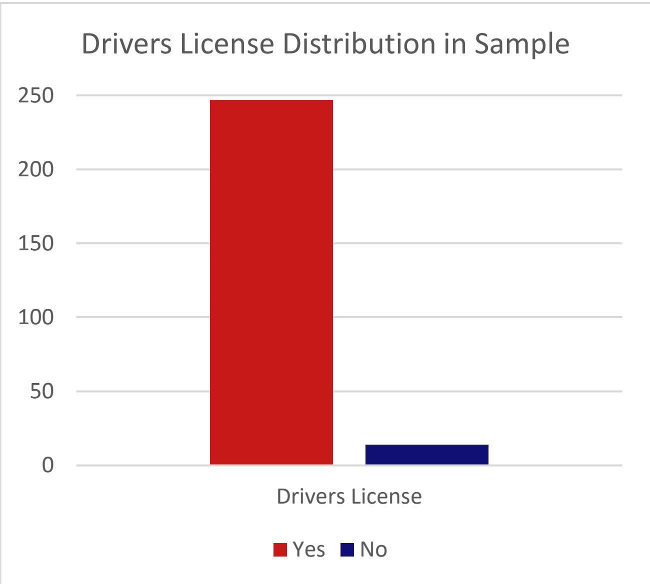
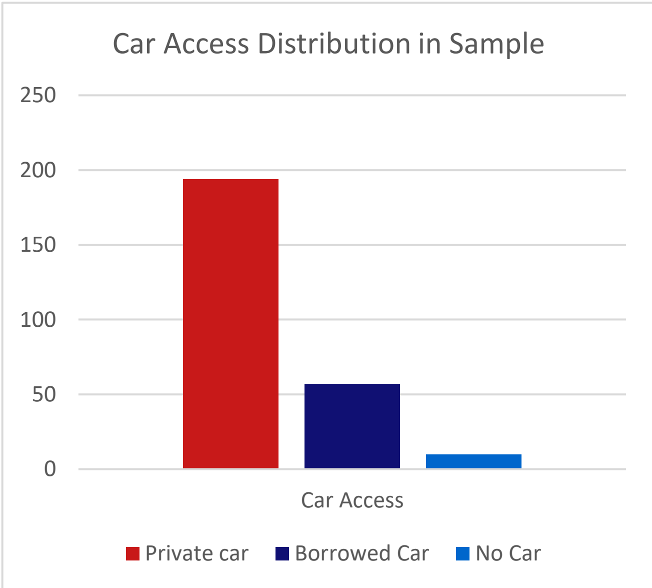


Figure 17: Distribution of the car access categories in the sample



6.2.3 Access to other modes of transport (besides the car)

When looking at the availability of other privately owned vehicles, the bike is the most common vehicle to have access to. This is logical in the context of the Netherlands because of the extensive bike infrastructure present throughout the country. In total, 243 bikes are owned by the participants (93%). Compared to the national average (72%), bike owners are overrepresented in this sample (CROW, 2022).

For the data analysis, the answers regarding different modes of transport have been clustered into four groups based on the national vehicle classification: Bicycles, Two-wheelers, Other, and None. The distribution of the modes of transport is shown in Figure 18.

6.2.4 Access to public transport

75% of the participants stated that they have public transport available within 400 meters of their residence. This leaves 25% with no public transport connections within walking distance. The bus was the most available public transport option, as 68% of the participants mentioned the bus. In the Netherlands, around 12% of citizens do not have a bus stop within 400 meters of their residence (Provincie Overijssel, 2021). This number is higher than the number in the sample. The bus is, therefore, underrepresented in this sample. Multiple reasons can be considered for why this has happened. For example, people may not be aware of the public transport facilities within their residential area, or the estimation of the distance may be less accurate than the objective measurement used for the national average.

Figure 18: Distribution of the mode of transport categories in the sample

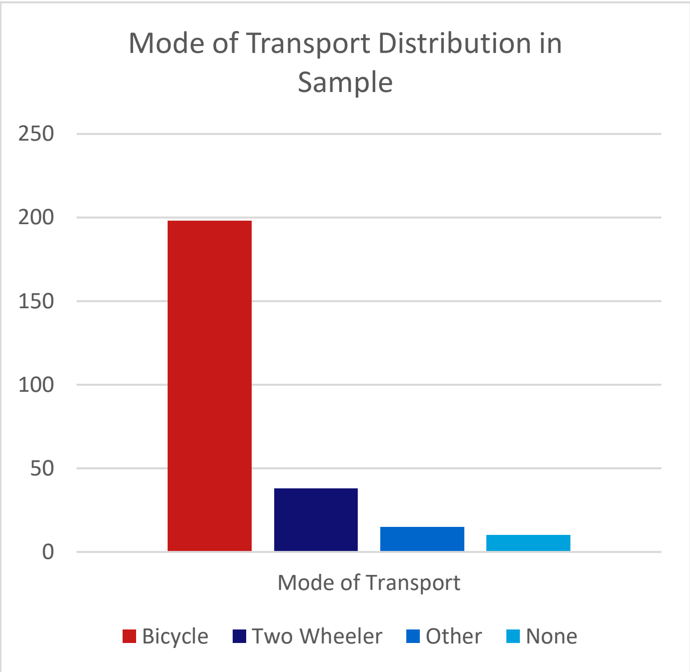
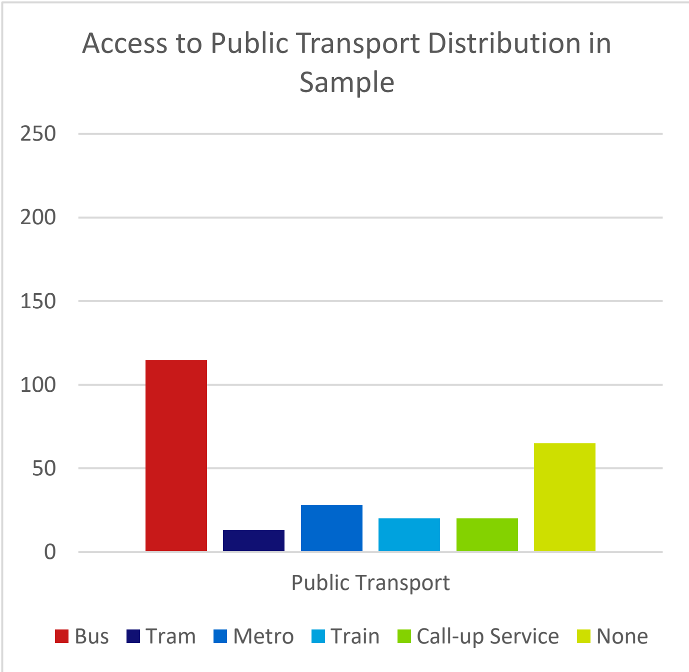


Figure 19: Distribution of the public transport categories in the sample



6.2.5 Payment method for public transport

Public transport allows its users to use different payment methods. Some of these payment methods are exclusive and only valid for certain target audiences, such as students and those aged 65+ (OV-Chipkaart, 2023). The payment method is, therefore, an influential tool that can create certain incentives to use public transport.

6.2.6 Access to shared mobility

Within the sample, 19% of the participants stated that they have a shared car available within 400 meters of their residential place. Compared to the national average, which is 30% (CROW, 2022b), shared cars are underrepresented in this sample. As expected, shared scooters have the highest percentage. The Netherlands is known for its high share of shared scooters from a global perspective (I&W, 2021). In 2019, there were around 6 thousand shared scooters in the Netherlands, which served 19 cities in the country. Looking at the percentage of shared scooters (30%), it is a reasonable representation of the national average.

6.2.7 Use of mobiltiy aid

99% of the sample stated that they do not use a mobility aid. Around 4.5% of Dutch citizens experience mobility disabilities (RIVM, 2023). If blind and deaf people are also taken into account, then the number increases to 8%. The 1% that does have a mobility aid is too small of a group to be taken into account in the analyses. Therefore, this study will not include the variable representing mobility aid in the analyses. Nevertheless, the study does acknowledge the potential relation between mobility aid and transport poverty.

Figure 20: Distribution of the payment method categories in the sample

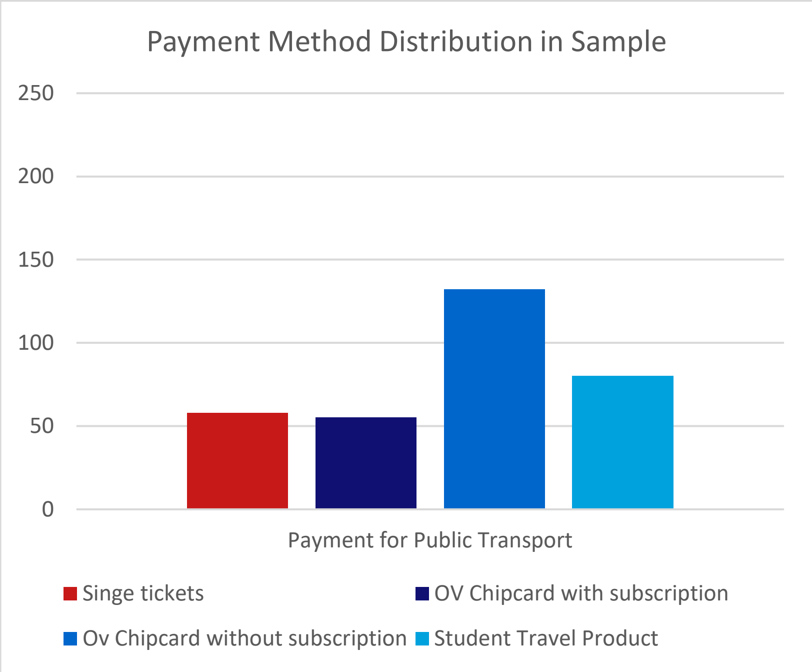
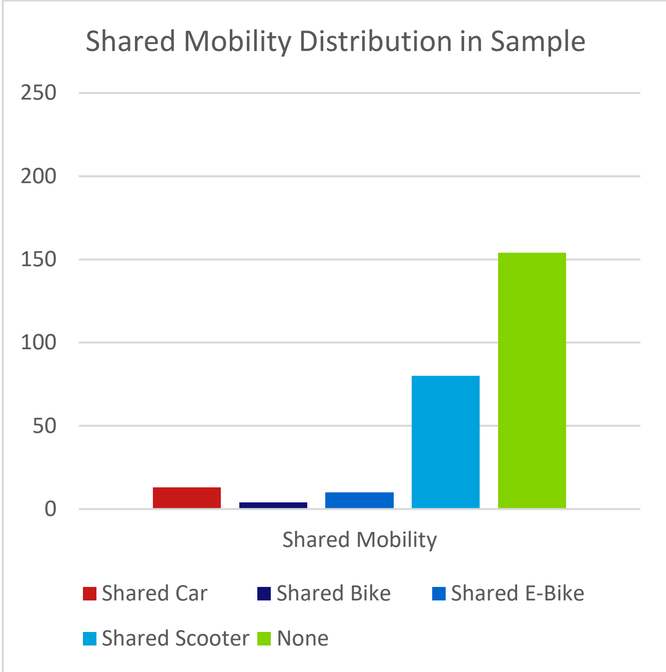


Figure 21: Distribution of the shared mobility categories in the sample



6.3 Levels of Transport Poverty

6.3.1 Overall Transport Poverty

In the previous chapter, the indicators and corresponding items of the transport poverty scale have been described. The scale has a positive direction, meaning that a higher score on the scale indicates that the participant is experiencing more transport poverty. From the initial nine items, four of them were negatively framed. In this way, participants were forced to pay attention to the questions, which should result in more accurate answers due to the removal of response bias.

Before the start of the analysis, the Cronbach's Alpha analysis is conducted to assess the presence of internal consistency between the indicators of the transport poverty variable. In Table 2, the results of the Cronbach's Alpha test for the overall transport poverty scale are 0.6698. According to the rules of thumb for the Cronbach's Alpha, this value is questionable (Glen, 2016). The consistency of the scale could be improved by removing item 6: "I worry about my road safety when I travel."

Table 2: Results of the Cronbach's Alpha for overall transport poverty with nine items

Cronbach's Alpha				Sign	Item	Cronbach's Alpha when deleted
Cases		N	%	-	I need to spend more money on my transportation than I can afford	0,6604
	Valid	260	100	-	I spend much more time travelling than I'd like	0,6741
	Excluded	0	0	+	There is a suitable travel option available when I want to travel	0,6445
	Total	260	100	+	I can easily reach my destinations	0,6434
Reliability Statistics				+	I feel safe when travelling	0,6701
Cronbach's Alpha		N of items		-	I worry about my road safety when I travel	0,7198
0,6892		9		+	I can travel without experiencing negative health consequences	0,6532
				+	I can travel in a way that is suited to my physical condition & abilities	0,6509
				-	I am limited in the number of activities I can attend due to problems with my transportation	0,6524

When item 6 had been removed, the Cronbach's Alpha value increased to 0.7198, which indicates an acceptable internal consistency between the items. Table 3 shows that no further significant improvements were possible. The result is now an 8-item scale with three negatively framed questions.

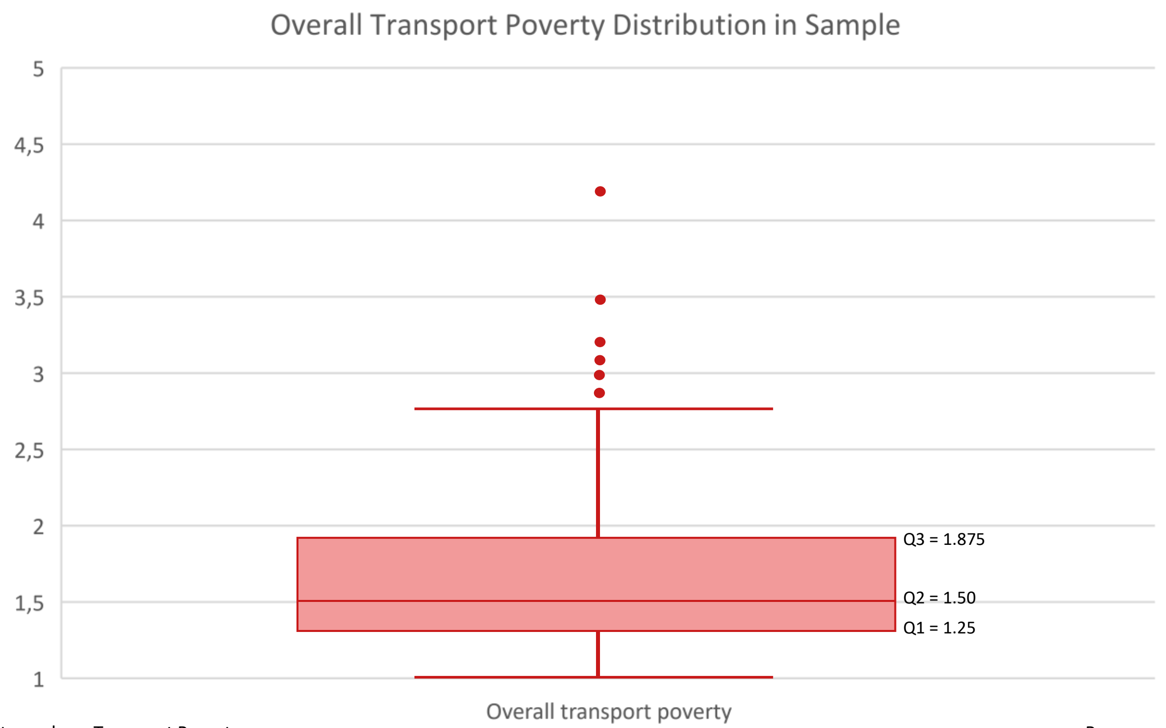
Table 3: Results of the Cronbach's Alpha for overall transport poverty with eight items

Cronbach's Alpha				Sign	Item	Cronbach's Alpha when deleted
Cases		N	%	-	I need to spend more money on my transportation than i can afford	0,6967
	Valid	260	100	-	I spend much more time travelling than I'd like	0,7211
	Excluded	0	0	+	There is a suitable travel option available when I want to travel	0,6713
	Total	260	100	+	I can easily reach my destinations	0,6727
Reliability Statistics				+	I feel safe when travelling	0,7141
Cronbach's Alpha	N of items			+	I can travel without experiencing negative health consequences	0,6934
0,7198	8			+	I can travel in a way that is suited to my physical condition & abilities	0,6781
				-	I am limited in the number of activities I can attend due to problems with my transportation	0,6889

By taking the mean from the sum of the 8 items, the overall transport poverty scale provides a value which represents the degree to which a person would agree with the transport poverty definition of Lucas et al. (2016). In this sample with 260 observations, the values range from 1 to 4.25, with a mean value of 1.62.

The data shows that, in general, participants indicate having a transport poverty score below the level of 2. The median of the dataset is 1.5, while the 75% cut has a value of 1.875. Looking at the skewness and kurtosis of the data, their values show that the data is not normally distributed and is rather centralized around the lower values. In Figure .., it is clearly visible that the data is positively skewed, which assumes that the overall transport poverty variable is not normally distributed. Six outliers can be identified in the box plot. However, as these outliers represent high levels of transport poverty, they will be kept in the data to provide a contrast to the low levels of transport poverty. This will be the case for all outliers in the dataset.

Figure 22: Distribution of overall transport poverty variable within the sample



6.3.2 Instance-based transport poverty

The process for the overall transport poverty scale has been repeated three times to establish the three instance-based transport poverty levels for commuting, shopping, and leisure

Commuting

The internal consistency of the momentary transport poverty scale for commuting shows a value of 0.7078, which is acceptable. Two items, time poverty and suitability, could improve the scale when being deleted. However, these items have been explicitly stated in the conditions of transport poverty by Lucas (2016). Removing the items would reduce the accuracy of the variable. The small improvements are, therefore, not implemented.

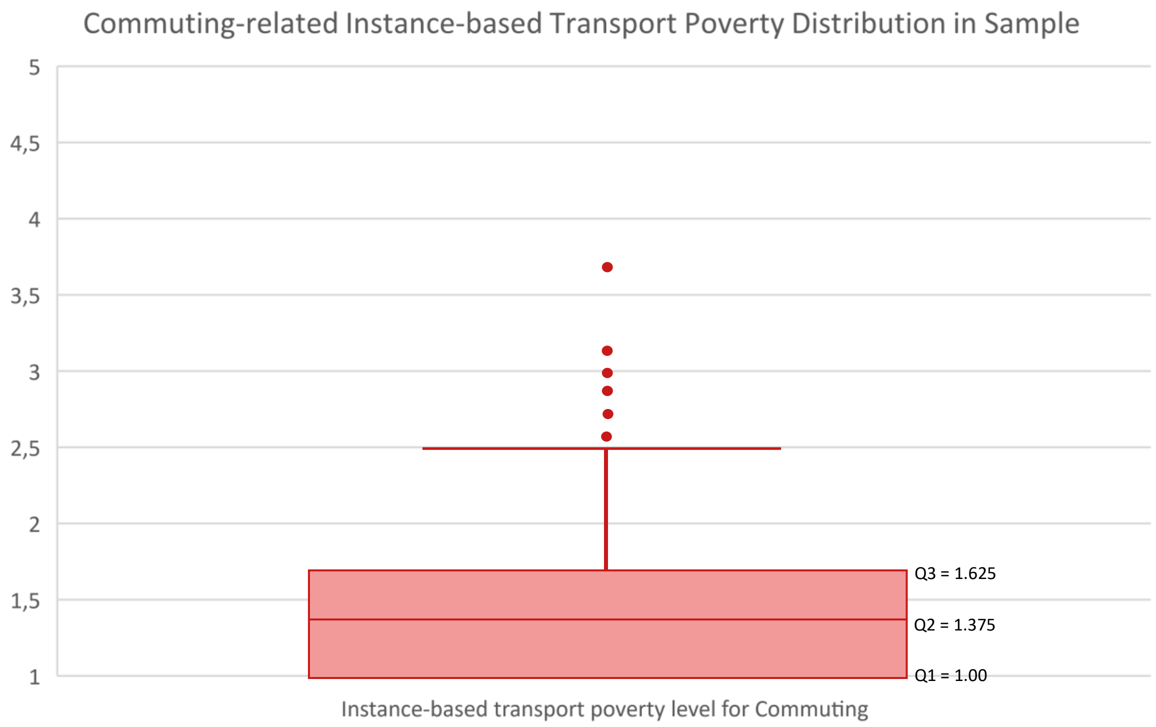
Table 4: Results of the Cronbach's Alpha for instance-based transport poverty for commuting with eight items

Cronbach's Alpha				Sign	Item	Cronbach's Alpha when deleted
Cases		N	%	-	I needed to spend more money on the transport of my most recent commuting trip than I could afford	0,6580
	Valid	260	100	-	The travel time of my most recent commuting trip I was longer than I liked There is a suitable travel option available for my most recent commuting trip	0,7098
	Excluded	16	7	+	There was a suitable travel option available for me for my most recent commuting trip	0,7229
	Total	244	93	+	I can easily reach the destination of my most recent commuting trip	0,6570
Reliability Statistics				+	I felt safe when to my most recent commuting trip	0,6752
Cronbach's Alpha		N of items		+	I could travel without experiencing negative health consequences during my most recent commuting trip	0,6798
0,7078		8		+	My physical condition was suited for making my most recent commuting trip	0,6847
				-	My most recent commuting trip caused problems which made me limit the number of activities I could attend	0,6483

Instance-based transport poverty experienced during commuting exhibits a range between 1 and 3.625, with a mean value of 1.49. This mean value is lower than the mean value of the overall transport poverty variable. The dataset comprises 244 observations, which is less than the total population size of 260. This decrease in participants arises due to the non-participation of certain individuals in working or studying activities, thereby eliminating their need for commuting trips associated with these activities.

The results of the instance-based transport poverty level for commuting are primarily centered around lower values and do not exhibit a normal distribution due to positive skewness. The median value is 1.375, indicating that a large proportion of the observations are situated between the values of 1 and 1.375, 50% to be precise. Additionally, the 75th percentile is 1.625. These values are lower than the quartile values of the overall transport poverty variable.

Figure 23: Distribution of instance-based transport poverty for commuting within the sample



Shopping

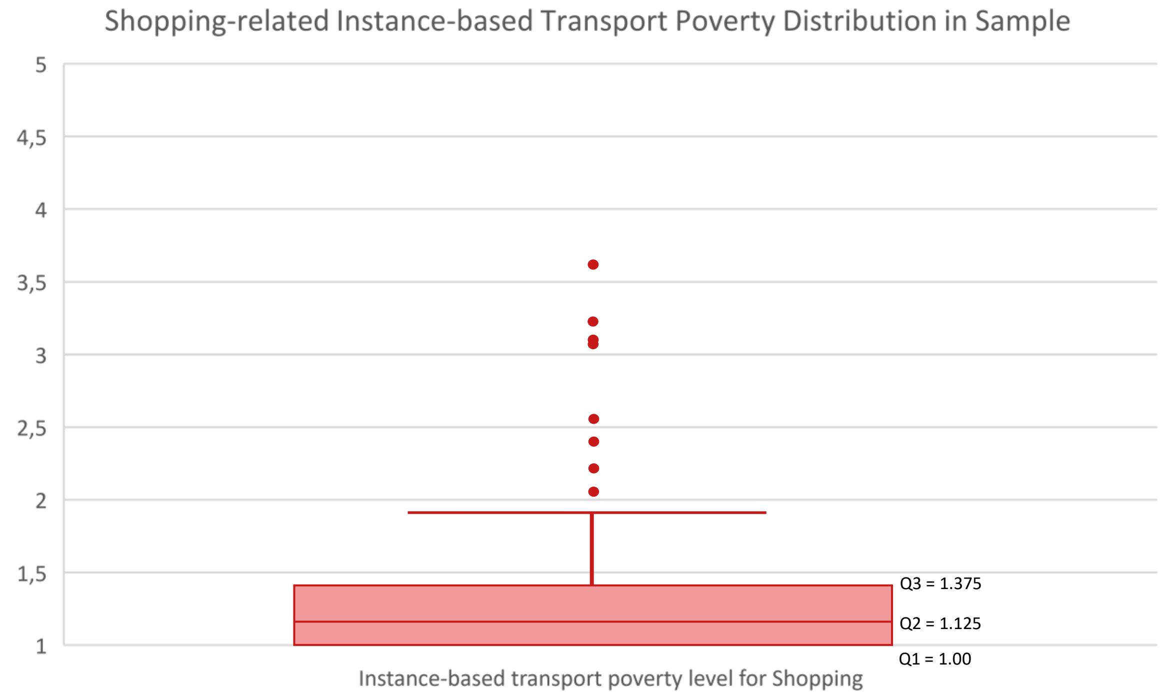
The instance-based transport poverty scale for shopping demonstrates satisfactory internal consistency, with an alpha value of 0.7548. This level of consistency is deemed acceptable for the scale. It should be noted that one item, namely suitability, has the potential to enhance the scale if removed. However, considering that this item is explicitly mentioned in the conditions of transport poverty by Lucas (2016), the marginal improvement achieved by eliminating it is outweighed by its conceptual importance. Thus, it is concluded that the item remains within the scale.

Table 5: Results of the Cronbach's Alpha for instance-based transport poverty for shopping with eight items

Cronbach's Alpha				Sign	Item	Cronbach's Alpha when deleted
Cases		N	%	-	I needed to spend more money on the transport of my most recent shopping trip than I could afford	0,7361
	Valid	260	100	-	The travel time of my most recent commuting trip I was longer than I liked There is a suitable travel option available for my most recent shopping trip	0,7358
	Excluded	0	0	+	There was a suitable travel option available for me for my most recent shopping trip	0,7683
	Total	260	100	+	I can easily reach the destination of my most recent shopping trip	0,7074
Reliability Statistics				+	I felt safe when to my most recent shopping trip	0,7258
Cronbach's Alpha		N of items		+	I could travel without experiencing negative health consequences during my most recent shopping trip	0,7295
0,7548		8		+	My physical condition was suited for making my most recent shopping trip	0,7202
				-	My most recent shopping trip caused problems which made me limit the number of activities I could attend	0,7113

Instance-based transport poverty in relation to shopping trips exhibits a range of 1 to 3.5, with a mean value of 1.29. These values are lower than both overall transport poverty and instance-based transport poverty for commuting. However, similar to the commuting scale, this shopping-related instance-based transport poverty scale is primarily centered around lower values and does not conform to a normal distribution due to positive skewness. The median value is 1.125, with a 25th percentile of 1.0. Additionally, the 75th percentile is at 1.375.

Figure 23: Distribution of instance-based transport poverty for shopping within the sample



Leisure

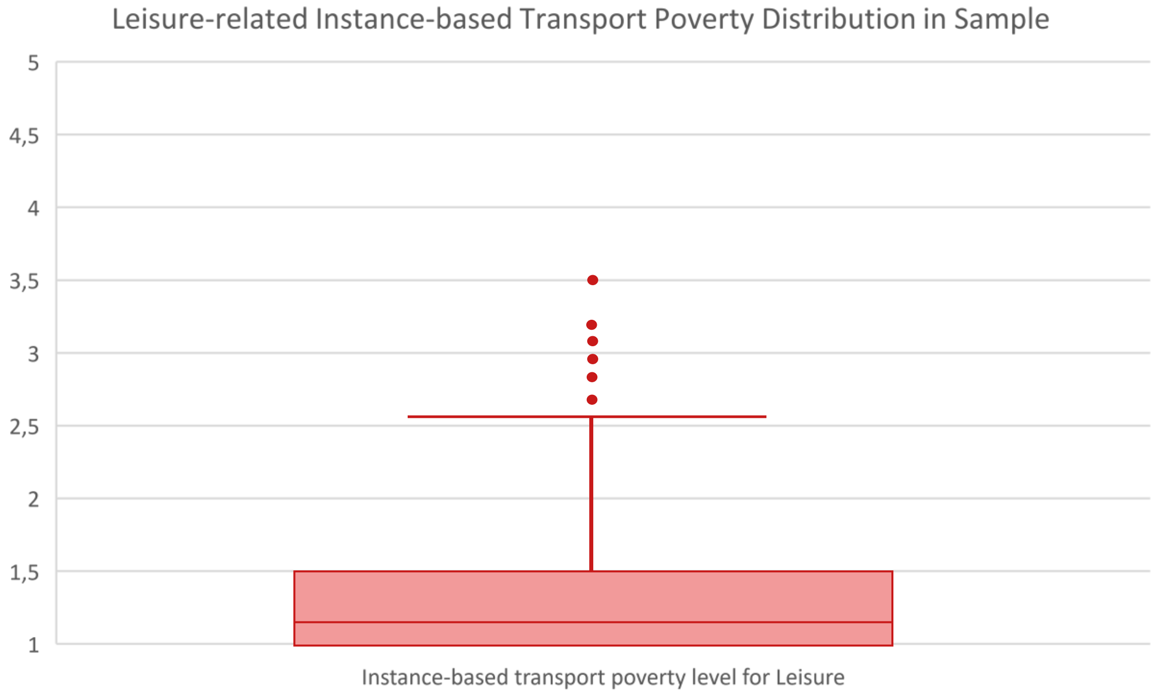
The internal consistency analysis of the momentary transport poverty scale for leisure trips yielded an acceptable coefficient alpha value of 0.7508. No items demonstrated a notable improvement in the scale's internal consistency when removed. Therefore, it is recommended to retain all items in the scale.

Table 6: Results of the Cronbach's Alpha for instance-based transport poverty for leisure with eight items

Cronbach's Alpha				Sign	Item	Cronbach's Alpha when deleted
Cases		N	%	-	I needed to spend more money on the transport of my most recent leisure trip than i could afford	0,7032
	Valid	260	100	-	The travel time of my most recent commuting trip I was longer than I liked There is a suitable travel option available for my most recent leisure trip	0,7301
	Excluded	0	0	+	There was a suitable travel option available for me for my most recent leisure trip	0,7308
	Total	260	100	+	I can easily reach the destination of my most recent leisure trip	0,7971
Reliability Statistics				+	I felt safe when to my most recent leisure trip	0,7340
Cronbach's Alpha		N of items		+	I could travel without experiencing negative health consequences during my most recent leisure trip	0,7107
0,7459		8		+	My physical condition was suited for making my most recent leisure trip	0,7287
				-	My most recent leisure trip caused problems which made me limit the number of activities I could attend	0,7214

Instance-based transport poverty in relation to leisure exhibits a range of 1 to 3.5, with a mean value of 1.38. Similar to the previously discussed scales, this leisure-related scale is primarily concentrated around lower values and does not adhere to a normal distribution due to positive skewness. The median value is 1.125, and the 25th percentile is 1. Additionally, the 75th percentile is at 1.5.

Figure 24: Distribution of instance-based transport poverty for leisure within the sample



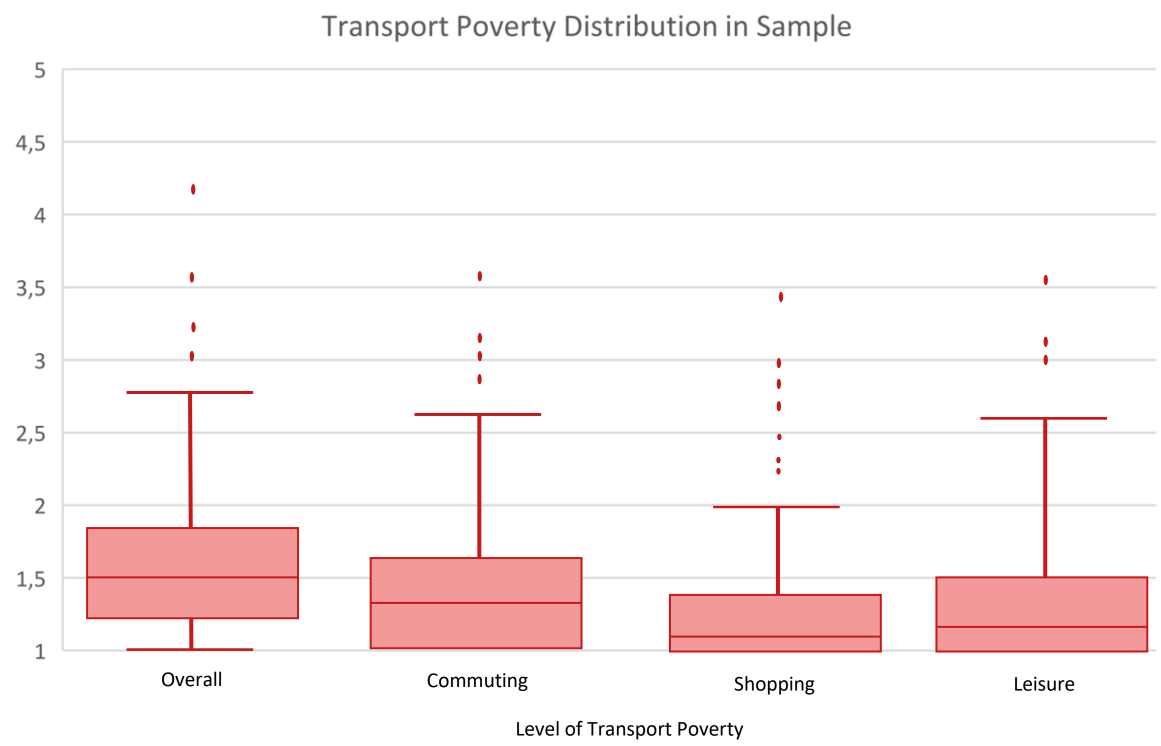
7 Results

This chapter presents the results obtained through various data analysis methods. The chapter will start with the findings of the signed-rank tests conducted across different levels of transport poverty. Following that, the chapter will delve into the results of the ordinal logistic regressions. Two sets of tests have been conducted beforehand to determine which independent variables can be added to the regression models.

7.1 Results of Signed-rank Test

As depicted in Figure 25, the descriptive presentation of the transport poverty variables in this study assumes differences among various levels of transport poverty. To statistically validate this assumption, the study has employed the Wilcoxon signed-rank test.

Figure 25: Distribution of all four transport poverty levels



The primary purpose of the Wilcoxon signed-rank tests is to assess whether a significant difference exists between two related or paired groups. In this study, the test is employed to determine if there is a significant difference between two matched pairs of transport poverty levels. In practice, consistency within the levels of transport poverty would imply that the three instance-based transport poverty levels have the same value as the overall transport poverty level within the repeated levels of one participant. To analyze this hypothesis, the Wilcoxon signed-rank test was conducted six times, as there are six possible null hypotheses among the four different levels of transport poverty. The null hypothesis of the Wilcoxon signed-rank test posits that there is no significant difference between the medians of the paired transport poverty levels.

7.1.1 Overall transport poverty vs. Instance-based transport poverty for Commuting

Table 7: Results of the Signed-rank test between overall transport poverty and instance-based transport poverty for commuting

Sign	Observations	Sum ranks	Expected
Positives	137	19988.5	14514.5
Negatives	66	9040.5	14514.5
Zero	41	861	861
All	244	29890	29890
Unadjusted variance	1218017.50	Z-score	4.985
Adjusted for ties	-6209.38	Prob > |z|	0.0000
Adjusted for zeros	-5955.25	Exact Prob	0.0000
Adjusted variance	1205852.88		

The first test was conducted between the overall transport poverty levels and the instance-based transport poverty levels for commuting. The difference between the overall transport poverty levels and the instance-based transport poverty levels is calculated using the equation:

Difference = Overall transport poverty – Instance-based transport poverty for Commuting

This difference can result in three different outcomes. A positive value indicates that the overall transport poverty level is higher than the instance-based transport poverty levels for commuting. A negative value implies the opposite situation, where the instance-based transport poverty levels for commuting are greater than the overall transport poverty level. Lastly, a neutral value occurs when the levels of transport poverty are the same. In Table 7, these three types of differences are represented as positives, negatives, and zeros.

The results of the test revealed a z-score of 4.985 and a p-value of 0.0000, indicating a statistically significant difference between the overall transport poverty level and the instance-based transport poverty level for commuting. For an individual, this means that the overall transport poverty level does not have to be equal to the level of instance-based transport poverty for a commuting trip. The differences appear to be primarily distributed towards a positive difference, as the number of positive observations (N=137) outweighs the negative observations (N=66). Consequently, it can be inferred that, in general, the instance-based transport poverty levels for commuting tend to be lower compared to the overall transport poverty level.

7.1.2 Overall transport poverty vs. Instance-based transport poverty for Shopping

Table 8: Results of the Signed-rank test between overall transport poverty and instance-based transport poverty for shopping

Sign	Observations	Sum ranks	Expected
Positives	188	28649	16632
Negatives	36	4651	16632
Zero	36	666	666
All	260	33930	33930
Unadjusted variance	1473127.50	Z-score	9,931
Adjusted for ties	-4992.00	Prob > |z|	0.0000
Adjusted for zeros	-4051.50	Exact Prob	0.0000
Adjusted variance	1464084		

The second test was conducted using the overall transport poverty levels and the instance-based transport poverty levels for shopping trips. The difference in this case is calculated with the following equation:

Difference = Overall transport poverty – Instance-based transport poverty for Shopping

The test revealed a z-score of 9.931 and a p-value of 0.0000, indicating a significant difference between the overall transport poverty levels and the instance-based transport poverty levels for shopping. Translating the results to an individual's perspective, it means that an individual's overall level of transport poverty does not have to be equal to their instance-based transport poverty level for a shopping trip. The difference appears to be skewed towards a positive variance, with a greater number of positive observations (N=188) than negative observations (N=36). Consequently, it is generally more likely for the instance-based transport poverty level for shopping to be lower than the overall transport poverty level.

7.1.3 Overall transport poverty vs. Instance-based transport poverty for Leisure

Table 9: Results of the Signed-rank test between overall transport poverty and instance-based transport poverty for leisure

Sign	Observations	Sum ranks	Expected
Positives	170	25733	16534.5
Negatives	49	7336	16534.5
Zero	41	861	861
All	260	33930	33930
Unadjusted variance	1473127.50	Z-score	7.609
Adjusted for ties	-5787.13	Prob > |z|	0.0000
Adjusted for zeros	-5955.25	Exact Prob	0.0000
Adjusted variance	1461385.13		

The third test was conducted using the overall transport poverty levels and the instance-based transport poverty levels for leisure. The difference in this case is calculated with the following equation:

Difference = Overall transport poverty – Instance-based transport poverty for Leisure

The test yielded a z-score of 7.609 and a p-value of 0.0000, indicating a significant difference between the overall transport poverty levels and the instance-based transport poverty levels for leisure. For an individual, this means that their overall transport poverty level does not have to be equal to their instance-based transport poverty level for a leisure trip. The difference appears to be skewed towards a positive variance, with a greater number of positive observations (N=170) compared to negative observations (N=49). Consequently, it is generally more likely for the instance-based transport poverty levels for leisure to be lower than the overall transport poverty level.

7.1.4 Instance-based transport poverty Commuting vs. Shopping

As the context between the different instance-based transport poverty levels differs, it is expected that the levels of transport poverty also differ. This will be tested with a signed-rank test between the three instance-based transport poverty levels.

Table 10: Results of the Signed-rank test between commuting vs shopping instance-based transport poverty

Sign	Observations	Sum ranks	Expected
Positives	133	21427.5	13594.5
Negatives	38	5761.5	13594.5
Zero	73	2701	2701
All	244	29890	29890
Unadjusted variance	1218017.50	Z-score	7.205
Adjusted for ties	-2965.63	Prob > |z|	0.0000
Adjusted for zeros	-33087.25	Exact Prob	0.0000
Adjusted variance	1181964.63		

The test between the instance-based transport poverty levels of commuting and shopping shows a significant probability with a z-score of 7.205. The difference here is calculated with the following equation:

Difference = Instance-based transport poverty for Commuting – Instance-based transport poverty for Shopping

The results indicate a higher number of positive observations (N=133) compared to negative observations (N=38), suggesting that, in general, the instance-based transport poverty levels for commuting are higher than those for shopping. From an individual's perspective, this means that instance-based transport poverty levels for commuting do not have to be equal to the instance-based transport poverty levels for shopping. It's noteworthy that the number of neutral cases (N=73) in this test is higher than the number of negative cases, which is remarkable compared to results from the tests related to the overall transport poverty levels. This suggests that equal levels of transport poverty for commuting and shopping are more common than shopping having high instance-based transport poverty levels.

7.1.5 Instance-based transport poverty Commuting vs. Leisure

Table 11: Results of the Signed-rank test between commuting vs leisure instance-based transport poverty

Sign	Observations	Sum ranks	Expected
Positives	104	17153.5	13482
Negatives	64	9810.5	13482
Zero	76	2926	2926
All	244	30135	30135

Unadjusted variance	1218017.50	Z-score	3.383
Adjusted for ties	-2968.63	Prob > |z|	0.0007
Adjusted for zeros	-37306.50	Exact Prob	0.0007
Adjusted variance	1177742.38		

The test between the instance-based transport poverty levels of commuting and leisure shows a significant probability with a z-score of 3.426, indicating a significant difference between the instance-based transport poverty levels of commuting and leisure. From an individual's perspective, this means that the instance-based transport poverty level of a commuting trip does not have to be equal to the instance-based transport poverty level of a leisure trip. The difference here is calculated with the following equation:

Difference = Instance-based transport poverty for Commuting – Instance-based transport poverty for Leisure

The results show that there are more positive observations (N=104) than negative observations (N=64) in this sample. Once again, the number of neutral cases (N=76) in this test is higher than the number of negative cases, which is noteworthy compared to the previous tests regarding the overall transport poverty levels.

7.1.6 Instance-based transport poverty Leisure vs. Shopping

Table 12: Results of the Signed-rank test between leisure vs shopping instance-based transport poverty

Sign	Observations	Sum ranks	Expected
Positives	96	18173	13744.5
Negatives	51	9316	13744.5
Zero	113	6441	6441
All	260	33930	33930

Unadjusted variance	1473127.50	Z-score	3.813
Adjusted for ties	-2280.62	Prob > |z|	0.0001
Adjusted for zeros	-121842.25	Exact Prob	0.0001
Adjusted variance	1349004.63		

The test between the instance-based transport poverty levels of shopping and leisure shows a significant probability with a z-score of 3.863, indicating a significant difference between the instance-based transport poverty levels of shopping and leisure. The difference here is calculated with the following equation:

Difference = Instance-based transport poverty for Leisure – Instance-based transport poverty for Shopping

The results show that there are more positive observations (N=97) than negative observations (N=51) in this sample. However, the majority of cases result in a neutral observation (N=113), indicating that there is no difference between the levels of shopping and leisure.

7.1.7 Interpretation of the results

All three signed-rank tests regarding the overall transport poverty levels show significant results, indicating that all three instance-based transport poverty levels differ from the overall transport poverty levels. Because the levels of transport poverty significantly differ from each other, it cannot be assumed that the level of overall transport poverty accurately represents the levels of instance-based transport poverty for commuting, shopping, and leisure.

Examining the z-scores of the tests, the instance-based transport level for shopping shows the most significant difference from the overall transport poverty level with a z-score of 9.931. Shopping is followed by leisure, which has a z-value of 7.609. Lastly, commuting has a z-value of 4.985. All three tests indicate that the instance-based transport poverty levels are generally lower than the overall transport poverty level, as all three tests had more positive than negative or neutral cases.

When looking at the results from the signed-rank tests between the instance-based transport poverty levels, the same order is maintained. However, the direction of the difference is harder to identify due to the smaller differences between the positive and negative cases. Moreover, in two of the three tests, the number of neutral cases is higher than the number of negative cases, suggesting that differences of zero occur regularly. This result assumes that, in general, the instance-based transport poverty levels are better representatives of each other than the overall transport poverty levels can be. This is evident from the higher number of zero observations among the instance-based transport poverty levels compared to the observations between the overall transport poverty levels and the instance-based transport poverty levels.

7.2 Bivariate analyses

The ordinal logistic regression analyses aim to identify the independent variables that can explain the variation present within the level of overall transport poverty and the three instance-based transport poverty levels. By assessing the effects of the independent variables within the different regression models, insights can be gained about the independent variables that contribute to the variations between the levels of transport poverty. To determine which independent variables can be included in the ordinal logistic regression analyses, the socio-demographic and mobility resources have been converted into dummy variables and tested for their significant relationship with the different transport poverty levels. Through non-parametric bivariate analyses, the significance of the independent variables is assessed to determine their relevance for this study. The significant independent variables are then incorporated into the ordinal logistic regression model corresponding to the specific transport poverty level. However, before adding the independent variables, it is crucial to ensure that the data meets the assumption of multicollinearity, which means that there are no strong correlations between the independent variables that will be included in the regression analsyses.

7.2.1 Results for Multicollinearity Test

An assumption of regression models is the absence of multicollinearity among the independent variables included in the model. Multicollinearity can affect the stability of parameter estimations, leading to issues such as unstable coefficients and inconsistent signs in the regression model when changes are made (Daoud, 2017). Multicollinearity among the independent variables was assessed using Chi-squared tests and Cramer's V coefficients to examine correlations between categorical variables. For interval variables, pairwise correlation coefficients within the correlation matrix were analyzed. Cramer's V values greater than 0.2 should be considered, but only values exceeding 0.6 are considered problematic (IBM, 2023). Regarding pairwise correlations, correlations of $r > 0.5$ should be considered, and correlations $r > 0.7$ are considered problematic (Jaadi, 2019).

For categorical variables, Chi-squared tests were employed to determine the presence of correlations. The results, found in Appendix [reference], reveal strong correlations between certain independent variables. Noteworthy correlations include those between the variables urban density, the availability of public transport, and the availability of shared mobility. Multiple modes of public transport and shared mobility exhibit correlations with Cramer's V values exceeding 0.2, indicating moderate correlations between these modes and urban density (IBM, 2023). Moderate correlations are strong enough to To avoid multicollinearity in the regression models, it was decided not to include any of the public transport or shared mobility variables. Instead, the variable urban density is assumed to represent the availability of public transport and shared mobility, as literature suggests a positive correlation between urban density and the availability of public or shared modes of transport. Therefore, this study assumes that participants residing in areas with high urban density have greater access to public transport and shared mobility options compared to participants in areas with low urban density.

Furthermore, the variables 'driver's license' and 'car access' exhibit a high correlation with a Cramer's V value of 0.74. Including both variables in one model would result in collinearity within the regression model. Consequently, it was decided to exclude 'car access,' as 'driver's license' represents the participant's ability to use a car, while 'car access' does not require verification of the participant's driving ability. For instance, a participant's household may have a car, but without a driver's license, the participant cannot use it independently. While being a passenger in the car is a possibility, this study does not consider the size of the travel group and assumes that participants travel alone.

Additionally, the variable representing the payment method for public transport shows moderate to strong correlations with multiple other independent variables. Since this variable had an explanatory function in this study, it will not be included in any of the models to prevent multicollinearity.

Lastly, the variable 'travel distance' exhibits a strong correlation with 'travel time' and 'mode of transport.' This correlation aligns with the theoretical framework. However, to avoid multicollinearity in the regression models, 'travel distance' will not be considered. The reason for this decision is the strong correlation, whereas 'travel time' and 'mode of transport' do not exhibit strong correlations between each other. Furthermore, 'travel time' directly correlates with the level of transport poverty, whereas the relationship between 'travel distance' and transport poverty is indirect.

The analyses for multicollinearity results in multiple independent variables to be disregarded. The independent variables that are taken to the bivariate analyses are age, gender, education, income, employment, household, urban density, car access, driver's license, mode(s) of transport, shared mobility awareness, travel time, starting time and mode choice.

7.2.2 Results of the bivariate analyses: Kruskal –Wallis test & Ranksum test

Age

The first independent variable discussed is age. Table 13 presents the results of the Kruskal-Wallis tests between the independent variable age and the dependent transport poverty variables. The yellow color indicates that the p-value of the test is significant at a power of alpha=0.90, while green indicates significance at a power of alpha=0.95.

The Kruskal-Wallis tests only show a significant result for overall transport poverty, indicating that the distributions of the overall transport poverty levels are not equal among the different age categories. The Kruskal-Wallis tests cannot determine the direction or size of the distribution, as the test lacks the expected rank sum values in the output. However, the effect size, measured by Epsilon-squared, is very small, with a value of only 0.01. Therefore, only a very small proportion of the variability in the overall transport poverty levels can be attributed to the variable of age. Nonetheless, within behavioral studies even small effects can be valuable, which is why the variable age will be included in the model of overall transport poverty.

Table 13: Results of Kruskal-Wallis tests for the independent variable of age

Age												
Category	Overall			Commuting			Shopping			Leisure		
	#	Ranksum	p-value	#	Ranksum	p-value	#	Ranksum	p-value	#	Ranksum	p-value
Below 35	95	13079.5		95	12249.5		95	13012.5		95	12968	

Between 35 en 65	150	18455.0		143	16815.5		150	18606		150	18888	
Above 65	15	2395.5		6	825		15	2311.5		15	2074	
Total	260		**0.09**	244		**0.40**	260		**0.15**	260		**0.48**
Epsilon^2			0.01			0.00			0.00			0.00

Gender
The second independent variable discussed is gender. Table 14 presents the results of the Ranksum tests between gender and the levels of transport poverty. None of the Ranksum tests show a significant result. Therefore, the variable gender will not be included in any of the regression models.

Table 14: Results of Kruskal-Wallis tests for the independent variable of gender

Gender												
Category	Overall			Commuting			Shopping			Leisure		
	#	Ranksum	p-value	#	Ranksum	p-value	#	Ranksum	p-value	#	Ranksum	p-value
Female	160	21088.0		149	18889.5		160	21305.0		160	20978.5	
Male	100	12842.0		95	11000.5		100	12625.0		100	12951.5	
Total	260		**0.72**	244		**0.22**	260		**0.44**	260		**0.86**
Epsilon^2			0.00			0.00			0.00			0.00

Education
Table 15 displays the results of Kruskal-Wallis tests between education and the levels of transport poverty. The results indicate a significant result for instance-based transport poverty levels for shopping. This suggests that the distribution of instance-based transport poverty levels for shopping is not equally distributed among the categories of education. Consequently, the variable of education will be included in the regression model for the shopping-related instance-based transport poverty variable. However, the effect size of this significant result is very small, at only 0.05. Therefore, the explanatory power of the variable education is minimal.

Table 15: Results of Kruskal-Wallis tests for the independent variable of education

Education												
Category	Overall			Commuting			Shopping			Leisure		
	#	Ranksum	p-value	#	Ranksum	p-value	#	Ranksum	p-value	#	Ranksum	p-value
Primary	33	4961.0		29	4225.5		33	5420.5		33	4770.5	
Secondary	76	10210.0		72	8736.5		76	10760.0		76	10385.5	
Tertiary	151	18759.0		143	16928.0		151	17749.5		151	18774.0	
Total	260		**0.16**	244		**0.15**	260		**0.00**	260		**0.23**
Epsilon^2			0.01			0.01			0.05			0.00

Income
Table 16 presents the results of the Kruskal-Wallis tests between income and the levels of transport poverty. Three out of four tests show significant results, all of which pertain to the instance-based transport poverty levels. These results suggest that the levels of instance-based transport poverty are not equally distributed across the different income categories. As a result, the variable income will be included in the regression model for all three instance-based transport poverty levels. Once again, the effect sizes are very small, indicating that the variable income will only have a minimal effect on the level of transport poverty.

Table 16: Results of Kruskal-Wallis tests for the independent variable of income

Income												
Category	Overall			Commuting			Shopping			Leisure		
	#	Ranksum	p-value	#	Ranksum	p-value	#	Ranksum	p-value	#	Ranksum	p-value
Low income	102	14292.0		95	11891.5		102	14503.5		102	14722.5	
Middle income	89	10810.0		86	11192.5		89	11061.5		89	10845.5	
High income	33	3805.5		32	3028.0		33	3614.5		33	3887.0	
No indication	36	5022.5		31	3778.0		36	4750.5		36	4475.0	
Total	260		**0.18**	244		**0.09**	260		**0.10**	260		**0.09**
Epsilon²			0.00			0.02			0.01			0.01

Employment

Table 17 presents the results of the Kruskal-Wallis tests for the employment variable. None of the results show a significant result. Therefore, the variable employment will not be included in the regression models.

Table 17: Results of Kruskal-Wallis tests for the independent variable of employment

Employment												
Category	Overall			Commuting			Shopping			Leisure		
	#	Ranksum	p-value	#	Ranksum	p-value	#	Ranksum	p-value	#	Ranksum	p-value
Working	224	28538.0		221	26812.5		224	28476.5		224	28615.5	
Not working	36	5392.0		23	3077.5		36	5453.5		36	5314.5	
Total	260		**0.12**	244		**0.41**	260		**0.15**	260		**0.12**
Epsilon²			0.00			0.00			0.00			0.00

Household

Next, table 18 shows the results of the pairwise correlation tests for the household variable. Only the instance-based transport poverty levels of leisure show a significant correlation between household size. This indicates that there is a linear relationship between the levels of instance-based transport poverty for leisure and the number of individuals that live in the household of the participant. The pairwise correlation is negative, meaning that the level of instance-based transport poverty decreases when the number of individuals living in one household increases. Therefore, the variable household will be added to the regression models of the instance-based transport poverty for leisure. Although the result is significant, the effect size is still weak (Jaadi, 2019). The variable therefore only explains a small portion of the variation in the levels of transport poverty for leisure.

Table 18: Results of pairwise correlation tests for the independent variable of household

Household												
Category	Overall			Commuting			Shopping			Leisure		
	#	Pearson r	p-value	#	Pearson r	p-value	#	Pearson r	p-value	#	Pearson r	p-value
Total	260	0.	**0.27**	244	0.02	**0.69**	260	-0.01	**0.80**	260	-0.10	**0.09**

Urban Density

Table 19 shows the results of the Kruskal-Wallis test for the urban density variable. The results show that there is a statistically significant difference in the distribution of instance-based transport poverty levels for leisure among the different categories of urban density. This means that the level of instance-based transport poverty for leisure is not the same across the different categories of urban density. Therefore, the variable of urban density will be included in the regression model of the leisure-related instance-based transport poverty variable. However, the effect size is very low, indicating that the effect of urban density on the levels of instance-based transport poverty for leisure is minimal.

Table 19: Results of Kruskal-Wallis tests for the independent variable of urban density

Urban Density												
Category	Overall			Commuting			Shopping			Leisure		
	#	Ranksum	p-value	#	Ranksum	p-value	#	Ranksum	p-value	#	Ranksum	p-value
Very high density	58	7621.0		56	7004.0		58	7629.0		58	8668.0	
High density	51	7509.0		47	6618.5		51	6771.5		51	7437.5	
Moderate density	89	11151.0		86	9992.5		89	11442.0		89	10383.0	
Little density	43	5738.5		40	4593.5		43	5936.0		43	5382.5	
No urban density	19	1910.5		15	1681.5		19	2151.5		19	2059.0	
Total	260		**0.19**	244		**0.30**	260		**0.77**	260		**0.01**
Epsilon^2			0.00			0.00			0.00			0.03

Car access

Table 20 shows the results of the Kruskal-Wallis tests between car access and the levels of transport poverty. Both the overall transport poverty level and the instance-based transport poverty level for leisure show a statistically significant result. This means that the levels of transport poverty, both overall and for leisure, are not equally distributed over the categories of car access. Therefore, the variable car access will be included in the regression models of overall transport poverty and instance-based transport poverty for leisure. However, the effect size is very low, indicating that the effect of car access on the levels of transport poverty is minimal.

Table 20: Results of Kruskal-Wallis tests for the independent variable of car access

Car Access												
Category	Overall			Commuting			Shopping			Leisure		
	#	Ranksum	p-value	#	Ranksum	p-value	#	Ranksum	p-value	#	Ranksum	p-value
Private Car	193	23913.5		179	21658.5		193	24719.0		193	23731.5	
Borrowed Car	57	8046.0		55	6709.0		57	7694.5		57	1643.5	
No Car	10	1970.5		10	1522.5		10	1516.5		10	8555.0	
Total	260		**0.00**	244		**0.38**	260		**0.50**	260		**0.01**
Epsilon^2			0.03			0.00			0.00			0.02

Driver's license

Table 21 shows the results of the Wilcoxon rank-sum tests between driver's license and the levels of transport poverty. Three out of four tests show a statistically significant result. For overall transport poverty, instance-based transport poverty for shopping, and instance-based transport poverty for leisure, the levels of transport poverty differ significantly between individuals who have a driver's license and individuals who do not. The variable driver's license will be included in the regression model of these three transport poverty variables.

The effect sizes of the results are low, indicating that the effect of driver's license on the levels of transport poverty is minimal.

Table 21: Results of Kruskal-Wallis tests for the independent variable of driver's license

Driver's License												
Category	Overall			Commuting			Shopping			Leisure		
	#	Ranksum	p-value	#	Ranksum	p-value	#	Ranksum	p-value	#	Ranksum	p-value
Yes	246	31465.5		230	27799		246	31566.5		246	31359	
No	14	2464.5		14	2091		14	2363.5		14	2052	
Total	260		**0.01**	244		**0.28**	260		**0.03**	260		**0.06**
Pearson r			0.16			0.10			0.11			0.12

Access to other modes of transport (besides the car)
Table 22 exploits the results of the Ranksum tests for the mode of transport variable. Each mode of transport has been converted into a dummy variable to determine the effect of the presence or absence of the mode of transport on the level of transport poverty. The instance-based transport poverty levels of shopping show a significant result for two mode of transport categories. Therefore, bicycles and other modes of transport will be included in the regression model of shopping.

Table 22: Results of Kruskal-Wallis tests for the independent variable of modes of transport

Modes of Transport (besides the car)												
Category	Overall			Commuting			Shopping			Leisure		
	#	Ranksum	p-value	#	Ranksum	p-value	#	Ranksum	p-value	#	Ranksum	p-value
Bicycles	242	31278.0	**0.32**	230	27866.0	**0.22**	242	31052	**0.06**	242	31268.0	**0.28**
Two wheeler	39	5585.0	**0.25**	38	5024.5	**0.34**	39	4922.5	**0.67**	39	5401.5	**0.45**
Other	16	2178.5	**0.75**	14	1622.5	**0.71**	16	2637	**0.04**	16	2249.5	**0.56**
None	9	1155.5	**0.92**	6	843.5	**0.51**	9	1492	**0.12**	9	1379.5	**0.33**

Shared mobility awareness
Table 23 shows the results of the Ranksum tests between shared mobility awareness and the levels of transport poverty. None of the tests were significant, so shared mobility awareness will not be added to any of the regression models.

Table 23: Results of Kruskal-Wallis tests for the independent variable of modes of transport

Shared Mobility Awareness												
Category	Overall			Commuting			Shopping			Leisure		
	#	Ranksum	p-value	#	Ranksum	p-value	#	Ranksum	p-value	#	Ranksum	p-value
Yes	207	26543.5		196	23713.5		207	26456.5		207	26684.5	
No	53	7386.5		48	6176.5		53	7473.5		53	7245.5	
Total	260		**0.33**	242		**0.49**	260		**0.22**	260		**0.48**
			0.08			-0.09			-0.10			-0.06

Travel time
Table 24 shows the results of the pairwise correlation tests for the travel time variable. All tests are significant, indicating that there are linear relationships between the levels of instance-based transport poverty for commuting, shopping, and leisure and the travel time of the trip. The pairwise correlations are positive, meaning that the levels of instance-based transport poverty increase when the travel time of the trip increases. Therefore, the variable travel time will be added to the regression models of the instance-based transport poverty of commuting, shopping, and leisure. The results of the tests, however, show low values for the correlations. Travel time, therefore, only explains a small portion of the variation in the levels of transport poverty for commuting, shopping, and leisure.

Table 24: Results of the pairwise correlation tests for the independent variable of travel time

Travel Time												
Category	Overall			Commuting			Shopping			Leisure		
	#	Pearson r	p-value	#	Pearson r	p-value	#	Pearson r	p-value	#	Pearson r	p-value
Total	260	-	-	244	0.34	**0.00**	260	0.12	**0.05**	260	0.19	**0.00**

Starting time
Table 25 shows the results of the pairwise correlation tests between the variable starting time and the different instance-based transport poverty variables. None of the tests show a significant result. Therefore, the variable starting time will not be added to the instance-based transport poverty models of set 2.

Table 25: Results of the pairwise correlation tests for the independent variable of starting time

Starting Time												
Category	Overall			Commuting			Shopping			Leisure		
	#	Pearson r	p-value	#	Pearson r	p-value	#	Pearson r	p-value	#	Pearson r	p-value
Total	260	-	-	244	-0.08	**0.19**	260	-0.07	**0.23**	260	0.01	**0.84**

Mode choice

Mode choice									
Category	Commuting			Shopping			Leisure		
	#	Ranksum	p-value	#	Ranksum	p-value	#	Ranksum	p-value
Bike	63	5850.0		67	7965.0		86	10582.0	
Public Transport	41	5745.5		4	619.0		13	2339.0	
Walking	5	424.5		53	6594.5		17	2112.5	
Car	122	15850.0		127	17098.5		129	16091.0	

Two-wheeler	11	1533.0		6	929.0		9	1595.0	
Other	-			1	205.0		4	691.5	
Total	244		0.00	260		0.41	260		0.01
Epsilon^2			0.07			-0.82			0.02

Table 26 shows the results of the Kruskal-Wallis tests between the chosen mode of transport and the levels of transport poverty. The results show that mode choice is significant for the instance-based transport poverty levels of commuting and leisure. Therefore, the variable of mode choice will be added to the regression models of both commuting and leisure. The effect sizes, however, are very small, indicating that the effect of mode choice on the instance-based transport poverty levels will be minimal.

Table 26: Results of Kruskal-Wallis tests for the independent variable of mode choice

In the end, the following variables will be included in the ordinal logistic regression models: age, education, income, household, urban density, car access, driver's license, modes of transport, travel time, starting time, and mode choice.

7.3 Ordinal Logistic regression models

The study conducted two sets of ordinal logistic regression analyses to compare the performance of two types of models: instance-based transport poverty models and overall transport poverty models. In the first set (set 1), the aim of the ordinal logistic regression models is to compare the performances of the instance-based models with the overall transport poverty model. The instance-based transport poverty levels include knowledge of the land-use component of the context, as the levels of instance-based transport poverty refer only to one specific trip purpose, instead of multiple, which is assumed to be the case in overall transport poverty. Therefore, it is expected that the models of the instance-based transport poverty levels perform better than the model for levels of overall transport poverty.

This assumption is based on the observation that the relation between the characteristics of the context and the level of instance-based transport poverty is customized for the trip purpose of the instance-based transport poverty levels. This is expected to improve the predictive performance of the independent variables, as a more accurate context is included. However, to equally compare the performances of the instance-based models with the overall transport poverty model, only the characteristics of the individual component of the context can be included as independent variables. The overall transport poverty levels have no knowledge of any characteristics coming from the transportation and temporal component of the context, making it impossible to include characteristics from these components of the context.

The second set (set 2) includes regression models which include characteristics from all components of the context. The aim of these models is to show that the inclusion of the transportation and temporal components of the context improves the performance of the models. It is expected that the models of set 2 have better performance than the models of set 1, as only the models of set 2 include all the components of the context, which provide a more accurate representation of the context.

Before the regression can be interpreted, the regression models need to pass the parallel lines test. If the test is significant (p-value < 0.05), then the assumption is not met. This gives reason to revise the categories of the ordinal dependent variable. The results of the parallel lines test in appendix C show a significant p-value for regression models of commuting and leisure in set 1. It is suggested to remove the 4th and 5th category of the dataset because of their very small sample size per category (n < 5). After this revision, the regression models meet the parallel lines test. Moreover, the parallel lines test for the regression models of set 2 is all non-significant.

Set 1: Individual component of the context
Four models have been developed using ordinal logistic regression. Each model contains the characteristics of the individual component of the context that were significant in the bivariate analyses. Table 24 presents the

results of the different models. Each model consists of a p-value and Pseudo-R2 value to assess the model's performance, a log-likelihood value to indicate the goodness of fit of the model, and the coefficients and p-values of the independent variables.

Table 27: The results of the ordinal regression models of set 1: only individual and land-use component of the context

Ordinal Logistic Regression Models Set 1									
Variable	Category	Overall transport poverty		Instance-based commuting		Instance-based shopping		Instance-based leisure	
		Odd Ratio	p-value	Odd Ratio	p-value	Odd Ratio	p-value	Odd Ratio	p-value
Model p-value			0.07		0.51		0.01		0.52
Pseudo R2		0.01		0.005		0.06		0.02	
Log-likelihood		-233.44		-210.39		-156.92		-197.25	
Age	35-	0.46	0.143						
	35-65	0.40	0.075						
	65+	0	0						
Education	Primary					0	0		
	Secondary					0.80	0.636		
	Tertiary					0.43	0.060		
Income	Low			1.78	0.190	1.32	0.584	1.41	0.419
	Middle			1.87	0.156	0.64	0.416	1.00	0.986
	High			0	0	0	0	0	0
	No indication			1.83	0.262	0.96	0.951	1.12	0.820
Household								1.08	0.107
Urban Density	Very high							0	0
	High							1.19	0.658
	Moderate							0.67	0.287
	Little							0.79	0.592
	None							0.60	0.393
Car Access	Private								
	Borrowed								
	None								
Driver's License	Yes	0.31	0.065			0.46	0.218	1.04	0.947
	No	0	0			0	0	0	0
Mode of transport	Bicycles					0.76	0.620		
	Other					1.96	0.236		
Cut values	/cut1	-2.13		0.91		-0.26		1.03	
	/cut2	0.56		3.00		1.86		3.12	

Two out of four models show a non-significant p-value, including instance-based transport poverty for commuting, and instance-based transport poverty for leisure. The non-significant p-values for these models mean that the included independent variables do not result in a better prediction of the dependent variable than a null model without any independent variables. The model of overall transport poverty shows a significant p-value for the alpha level of 0.90. This study accepts the increased chance of type 1 errors by stating that this model is significant. The model for instance-based transport poverty for shopping is significant, indicating that the independent variables perform better than a null model with zero independent variables.

Comparing the performances of the models is not possible due to the insignificance of the models. However, the R2 and log-likelihood ratios still show that there are no major differences in the performances of the models. The Pseudo R-squared values of the models are very low, far below the acceptable range. According to the benchmark for Pseudo R-squared, the acceptable range for behavioral studies is between 0.2 and 0.4 (Hemmert et al., 2016). The low Pseudo R-squared values indicate that only a very small proportion of variation in the level of transport poverty can be predicted with the set of independent variables.

Another way to compare the models is by looking at the log-likelihood values of the models. The aim of the log-likelihood value is to reach the maximum likelihood (UCLA, 2021). However, in this study, it is difficult to compare the log-likelihoods of the models. Significant models often have higher log-likelihood values than non-significant models. For this reason, the log-likelihood of the instance-based transport poverty for shopping is higher than the log-likelihood values of the other models. Even when the models are assumed to be significant, the log-likelihoods are difficult to compare due to differences in the number of independent variables and sample size.

Comparing the performances of the different models, the overall transport poverty model shows the lowest log-likelihood value. This would indicate that instance-based transport poverty models are better at estimating a transport poverty level than overall transport poverty models.

Interpretating the results
The odds ratios cannot be interpreted due to the insignificance of the models. However, when assuming that the models are significant, the models show that only a few variables are significant. This section will explain the conclusions based on the significant independent variables for each transport poverty model.

Overall transport poverty:

- Age: The significant p-value in the model of overall transport poverty suggests that individuals between the ages of 35 and 65 tend to have a lower probability of experiencing a higher category in the level of transport poverty than older individuals. This is because the odds ratios of the age category are lower than 1.
- Driver's license: Also, the presence of a driver's license results in a lower probability of experiencing a higher category in the level of transport poverty.

Instance-based transport poverty for commuting:
No independent variables show a significant p-value. Therefore, it is assumed that the model does not include the independent variables that influence the level of instance-based transport poverty for commuting.

Instance-based transport poverty for shopping:

- Education: The odds ratio of 'tertiary education' shows that individuals with a high degree decrease the probability of experiencing an outcome in a higher transport poverty category than the baseline (baseline is category 1) compared to individuals with a primary education degree.

Instance-based transport poverty for leisure:
No independent variables show a significant p-value. Therefore, it is assumed that the model does not include the independent variables that influence the level of instance-based transport poverty for leisure.

Set 2: The complete context
Next, three new regression models have been developed for the three instance-based transport poverty variables. This time, the characteristics of all four components of the context could be added to the model as independent variables. The characteristics of the transportation and temporal component of the context were added without any bivariate analysis upfront, as the characteristics are directly supported by literature to have a relation with transport poverty. Moreover, the explorative design of these models requires the characteristics to be tested.

Table 28 presents the results of the different models. Each model consists again of a p-value and Pseudo-R2 value for assessing the model's performance, a log-likelihood value to evaluate the goodness of fit of the model, and the coefficients and p-values of the independent variables.

Table 28: The results of the ordinal regression models of set 2: all significant components of the context included

Ordinal Logistic Regression Models Set 2							
Variable	Category	Instance-based commuting		Instance-based shopping		Instance-based leisure	
		Odd Ratio	p-value	Odd Ratio	p-value	Odd Ratio	p-value
Model p-value			0.000		0.009		0.018
Pseudo R2		0.103		0.073		0.070	
Log-likelihood		-189.61		-155.91		-187.02	
Age	35-						
	35-65						
	65+						
Education	Primary			0	0		
	Secondary			0.85	0.740		
	Tertiary			0.39	0.044		
Income	Low	2.15	0.101	1.01	0.973	1.26	0.606
	Middle	1.49	0.392	0.63	0.399	0.82	0.675
	High	0	0	0	0	0	0
	No indication	1.82	0.301	0.81	0.749	1.08	0.880
Urban Density	Very high					0	0
	High					1.00	0.998
	Moderate					0.63	0.257
	Little					0.75	0.543
	None					0.54	0.341
Household						1.11	0.057
Car Access	Private					0	0
	Borrowed					0.86	0.725
	None					0.14	0.113
Driver's License	Yes			0.50	0.300	0.38	0.337
	No			0	0	0	0
Mode of transport	Bicycles			1.00	0.998		
	Other			1.80	0.307		
Travel Time		1.02	0.000	1.01	0.151	1.004	0.077
Mode choice	Bike	0	0			0	0
	Public Transport	1.25	0.640			5.98	0.003
	Walking	2.49e-06	0.981			1.58	0.452
	Two-wheeler	2.34	0.284			4.39	0.035
	Car	2.34	0.016			1.28	0.440
	Other	X	X			9.49	0.029
Cut values	/cut1	2.36		-1.23		1.54	
	/cut2	4.75		1.66		3.79	

All three models show a significant p-value at for the model. The significant p-value of these models means that the included independent variables result in a better prediction of the dependent variable than a null model without any independent variables. However, the Pseudo R2 values of the models still do not meet the acceptable benchmark (Hemmert et al., 2016). In comparison with the models of set 1, the Pseudo R2 values have increased for the models of commuting and leisure. However, this increase is also influenced by the fact that the models are now significant, which was not the case in set 1. The model of shopping also shows an increase in the Pseudo R2, but only with a very small value. Commuting has made the biggest improvement, with an increase in Pseudo R2 of 0.098.

Comparing the log-likelihood values of set 2 with the log-likelihood values of set 1 also indicates that the models of commuting and leisure have improved with the addition of the characteristics of the transportation component of the context. The log-likelihood of shopping has increased as well, but only with a very small value. The log-likelihood values are also higher than the log-likelihood value of the overall transport poverty model in set 1. However, conclusions about these differences should be interpreted carefully, as it is statistically not possible to calculate whether the differences in log-likelihood values are significant. This is because the models differ in their independent variables and sometimes also in sample size.

Interpretating the results
Looking at the odds ratios and significance of the independent variables themselves, the significance of some variables changed. This section will explain the conclusions based on the significant independent variables for each transport poverty model.

Instance-based transport poverty for commuting

- Income: Low income shows a significant result, and therefore, the odds ratio of the variable can be interpreted as an increase in the probability of experiencing an outcome in a higher transport poverty category than the baseline (baseline is category 1) compared to individuals with high income.
- Travel Time: The travel time of a trip shows a significant result with an odds ratio above 1. This indicates that a one-unit increase in travel time increases the probability of experiencing an outcome in a higher transport poverty category than the baseline (baseline is category 1).
- Mode choice (Car): Trips with a mode choice of car show a significant result, which means that the odds ratio can be interpreted as an increase in the probability of experiencing an outcome in a higher transport poverty category than the baseline (baseline is category 1) compared to individuals with a mode choice of a bike.

Instance-based transport poverty for shopping

- Education: The odds ratio of 'tertiary education' shows that individuals with a high degree decrease the probability of experiencing an outcome in a higher transport poverty category than the baseline (baseline is category 1) compared to individuals with a primary degree.

Instance-based transport poverty for leisure

- Travel Time: The travel time of a trip shows a significant result with an odds ratio above 1. This indicates that a one-unit increase in travel time increases the probability of experiencing an outcome in a higher transport poverty category than the baseline (baseline is category 1).
- Mode choice (Public Transport): Trips with a mode choice of public transport show a significant result. The odds ratio indicates an increase in the probability of experiencing an outcome in a higher transport poverty category than the baseline (baseline is category 1) when traveling by public transport compared to individuals with a mode choice of a bike.
- Mode choice (Two-wheeler): Trips with a mode choice of a two-wheeler show a significant result. The odds ratio indicates an increase in the probability of experiencing an outcome in a higher transport poverty category than the baseline (baseline is category 1) when traveling by a two-wheeler compared to individuals with a mode choice of a bike.
- Mode choice (Other): Trips with a mode choice of 'other' show a significant result. The odds ratio indicates an increase in the probability of experiencing an outcome in a higher transport poverty category than the baseline (baseline is category 1) when traveling by another mode of transport compared to individuals with a mode choice of a bike.

Interpretation of combined results of set 1 and set 2
Comparing the performances of the regression models shows that Pseudo R2 and log-likelihood values in set 2 have improved compared to the values of set 1. These improvements indicate that the inclusion of the transportation component of the context increases the portion of variation in the level of transport poverty

that can be explained with the independent variables. However, the Pseudo R2 values do not meet the acceptable benchmark in any of the models. Therefore, it can be concluded that the context of transport poverty only explains a small portion of the variation present within the levels of transport poverty. Moreover, it is likely to assume that there are other characteristics of the context that better explain the variation in transport poverty levels.

The interpretation of the independent variables
The models in set 2 are significant, which means that the included independent variables result in a better prediction of the dependent variable than a null model without any independent variables. The fact that the different instance-based transport poverty models contain different independent variables allows us to assume that the trip purpose of the context determines which other characteristics of the context play a role in the construction of the level of transport poverty. This assumption also presumes that the effect of a characteristic of the context can differ based on the trip purpose the context is referring to.

Analyzing the significance of the independent variables across the different models shows that characteristics differ in their significance across the different models. This result provides an additional reason to assume that the effects of the characteristics are not constant across an individual's level of transport poverty. To illustrate this phenomenon, the results for the significant characteristics from the different models will be clustered and discussed in the next section.

- Income: The income variable only shows a significant result in the regression model of instance-based transport poverty for commuting. In this model, low income exhibits a significant odds ratio of 2.15, indicating that having a low income increases the probability of experiencing a higher category of instance-based transport poverty for commuting. This relationship does not appear in the models for shopping and leisure, suggesting that income does not influence the instance-based transport poverty levels for these trip purposes.
- Education: The 'tertiary' education category shows a significant result in both regression models of instance-based transport poverty for shopping. Compared to set 1, the odds ratios decreased in set 2 in favor of individuals with a tertiary degree. This suggests that the effect has become stronger now that the context is better defined.
- Travel Time: Travel time shows significant results in both the model of instance-based transport poverty for commuting and instance-based transport poverty for leisure. The odds ratios are similar to each other, indicating that an increase in travel time increases the probability of experiencing a higher transport poverty category than the baseline (baseline is category 1). The instance-based transport poverty level for shopping does not indicate a significant result, suggesting that travel time does not have the same effect as for commuting or leisure trips.
- Mode Choice: Different modes of transport show significant results across the various regression models. Also, the odds ratios differ between models, suggesting that mode choices have different effects on the level of transport poverty depending on the trip purpose. Notably, there are high odds ratios in the instance-based transport poverty model for leisure. Compared to biking, other mode choices increase the probability of experiencing a transport poverty outcome in a higher transport poverty category than the baseline (baseline is category 1). However, it's worth noting that existing literature on car dependency and transport poverty typically shows that car use reduces the level of transport poverty (Banister, 2019; Mattioli, 2021).).

8 Conclusion and Discussion

The aim of the research is to demonstrate that instance-based transport poverty can provide valuable insights into the effect of the context on an individual's level of transport poverty. It aims to show that different contexts might be related to different levels of transport poverty. Integrating context into the assessment of transport poverty can be the first step in understanding how transport poverty affects individuals. Obtaining practical insights into the characteristics that lead to transport poverty can help bridge the knowledge gap that exists between transport poverty and finding solutions to address social exclusion resulting from the inability to travel.

8.1 Conclusions of sub questions

To answer the main research question, "How can the concept of instance-based transport poverty provide insights into the effect of the context on an individual's level of transport poverty?" a literature review was conducted, leading to the development of four sub-research questions. This chapter will first address the four sub-questions and later combine the insights to answer the main research question.

1. *How can instance-based transport poverty be measured?*

The concept of transport poverty is designed to identify factors that may lead to an individual's social exclusion due to limitations in their mobility. Lucas (2016) developed five conditions to identify individuals experiencing transport poverty within the scope of their daily activities. These conditions are derived from four key components of mobility: affordability, mobility poverty, accessibility, and externalities. To measure the level of transport poverty, these five conditions have been translated into nine indicators, forming the basis of the Transport Adequacy Scale (Ettema et al., 2023). To determine an individual's level of transport poverty, participants are asked to assess the presence of these nine indicators in a specific situation, typically a past trip. The results are then clustered on a 5-point Likert scale, ranging from "strongly agree" to "strongly disagree," to determine the individual's level of transport poverty.

2. *How can the context of transport poverty be operationalized?*

The context of transport poverty in this study refers to the situations in which transport poverty exists or occurs and helps to explain the concept of transport poverty. Trips are chosen as the medium that reflects the situations in which transport poverty can happen. To define a trip, this study had to determine the characteristics that a trip consists of. Literature on the concept of accessibility showed significant overlaps with the common understanding of transport poverty in that both accessibility and transport poverty require an understanding of the components that facilitate or constrain participation in activities. Therefore, the context of transport poverty has been operationalized in this study as the trip characteristics that facilitate or constrain participation in activities.

In this study, the context of transport poverty has been operationalized according to four different components. The individual component of the context refers to the sociodemographic characteristics and mobility resources of the individual, corresponding to the capabilities of the individual that have been studied in the context of transport poverty in previous literature. The land-use component of the context refers to the trip purpose of the trip that is being reflected upon and is suggested to be fixed to enable comparisons of different levels of transport poverty with each other. The transportation context refers to the travel cost and travel time of the trip that is being reflected upon and is assumed to be related to the mode choice and travel distance of the trip. Lastly, the temporal component of the context refers to the starting time of the trip.

3. *How can variation within an individual's level of transport poverty be defined and operationalized?*

Variation in an individual's level of transport poverty can be defined as the significant differences between two or more levels of transport poverty. However, stating that an individual's level of transport poverty contains variation is only valid when multiple different contexts have been evaluated and assessed. If there were no variation in an individual's level of transport poverty, the levels of transport poverty must remain the same for the different trips made by the individual. Testing for variation, therefore, requires the assessment of two or more levels of transport poverty that differ from each other in their context to ensure that they represent different trips.

The variation in an individual's level of transport poverty could be operationalized using the basic formula of difference, which involves subtraction. However, stating that the differences are significant requires a statistical test called the Wilcoxon signed-rank test. Four different levels of transport poverty per participant have been examined with the signed-rank tests to determine the presence of variation in the individual's level of transport poverty. One level represents the overall level of transport poverty for individuals and reflects upon the nine indicators of transport poverty from the perspective of the individual's daily life. The other three transport poverty levels represent instance-based transport poverty levels that are dedicated to trips with predefined trip purposes. By making the participant reflect upon their most recent trips for three different activities—commuting, shopping, and leisure—it was ensured that the participant would use different contexts in determining the three levels of instance-based transport poverty.

The results of the signed-rank tests did show that variation in an individual's level of transport poverty becomes apparent when comparing the levels of transport poverty for trips with different trip purposes. This assumes that there is a relation between the purpose of a trip and the level of transport poverty. However, the causation between the trip purpose and the variation in the individual's level of transport poverty cannot be concluded, as it is not certain that trips with the same trip purpose always result in the same level of transport poverty for an individual. It is more reasonable to believe that a change in any of the characteristics of the context can cause variation within an individual's level of transport poverty. Therefore, measuring variation can be operationalized by comparing trips that share a common characteristic because it has been fixed at the start. For example, this study fixed the trip purpose characteristic, but the mode choice could also have been fixed to establish instance-based transport poverty levels for different modes of transport, which could then be compared with each other.

Still, signed-rank tests or similar statistical tests that can determine the presence of a significant difference between two datasets can be used to operationalize and examine the variation present in an individual's level of transport poverty.

4. *To what extent does the inclusion of the context improve the estimation of an individual's level of transport poverty?*

To determine the effect of the characteristics of the context on individuals' levels of transport poverty, ordinal logistic regression models have been conducted. The performances of these models indicate to what extent the characteristics of the context can explain the variation present within an individual's level of transport poverty. Two sets of ordinal logistic regression models have been created to determine the effect of the context on individuals' levels of transport poverty. In the first set (set 1), the aim of the ordinal logistic regression models is to compare the performances of the instance-based models with the overall transport poverty model. The instance-based transport poverty levels include knowledge of the land-use component of the context, as the levels of instance-based transport poverty refer only to one specific trip purpose, instead of multiple, which is assumed to be the case in overall transport poverty. The second set (set 2) includes regression models that incorporate characteristics from all components of the context. The aim of these models is to show that the inclusion of the transportation and temporal components of the context improves the performance of the models.

The results of the different regressions show that the performances of instance-based transport poverty models are better than the performance of the overall transport poverty regression model. In the first set, no conclusion can be made about the effect of setting the trip purpose to one specific trip purpose, as there are no significant differences between the performances of the models in set 1. Moreover, three out of four models are insignificant, indicating that the characteristics of the context included as independent variables do not predict the variation in the levels of transport poverty better than the null model. However, when comparing the model performances between set 1 and set 2, it becomes evident that the inclusion of the transportation and temporal components of the context improves the performances of the instance-based transport poverty models. The improvements range from an increase in Pseudo R2 between +0.027 and +0.109.

The results of the ordinal logistic regression models provide reason to conclude that defining more characteristics of the context improves the estimation of an individual's level of transport poverty compared to models that do not incorporate characteristics from the context. This conclusion is based on the improvements in performance of the models when characteristics of the transportation and temporal components of the context are added. However, as can be seen by the comparison of the three instance-based transport poverty models in set 2, identifying the influential characteristics is essential for obtaining a good estimation of the effect of the context. The model of instance-based transport poverty shows the lowest increase in performance, which is suspected to be the result of the insignificance of the characteristics from the transportation and temporal components of the context. This observation indicates that the characteristics of the context included in the model do not predict the instance-based transport poverty levels to the same extent for every trip purpose. The results of the regressions support this conclusion by providing evidence that the significance of characteristics differs between instance-based models.

8.2 Conclusion of the main research question

With the conclusions to the sub questions, a conclusion for the main research question can be developed. The main research question was stated as follows:

How can the concept of instance-based transport poverty provide insights about the effect of the context on an individual's level of transport poverty?

The concept of instance-based transport poverty can offer insights into the effect of the context on an individual's level of transport poverty by associating the defined characteristics of the context with an individual's level of transport poverty. These characteristics can be grouped into four components, which collectively encompass the factors that influence individuals' opportunities to participate in activities in different locations. When defining the level of transport poverty with a quantitative value, the context can determine the conditions under which this level of transport poverty is applicable.

Various insights can be derived from the use of instance-based transport poverty levels. First, by estimating transport poverty levels while considering their context, one can gain insights into whether levels of transport poverty vary within an individual's life. Understanding when and where an individual experiences transport poverty provides valuable knowledge about the circumstances and conditions under which transport poverty occurs. This localization of transport poverty can only be achieved when the context of the transport poverty level is known since these levels must be traceable through characteristics that exist in an individual's life.

Second, comprehending the context enables the quantification of the impact of context-related characteristics on an individual's level of transport poverty. By quantifying the connection between these characteristics and the level of transport poverty, instance-based transport poverty levels allow for a detailed examination of these effects. Data analysis tools such as regressions can be employed to determine the extent to which context-related characteristics relate to the variation that can occur in transport poverty levels. However, it can be challenging to establish how these characteristics relate to a specific level of transport poverty. On the other hand, clustering transport poverty levels based on shared context-related characteristics can provide more comprehensive insights by generalizing the effect across multiple trips. The cluster variable that these trips have in common can be used to generate insights into the impact of the context, as demonstrated in this study with the clusters of trip purposes.

Ultimately, instance-based transport poverty levels offer a more detailed understanding of the situations in which transport poverty occurs, paving the way for further investigations to uncover its root causes.

8.3 Interpretations of conclusions

The introduction of instance-based transport poverty has established a connection between the concept of transport poverty and an individual's revealed travel behavior. When considering the presence of transport poverty using instance-based transport poverty levels, the characteristics of the context act as a bridge between the concept of transport poverty and an individual's travel behavior. The level of detail provided by the connection between the nine indicators of transport poverty and the revealed travel behavior, as influenced by the context, can help individuals pinpoint which trips experience transport poverty conditions. This level of detail complements the conditions stated by Lucas (2016) and Ettema (2023), whose statements can only be broadly categorized as 'agree' or 'disagree,' overlooking the size and impact that transport poverty can have. The lack of insights regarding the context within the concept of transport poverty has been a gap in the existing literature, making it challenging for researchers to communicate the concept of transport poverty to mobility policymakers and transport engineers (Lucas et al., 2016).

Acknowledging that transport poverty can be inconsistent provides a fresh perspective on the concept. While transport poverty literature argues that "a person is transport poor if, in order to satisfy their daily basic activity needs, at least one of the transport poverty conditions applies" (Lucas et al., 2016), instance-based transport poverty suggests that the label of 'transport poor' does not universally apply to every context in an individual's daily life. This introduces complexities in defining an individual as 'transport poor' as the presence of transport poverty conditions can vary, impacting the level of transport poverty experienced. For example, consider an individual who wishes to visit their parents living in a rural area outside the city. The individual is constrained by the schedule of the public transport system when determining the day of their visit. Adequate service is available on weekdays, but no service operates on weekends. Consequently, the individual must cycle to their parents' house on weekends. According to Lucas's transport poverty definition, the individual would be classified as transport poor. However, when measuring instance-based transport poverty during weekdays when the trip is feasible by public transport, no transport poverty is detected, as the destination is accessible. Traveling on a weekday enables the individual to maintain a reasonable quality of life by sustaining social relationships with their parents.

This example illustrates the complexity of labeling an individual as transport poor. It raises questions about whether society should define an acceptable benchmark for transport poverty. Is it acceptable to have a suitable travel option for 5 out of 7 days, or should society strive for ultimate mobility freedom, ensuring that everyone can access all destinations at all times? The answer depends on the impact of weekday and weekend trips on an individual's life. Ultimately, transport poverty becomes a problem only when it excludes individuals from participating in activities.

While overall transport poverty levels generalize the effects of weekday and weekend accessibility on an individual's life, instance-based transport poverty levels differentiate between the effects of weekday and weekend trips when measured separately. This level of detail, derived from contextual examples, can explore the genuine impact of experienced transport poverty. Instance-based transport poverty enables a more detailed study of the effects of variations in trip characteristics, such as cycling versus using public transport services, on an individual's level of transport poverty concerning the context.

8.4 Limitations

This study cannot provide an answer to the discussion initiated in the previous section, as it does not take into account the effect of transport poverty on the experience of social exclusion. This conceptual limitation restricts the study's ability to draw conclusions from the case studies that have been examined. A part of this limitation stems from the lack of clear definitions for the categories of transport poverty. Currently, the categories of transport poverty are only defined numerically, and their practical implications have never been clearly defined. Consequently, it is impossible to draw any conclusions about the real-world effects of these characteristics, as the numbers are not tied to any concrete implementation of transport poverty, such as the definition of low and high levels of transport poverty. Expanding the theoretical framework of the study with theories on well-being could have potentially addressed this issue. However, due to time constraints within this thesis, the scope of the theoretical framework was limited solely to the definition of the context.

During the study, several statistical limitations also became apparent and should be discussed. Firstly, the sample of this study differs from the general Dutch population. Participants were often highly educated and had a Western background, which is not representative of the entire Dutch population. The distribution of the survey may have contributed to this bias towards highly educated individuals, as the student's personal network was used to collect participants. Therefore, the results of the study should be interpreted cautiously, particularly when examining the significance and odds ratios of the independent variables. Furthermore, the survey's format may have played a role in biasing towards highly educated and Western participants. The survey was presented via a weblink or QR code, both of which required participants to have a certain level of digital literacy to access. Individuals without these digital skills were excluded, even if they intended to complete the survey. Additionally, the survey contained 72 questions, which could be quite extensive. The survey's length might have impacted participants' motivation to complete it, potentially resulting in a higher percentage of participants with a greater willingness to participate in studies in general. External motivations, such as financial rewards or feedback on the participant's transport poverty level, could have attracted a more diverse group of participants.

Another statistical limitation arises when interpreting the odds ratios of the regression models. The regression models only include transport poverty categories 1, 2, and 3, as categories 4 and 5 had sample sizes that were too small. Consequently, the models interpret category 3 as the highest possible category, though it should be considered the middle category. This limitation could potentially affect the magnitude of the odds ratios. However, the increase in odds ratios can still provide an indication of the direction of the effect. To reduce the dependence on a sufficient number of observations per category in the future, different analysis methods can be applied. Factor analysis, for example, can offer a good alternative in which new values are created based on the transport poverty factor represented by the collectives of the transport poverty indicators. However, it's important for the indicators of transport poverty to exhibit good internal consistency and relatively low uniqueness values to meet the assumptions for factor analysis.

Considering the study's results, it's worth noting that only the most recently completed trips were included in instance-based transport poverty levels. As transport poverty studies examine the effect of mobility on social exclusion (Khan et al., 2015), it's desirable to understand how mobility influences an individual's ability to participate in activities to fulfill basic daily requirements (Lucas et al., 2016; Allen and Farber, 2019). Focusing solely on revealed travel behavior limits the data to successfully completed trips, whereas understanding the decisions for activities that were not successfully completed by individuals is also essential. This limitation may have contributed to the lack of normality within the dependent variables, as responses were biased towards the lower categories of transport poverty.

Another consequence of this limitation is that the effects of the characteristics cannot be directly interpreted as representative of the context's impact on an individual's level of social exclusion. Since the levels of transport poverty pertain to trips that have been taken, these levels are assumed to contribute positively to an individual's social exclusion. However, interpreting the odds ratios of this study in the context of social exclusion, it would appear that both positive and negative relations between characteristics and levels of transport poverty improve an individual's social exclusion. Nevertheless, it is theoretically expected that characteristics increasing a level of transport poverty would worsen an individual's social exclusion. Therefore, the study's design is limited in its relation to social exclusion, which can be problematic when attempting to determine the connections between the context of transport poverty and an individual's level of social exclusion.

8.5 Recommendations for future research

As this is the first study to introduce the concept of instance-based transport poverty, the implementation of this concept was limited. Nevertheless, this study has served as a valuable learning experience in terms of how to define and interpret the context of transport poverty with instance-based transport poverty. This allows for recommendations to be made for future research.

First and foremost, future research should consider including trips that have been canceled by individuals when evaluating the level of transport poverty. Incorporating such trips into the concept of instance-based transport poverty would entail a shift in focus from revealed travel behavior to the decision-making process behind travel behavior. An emphasis on the decision-making process would require individuals to reflect on the transport poverty level of their mobility opportunities. Intentions could serve as a useful starting point here, as they are known, according to the theory of planned behavior, to immediately influence behavioral actions, even before individuals have made their choices (Kan & Fabrigar, 2017). Evaluating the potential transport poverty level of travel intentions could thus be a way to encompass all trips.

Secondly, this study employed a fixed set of independent variables; however, there are many more characteristics that could be included within the components of the context. For instance, land-use patterns were operationalized as trip purposes, but numerous other characteristics related to the land-use system have the potential to influence the level of transport poverty. The absence of influential characteristics might be a reason for the models' suboptimal performance. Additionally, missing influential characteristics could explain certain characteristics exhibiting unusual odds ratios. For example, the odds ratios of urban density in the model of instance-based transport poverty for leisure do not follow a logical order. These odd ratios could potentially be influenced by another characteristic acting as a mediator in the relationship between urban density and transport poverty levels.

Completing the context is crucial not only for causality but also for defining the categories of transport poverty. To determine which level of transport poverty can be classified as low and which as high, it is essential to comprehend the real-life situations in which it occurs. Only when the context is fully understood can we provide thoughtful answers regarding which situations are socially acceptable in terms of transport poverty. Therefore, future research should focus on identifying additional characteristics of the context to provide a comprehensive understanding of transport poverty's context.

Finally, researchers are strongly encouraged to apply the concept of instance-based transport poverty in longitudinal studies. Longitudinal studies can collect multiple instance-based transport poverty levels for the same context over time. Firstly, by examining whether the level of transport poverty remains constant over two trips with identical contexts, researchers can conclude whether the effects of the context on the level of transport poverty are consistent. Secondly, when changes in the level of transport poverty do occur, the data can be used to identify new influential characteristics that contributed to the variation in transport poverty levels. Researchers could ask participants to reflect on their trips and specify which factors outside of the defined context changed over time. This approach enables the study of the influence of more psychological characteristics of the context, such as attitudes and preferences, on the level of transport poverty.

9 Policy recommendations

As mobility and its infrastructure are organized by public institutions, solutions for transport poverty are likely to be implemented through policy interventions. It is, therefore, essential that the concept of instance-based transport poverty can be implemented within policies by policymakers. There are multiple ways in which the concept of instance-based transport poverty can provide insights for policymakers to successfully address or contribute to the problem of transport poverty. This chapter will explain different practical implementations of instance-based transport poverty and provide recommendations on how to use the concept in policy making.

9.1 Identification of vulnerable citizens

To solve the problem of transport poverty, it is important to identify the citizens who need to be targeted by policy implementations. Public organizations have limited resources to allocate to solving transport poverty, making it imperative that the solutions are both effective and accurate. Targeting the right citizens is, therefore, crucial for the efficiency of policy interventions.

Instance-based transport poverty levels can be applied to identify vulnerable citizens. Firstly, the measurement scale of instance-based transport poverty can assign levels of transport poverty to the trips that citizens make in their daily lives. By comparing these levels of transport poverty among citizens, it becomes possible to rank citizens from resilient to vulnerable based on their levels of instance-based transport poverty. If this study were to be applied to identify vulnerable citizens, the results would indicate that citizens with low or middle incomes are vulnerable during commuting trips. Policy makers should, therefore, pay attention to the aspects of transport affordability when seeking to improve transport poverty conditions for commuting trips.

One benefit of instance-based transport poverty is that it can help policymakers make detailed distinctions between citizens and their vulnerability to transport poverty. While the results show that low-income citizens have a highly increased chance of experiencing a higher level of transport poverty during commuting, this same effect is not present within shopping and leisure trips. This level of detail is desired by policymakers to effectively implement policy interventions.

Secondly, by combining the results of multiple instance-based transport poverty levels, policymakers can determine whether the conditions of transport poverty occur systematically. Citizens who experience the conditions of transport poverty systematically are expected to be more vulnerable because the consequences of transport poverty can accumulate over time, resulting in negative social consequences that can affect individual characteristics (Lucas et al., 2016). This makes the frequency of experiencing high instance-based transport poverty levels an indicator of a citizen's vulnerability.

One significant challenge in identifying vulnerable citizens is the underdefined relation between transport poverty and social exclusion, which affects the definition of vulnerability. Without knowing which levels of transport poverty cause problematic situations in which citizens are socially excluded, it is difficult to identify who is vulnerable. The lack of a benchmark for transport poverty, representing the level of transport poverty that is no longer socially acceptable, might result in mistakenly identifying citizens as vulnerable or robust.

9.2 Creating a benchmark for transport poverty

Fortunately, the concept of instance-based transport poverty can also contribute to the creation of a benchmark for transport poverty. Social discussions need to be held regarding which transport poverty levels are acceptable or not in various contexts. Understanding the impact of the context helps to inform these discussions, as the consequences of the characteristics of the context are made clear by the instance-based transport poverty levels. This allows societies to make informed judgments. In this way, it is easy to create a division between which contexts are acceptable and which are not. However, when it comes to the details of the characteristics, it is harder to determine what is acceptable and what is not. Similar to the basic insurance of healthcare, in which social acceptance determines which treatments are covered and which are not, societies must decide which transport poverty conditions are acceptable in which contexts, and which conditions require solving with collective resources.

Although this study did not make use of this method, interactions between characteristics can be included in the context to add more detail to the context. Interactions result from two or more variables interacting with each other, creating a new variable that represents the interaction. This interaction often involves more than just the sum of the two variables, as the effect of one variable changes due to the effect of the other variable. For example, the travel distance of a trip can be determined by the mode of transport. However, the variable "mode of transport" requires an interaction with the variable "weather conditions," as weather conditions can change the effect of the mode of transport on travel distance. This added level of detail can help determine which levels of transport poverty are acceptable in various contexts.

In the social discussion, it is important to provide clear examples of contexts that highlight the dilemmas involved in the social acceptance of transport poverty. As there are many different possible contexts, providing clear examples of acceptable and unacceptable situations in which characteristics are isolated can facilitate judgment. It is not desirable to have a benchmark that depends on complex rules and exceptions, as this would make implementing the benchmark more complex.

9.3 Testing the effect of policy interventions

When the characteristics of the context are known in the levels of instance-based transport poverty, it is also possible to measure the effects of policy interventions that focus on these characteristics. By isolating the change in a characteristic in an experiment, policy interventions can test the effect of the intervention on an individual's level of transport poverty.

There are multiple possible methods in which instance-based transport poverty can be applied to examine the effect of a policy intervention. These methods differ on various aspects, such as the choice of data sources, the selection of appropriate indicators to measure transport poverty, the geographic scale of analysis (e.g., neighborhood, city, region), and the time frame considered (cross-sectional or longitudinal). The choice of these methodological aspects can significantly influence the accuracy and reliability of the findings, making it crucial to carefully select and justify the approach that best aligns with the research objectives and available data. Furthermore, sensitivity analyses and robustness checks should be employed to ensure the validity of the results and account for potential biases or limitations inherent in the chosen method. The choice of the method should, therefore, align with the required accuracy for determining the effects.

9.4 Determining where responsibilities are located

Knowing whether policy implementations are effective is not only beneficial for ensuring that resources have been spent responsibly but also for understanding which organization should create and apply policy interventions to solve transport poverty. As the context consists of many different characteristics that can be influenced by policy interventions, it is known that not all characteristics of the context are linked to the mobility system. Characteristics from the individual component of the context might be related to the financial or social departments of the local authorities, while characteristics from the land-use component can be related to the urban planning department of an area. Only these organizations have access to funds to pay for policy implementations that align with their expertise, so the responsibility for implementing policy interventions should lie with the organizations and departments that have access to the funds.

For this reason, this study argues that it is not only up to the mobility department of public organizations to create and implement policy interventions that address the problem of transport poverty. Public organizations capable of influencing a characteristic should be in charge of policy interventions related to that characteristic. Therefore, it is recommended to understand whether a characteristic of the context is related to an individual's level of transport poverty before public organizations are tasked with solving the problem of transport poverty with policy interventions. When a characteristic is labeled as influential, it is necessary to assign a public organization in charge of all policy interventions related to that characteristic.

9.5 Key learning points

As the example policy implementations on instance-based transport poverty show, it is recommended to have a clear understanding of both the scale and the context of transport poverty. The following key points summarize the key elements that should be at the center of attention when creating policy interventions to tackle the problem of transport poverty:

1. Define what is meant by "transport poor." Policies are bound by their effectiveness, leaving little room for failures. It is, therefore, important to target the right audience, which carries the accurate definition of being transport poor. However, this definition can take various forms, as the lexicon on transport poverty has shown (Lucas et al., 2016). It is essential to have a social, or even political, definition of transport poverty that is accepted locally. A threshold based on different contexts can serve as a guideline for this discussion. Until then, it is advisable to start by targeting individuals who experience the highest level of transport poverty.
2. Understand the consequences of transport poverty levels on an individual's level of social exclusion. It is, therefore, key to define and understand all the characteristics of the context, as these characteristics can be related to an individual's experience of social exclusion.
3. Understand the scope of the policy to determine the level of detail desired within the policy intervention. National policies often do not have enough resources to provide tailor-made solutions for every individual, which requires national public organizations to generalize interventions for certain groups in societies. Local policy interventions, on the other hand, have more flexibility as they target a smaller group of individuals.
4. Define which public organization is responsible for which characteristic of the context. In this way, the stakeholders of a policy intervention are clear from the start.

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10 Appendix

10.1 Appendix A: Pre-defined answers of independent variables

Variable	Values
Driver licence	Yes
	No
Car access	Yes, private car
	Yes, lease car
	Yes, household possess a car
	Yes, I can borrow from friend/family
	Yes, car sharing
	No
	Other
Access to modes of transport	Bike
	Electric Bike
	Speedpedelec
	(Electric scooter)
	Cargo bike
	Motorcycle
	Microcar
	Tractor
	None of the above
	Other
Access to public transport	Bus
	Tram
	Metro
	Train
	Call-up taxi/bus
	None of the above
	Other
Access to shared mobility	Shared car
	Shared bike
	Shared scooter
	Shared cargo bike
	None of the above
	Other
Public transport payment method	OV chipcard with subscription
	OV chipcard without subscription
	Student travel product
	Single tickets
	None of the above
	Other
Mobility aid	Yes, walking cane, crutches, or white cane
	Yes, walker
	Yes, wheelchair
	Yes, mobility scooter
	None of the above
	Other

Variable	Values
Age	18-25
	26-35
	36-45
	46-55
	56-65
	66-75
	76-85
	85+
	I don't want to share this info
Gender	Male
	Female
	Non-binair
	Other
	I don't want to share this info
Ethnical background	Western
	Hispanic/Latino
	Arabic
	African
	Central-Asian
	East-Asian
	African-American
	Multiracial
	I don't want to share this info
	Other
Employment	Fulltime
	Parttime
	Seasonal
	Entrepeneur/self-employed
	Retired
	Student
	Stay-at-home-parent
	Caregiver
	Jobseeker
	Unemployed
	I don't want to share this info
	Other
Income	0-830
	830-1660
	1660-2500
	2500-3330
	3330-4160
	4160-8330
	8330-16660
	16660+
	I don't want to share this info
	I don't know
Education	Primary education
	VMBO, lower HAVO/VWO MBO1
	HAVO, VWO, MBO 2-4
	HBO-/WO bachelor
	HBO-/WO master, PhD

	I dont want to share this information
Household size	[number]
Zipcode	[4 digitis]

10.2 Appendix B: Descriptive results per independent variable

Variable	Response	Percentage
Driver licence	261	100%
Yes	247	95%
No	14	5%
Car access	261	100%
Yes, private car	169	65%
Yes, lease car	21	8%
Yes, household car	34	13%
Yes, borrow friend/family	17	7%
Yes, car sharing	5	2%
No	9	3%
Other	6	2%
Access to modes of transport	Multiple answers possible, N=261	
Bike	192	73%
Electric Bike	103	41%
Speedpedelec	1	0%
(Electric) scooter	28	11%
Cargo bike	4	1%
Motorcycle	15	6%
Microcar	3	1%
Tractor	12	5%
None of the above	9	3%
Access to public transport	Multiple answers possible, N=261	
Bus	179	68%
Tram	29	11%
Metro	38	14%
Train	23	9%
Call-up Taxi/Bus	19	7%
None of the above	65	25%
Access to shared mobility	Multiple answers possible, N=261	
Shared car	52	19%
Shared bike	34	12%
Shared electric bike	28	10%
Shared scooter	80	30%
Shared cargo bike	17	6%
None of the above	104	41%
I don't know	53	21%
Public transport payment method	261	100%
OV chipcard with subscription	55	21%
OV chipcard without subscription	132	51%
Student travel product	16	6%
Single tickets	28	11%
None of the above	30	11%

Mobility aid	Multiple answers possible, N=261	
Yes, walking cane, crutches, or white cane	4	1%
Yes, walker	1	0%
Yes, wheelchair	1	0%
Yes, mobility scooter	1	0%
None of the above	254	99%

Variable	Responses	Percentage
Age	260	100%
18-25	45	17%
26-35	50	19%
36-45	24	9%
46-55	77	30%
56-65	49	19%
66-75	12	5%
76-85	3	1%
85+	0	0%
Gender	260	100%
Male	100	39%
Female	160	61%
Non-binair	0	0%
Other	0	0%
Ethnical background	258	100%
Western	246	95%
Hispanic/Latino	2	1%
Arabic	0	0%
African	0	0%
Central-Asian	0	0%
East-Asian	3	1%
African-American	0	0%
Multiracial	0	0%
Other	7	3%
Employment	260	99%
Fulltime	115	44%
Parttime	86	33%
Seasonal	0	0%
Entrepreneur/self-employed	23	9%
Retired	16	6%
Student	17	7%
Stay-at-home-parent	1	0%
Caregiver	0	0%
Jobseeker	0	0%
Unemployed	2	1%
Income	228	88%
0-830	18	7%
830-1660	30	11%
1660-2500	54	21%
2500-3330	54	21%
3330-4160	35	13%
4160-8330	29	11%
8330-16660	3	2%
16660+	1	0%

I don't know	4	2%
Education	260	100%
Primary education	2	1%
VMBO, lower HAVO/VWO MBO1	31	12%
HAVO, VWO, MBO 2-4	76	30%
HBO-/WO bachelor	79	30%
HBO-/WO master, PhD	72	28%
Household size	260	100%
1	25	10%
2	89	34%
3	51	20%
4	69	26%
5	18	7%
6 and more	8	3%

Multicollinearity matrix

Variable	Age		Income		Gender		Education		Employment		Urban Density		Household	
	p-value	V	p-value	V	p-value	V	p-value	V	p-value	V	p-value	V	p-value	V
Age	-	1												
Income	0.00	0.26	-	1										
Gender	0.51	0.07	0.00	0.32	-	1								
Education	0.00	0.17	0.00	0.28	0.27	0.10	-	1						
Employment	0.00	0.41	0.01	0.20	0.43	0.08	0.061	0.13	-	1				
Urban Density	0.01	0.19	0.59	0.11	0.54	0.10	0.00	0.21	0.42	0.12	-	1		
Household	0.00	0.24	0.00	-0.18	0.57	-0.03	0.89	-0.03	0.16	0.09	0.00	0.21	-	1

Variable	Age		Income		Gender		Education		Employment		Urban Density		Household	
	p-value	V	p-value	V	p-value	V	p-value	V	p-value	V	p-value	V	p-value	Rho
Driver's license	0.00	0.26	0.00	0.21	0.95	0.00	0.01	0.18	0.00	0.27	0.24	0.14	0.37	0.07
Car Access	0.00	0.30	0.01	0.17	0.61	0.06	0.37	0.09	0.01	0.15	0.00	0.27	0.41	-0.05
Mobility Aid	0.02	0.21	0.18	0.13	0.96	0.00	0.53	0.06	0.00	0.19	0.50	0.11	0.06	-0.11
Bicycles	0.08	0.13	0.49	0.09	0.98	0.00	0.09	0.13	0.04	0.15	0.82	0.07	0.21	0.07
Two wheeler	0.26	0.10	0.69	0.07	0.63	0.02	0.13	0.12	0.82	0.03	0.22	0.14	0.84	-0.01
Other	0.96	0.01	0.63	0.08	0.53	0.03	0.00	0.19	0.94	0.02	0.00	0.22	0.43	0.04
No mode	0.25	0.10	0.98	0.02	0.29	-0.06	0.61	0.06	0.01	0.23	0.98	0.03	0.46	-0.04
Bus	0.08	0.13	0.00	0.26	0.45	0.04	0.26	0.10	0.84	0.03	0.00	0.28	0.68	0.04
Tram	0.18	0.11	0.51	0.09	0.58	-0.03	0.04	0.15	0.20	0.11	0.00	0.51	0.02	-0.16
Metro	0.36	0.08	0.88	0.05	0.68	0.02	0.69	0.05	0.36	0.08	0.00	0.27	0.53	-0.03
Train	0.88	0.03	0.33	0.11	0.12	0.09	0.01	0.18	0.35	0.08	0.00	0.26	0.00	-0.17
Call-up Taxi/Bus	0.30	0.09	0.16	0.14	0.21	0.07	0.14	0.12	0.87	0.03	0.90	0.06	0.52	-0.03
No pt	0.04	0.15	0.00	0.22	0.98	-0.00	0.13	0.12	0.70	0.05	0.00	0.39	0.90	-0.01
Shared bike	0.01	0.23	0.25	0.12	0.01	0.15	0.02	0.17	0.29	0.09	0.00	0.37	0.20	-0.07
Shared car	0.00	0.23	0.10	0.15	0.00	0.23	0.00	0.33	0.25	0.10	0.00	0.56	0.04	-0.11
Shared electric bike	0.01	0.18	0.29	0.11	0.01	0.15	0.05	0.20	0.19	0.11	0.00	0.45	0.05	-0.11

Shared scooter	0.02	0.17	0.41	0.10	0.59	-0.03	0.07	0.14	0.10	0.13	0.00	0.30	0.15	-0.06
Shared cargo bike	0.10	0.13	0.78	0.06	0.22	0.07	0.02	0.16	0.04	0.15	0.00	0.43	0.84	-0.00
No shared m	0.21	0.10	0.86	0.05	0.73	-0.02	0.06	0.20	0.45	0.07	0.00	0.47	0.38	0.05
Payment method	0.00	0.30	0.00	0.19	0.05	0.17	0.00	0.27	0.00	0.33	0.00	0.26	0.00	0.11

Variable	Driver's License		Car Access		Mobility Aid		Payment	
	p-value	V	p-value	V	p-value	V	p-value	V
Drivers License	X	1						
Car Access	0.00	0.74	X	1				
Mobility Aid	0.60	0.03	0.90	0.02	X	1		
Payment	0.00	0.30	0.00	0.31	0.21	0.13	X	1

Variable	Driver's License		Car Access		Mobility Aid		Payment	
	p-value	V	p-value	V	p-value	V	p-value	V
Bicycles	0.22	0.07	0.60	0.06	0.24	-0.07	0.00	0.25
Two wheeler	0.42	0.04	0.39	0.08	0.77	0.01	0.32	0.11
Other	0.35	0.05	0.22	0.10	0.57	-0.03	0.08	0.16
No mode	0.39	-0.05	0.61	0.06	0.66	-0.02	0.01	0.20

Variable	Driver's License		Car Access		Mobility Aid		Payment	
	p-value	V	p-value	V	p-value	V	p-value	V
Bus	0.01	-0.15	0.01	0.18	0.16	-0.08	0.02	0.19
Tram	0.02	-0.14	0.00	0.25	0.04	0.12	0.03	0.18
Metro	0.09	-0.10	0.02	0.16	0.73	0.02	0.05	0.17
Train	0.00	-0.24	0.00	0.32	0.35	0.05	0.07	0.16
Call-up Taxi/Bus	0.02	-0.13	0.01	0.18	0.27	0.06	0.55	0.08
No pt	0.03	0.13	0.03	0.16	0.42	0.04	0.00	0.22

Variable	Driver's License		Car Access		Mobility Aid		Payment	
	p-value	V	p-value	V	p-value	V	p-value	V
Shared bike	0.80	-0.01	0.00	0.25	0.37	-0.05	0.00	0.25
Shared car	0.78	-0.01	0.00	0.28	0.25	-0.07	0.00	0.41
Shared electric bike	0.59	-0.03	0.00	0.25	0.43	-0.04	0.00	0.32
Shared scooter	0.99	-0.00	0.00	0.20	0.13	-0.09	0.00	0.25
Shared cargo bike	0.86	-0.01	0.02	0.17	0.54	-0.03	0.01	0.19
No shared m	0.48	0.04	0.01	0.18	0.35	0.05	0.00	0.35

Variable	Bicycle		Two wheeler		Other		No mode	
	p-value	V	p-value	V	p-value	V	p-value	V
Bicycles	X	1						
Two wheeler	0.03	-0.13	X	1				
Other	0.31	-0.06	0.81	-0.01	X	1		
No mode	0.00	-0.69	0.19	-0.08	0.44	-0.04	X	1
Bus	0.07	0.10	0.36	-0.05	0.01	-0.15	0.11	-0.09
Tram	0.45	-0.04	0.41	-0.05	0.15	-0.08	0.28	0.06
Metro	0.35	-0.05	0.35	-0.05	0.36	-0.05	0.51	0.04
Train	0.68	-0.02	0.03	-0.13	0.79	-0.01	0.77	0.01
Call-up Taxi/Bus	0.11	-0.09	0.97	0.00	0.26	-0.07	0.08	0.10
No pt	0.38	-0.05	0.22	0.07	0.00	0.20	0.85	-0.01
Shared bike	0.78	0.01	0.24	-0.07	0.98	0.00	0.85	-0.01
Shared car	0.32	0.06	0.08	-0.10	0.49	-0.04	0.87	0.00
Shared electric bike	0.45	0.04	0.19	-0.08	0.16	-0.08	0.98	0.00
Shared scooter	0.78	0.01	0.16	0.08	0.13	-0.09	0.57	-0.03
Shared cargo bike	0.85	0.01	0.06	-0.11	0.28	-0.06	0.57	0.03
No shared m	0.05	-0.11	0.15	0.08	0.02	0.13	0.33	0.06

Commuting	Travel Distance		Travel time		Starting time		Mode of tranpsort	
	p-value	coefficient	p-value	coefficient	p-value	coefficient	p-value	Coefficient
Travel distance	-	1						
Travel Time	0.00	0.83	-	1				
Starting time	0.98	-0.06	1	-0.02	-	1		
Mode of transport	0.00	0.27	0.00	0.18	0.46	X	-	1

Shopping	Travel Distance		Travel time		Starting time		Mode of tranpsort	
	p-value	coefficient	p-value	coefficient	p-value	coefficient	p-value	Coefficient
Travel distance	-	1						
Travel Time	0.00	0.72	-	1				
Starting time	0.88	-0.06	0.54	-0.08	-	1		
Mode of transport	0.00	0.28	0.16	X	0.02	0.04	-	1

Leisure	Travel Distance		Travel time		Starting time		Mode of tranpsort	
	p-value	coefficient	p-value	coefficient	p-value	coefficient	p-value	Coefficient
Travel distance	-	1						
Travel Time	0.00	0.82	-	1				
Starting time	0.02	-0.16	0.00	-0.21	-	1		
Mode of transport	0.00	0.21	0.00	0.07	0.94		-	1

Appendix C: Result of Parallel lines test

Parallel lines test set 1 – before revision	
Model	P-value
Overall transport poverty	0.4314
Instance-based commuting	0.0000
Instance-based shopping	0.4020
Instance-based leisure	0.0000

Parallel lines test set 1 – after revision	
Model	P-value
Overall transport poverty	0.2891
Instance-based commuting	0.3165
Instance-based shopping	0.9131
Instance-based leisure	0.4809

Parallel lines test set 2	
Model	P-value
Instance-based commuting	0.6198
Instance-based shopping	0.9369
Instance-based leisure	0.7745

Appendix D: English version of survey

Welcome

Thank you for taking the time to fill in this survey. This study is intended only for people living in the Netherlands who are between 18 and 75 years old.

The aim of this study is it learn more about how citizens experience mobility. By filling in this survey, you contribute to scientific insights into the experience of mobility in the Netherlands. This knowlegde will be used to improve mobility policies within the Netherlands.

This survey consists of different sections and will approximately take 10 minutes to complete. The questions of the different sections relate to your available mobility resources, your general opinion about your available mobility system and your personal opinion about specific trips.

During the survey you will be asked to recall specific trips which you have made in the past. We want to ask you fill in the trip characteristics as accurate as possible.

Your travel options

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

1. Do you have a driver's license?
   - o Yes
   - o No
   - o I dont want to share this information

2. Do you have access to a car?
   - o Yes, I have a private car
   - o Yes, I have a lease car
   - o Yes, my household possesses a car which I can use when needed
   - o Yes, I can borrow a car from family/friends when needed
   - o Yes, I make use of a car sharing initiative
   - o No, i don't have access to a car at any circumstances
   - o I dont want to share this information
   - o Other:

3. Which other mode(s) of transport do you possess? (multiple choice)
   - o Bike
   - o Electric Bike
   - o Cargo Bike
   - o Speedpedelec
   - o (Electric) Scooter
   - o Microcar (45 km/h car)
   - o Motorcycle
   - o Tractor
   - o None of the above
   - o I dont want to share this information
   - o Other:

4. Which public transport options are available within 400 meter of your house?
   - o Bus
   - o Tram
   - o Metro
   - o Train
   - o Call-up Bus
   - o None of the above
   - o I dont want to share this information
   - o Other:

5. Which shared mobility options are available within 400 meters of your house?
   - o Shared car
   - o Shared bike
   - o Shared electric bike
   - o Shared cargo bike
   - o Shared scooter
   - o None of the above
   - o I dont want to share this information
   - o Other:

6. Which payment method do you use for public transport?
   - o OV Chipcard with subscription
   - o OV Chipcard without subscription

- Student travel product
- Single ticket(s)
- Irrelevant to me
- I don't want to share this information

7. Do you make use of a mobility aid or device when travelling?
    - Yes, i make use of a walking cane, crutches, or a white cane
    - Yes, I make use of a walker
    - Yes i make use of a(n) (electric) mobility scooter
    - Yes, I make use of a(n) (electric) wheelchair
    - No, i dont make use of a mobility aid or device
    - I dont want to share this information
    - Other:

Your opinion on mobility

The second section asks you to reflect on your opinion regarding your available mobility. Please, indicate to which degree you agree or disagree with the following situations. The situation ask for your general opinion, meaning you reflect on them from your daily life perspective.

8. I need to spend more money on my transportation than i can afford
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly Disagree

9. I spend much more time travelling than I'd like
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly Disagree

10. There is a suitable travel option available when i want to travel
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly Disagree

11. I can easily reach my destinations
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly Disagree

12. I feel safe when travelling
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly Disagree

13. I worry about my road safety when i travel
    - Strongly agree

- o Agree
- o Neutral
- o Disagree
- o Strongly Disagree

14. I can travel without experiencing negative health consequences
    - o Strongly agree
    - o Agree
    - o Neutral
    - o Disagree
    - o Strongly Disagree

15. I can travel in a way that is suited to my physical condition & abilities
    - o Strongly agree
    - o Agree
    - o Neutral
    - o Disagree
    - o Strongly Disagree

16. I am limited in the number of activities i can attend due to problems with my transportation
    - o Strongly agree
    - o Agree
    - o Neutral
    - o Disagree
    - o Strongly Disagree

Activity patterns
This third section ask you how often you travel to a certain activity. We ask these questions to better understand your experience with travel and transportation.

17. How often do you travel to work or study?
    - ○ Every day
    - ○ Multiple times per week
    - ○ Once per week
    - ○ Multiple times per month
    - ○ Once per month
    - ○ Less than monthly
    - ○ Never

18. How often do you go shopping outside of your home?
    - o Every day
    - o Multiple times per week
    - o Once per week
    - o Multiple times per month
    - o Once per month
    - o Less than monthly
    - o Never

19. How often do you travel to your sport, hobby or social contacts?
    - o Every day
    - o Multiple times per week
    - o Once per week
    - o Multiple times per month
    - o Once per month
    - o Less than monthly

- o Never

Explanation of the next sections
The next sections will be about your past travel behaviour to certain activities. We ask you to take in mind your most recent trip to a pre-defined activity, and evaluate on this trip by answering the questions. This process will be repeated a maximum of three times and the following activities could be included:

- Work or study
- Shopping
- Leisure

Every activities will be defined and evaluated according to multiple choice questions. If you are filling in this survey while travelling, you can exclude the trip you are currently making. Important is to define the most recent trip you made within the category. When you dont know the exact details of the trip, for example you dont know the exact distance, you are free to give a considered estimation.

Commuting trips
The following set of questions will ask you to define your most recent commuting trip.

20. What was the motive of your most recent commuting trip?
    - Work
    - Study
    - Internship

21. What was the distance of you most recent commuting trip?
    [open question] kilometers

22. What was the starting time of your most recent commuting trip?
    [open answer] HH:mm

23. What was the travel time in minutes of your most recent commuting trip?
    [open answer] minutes

24. Which mode of transport did you use for your most recent commuting trip?
    - Car (driver)
    - Car (passenger)
    - Public transport
    - (Electric) scooter
    - Motorcycle
    - Bike
    - Electric bike
    - Speedpedelec
    - Cargo bike
    - Walking
    - Microcar
    - Tractor
    - Other:

To what extend do you agree or disagree with the following statements? We ask you to reflect upon your most recent commuting trip.

25. I needed to spend more money on the transport of my most recent commuting trip than i can afford

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

26. The travel time of my most recent commuting trip I was longer than i liked
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly Disagree

27. There was a suitable travel option available for me for my most recent commuting trip
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly Disagree

28. I could easily reach the destination of my most recent commuting trip
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly Disagree

29. I felt safe when making my most recent commuting trip
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly Disagree

30. I worried about my road safety during my most recent commuting trip
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly Disagree

31. I could travel without experiencing negative health consequenses during my most recent commuting trip
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly Disagree

32. My physical condition was suited for making my most recent commuting trip
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly Disagree

33. My most recent commuting trip caused problems which made me limit the number of activities i could attend
    - o Strongly agree
    - o Agree
    - o Neutral
    - o Disagree
    - o Strongly Disagree

Shopping trips
The following set of questions will ask you to define your most recent shopping trip.

34. What was the motive of your most recent shopping trip?
    - ○ Weekly groceries
    - ○ Non-weekly groceries
    - ○ Special purchase

35. What was the distance of you most recent shopping trip?
    [open question] kilometers

36. What was the starting time of your most recent shopping trip?
    [open answer] HH:mm

37. What was the travel time in minutes of your most recent shopping trip?
    [open answer] minutes

38. Which mode of transport did you use for your most recent shopping trip?
    - ○ Car (driver)
    - ○ Car (passenger)
    - ○ Public transport
    - ○ (Electric) scooter
    - ○ Motorcycle
    - ○ Bike
    - ○ Electric bike
    - ○ Speedpedelec
    - ○ Cargo bike
    - ○ Walking
    - ○ Microcar
    - ○ Tractor
    - ○ Other:

To what extend do you agree or disagree with the following statements? We ask you to reflect upon your most recent shopping trip.

39. I needed to spend more money on the transport of my most recent shopping trip than i can afford
    - ○ Strongly agree
    - ○ Agree
    - ○ Neutral
    - ○ Disagree
    - ○ Strongly Disagree

40. The travel time of my most recent shopping trip I was longer than i liked
    - o Strongly agree
    - o Agree

- Neutral
- Disagree
- Strongly Disagree

41. There was a suitable travel option available for me for my most recent shopping trip
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly Disagree

42. I could easily reach the destination of my most recent shopping trip
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly Disagree

43. I felt safe when making my most recent shopping trip
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly Disagree

44. I worried about my road safety during my most recent shopping trip
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly Disagree

45. I could travel without experiencing negative health consequences during my most recent shopping trip
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly Disagree

46. My physical condition was suited for making my most recent shopping trip
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly Disagree

47. My most recent shopping trip caused problems which made me limit the number of activities i could attend
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly Disagree

Leisure trips
The following set of questions will ask you to define your most recent leisure trip.

48. What was the motive of your most recent leisure trip?
    - Sport activity
    - Practicing hobby
    - Visiting family/friends
    - Entertainment
    - Relaxation

49. What was the distance of you most recent leisure trip?
    [open question] kilometers

50. What was the starting time of your most recent leisure trip?
    [open answer] HH:mm

51. What was the travel time in minutes of your most recent leisure trip?
    [open answer] minutes

52. Which mode of transport did you use for your most recent leisure trip?
    - Car (driver)
    - Car (passenger)
    - Public transport
    - (Electric) scooter
    - Motorcycle
    - Bike
    - Electric bike
    - Speedpedelec
    - Cargo bike
    - Walking
    - Microcar
    - Tractor
    - Other:

To what extend do you agree or disagree with the following statements? We ask you to reflect upon your most recent leisure trip.

53. I needed to spend more money on the transport of my most recent leisure trip than i can afford
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly Disagree

54. The travel time of my most recent leisure trip I was longer than i liked
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly Disagree

55. There was a suitable travel option available for me for my most recent leisure trip
    - Strongly agree
    - Agree
    - Neutral

- o Disagree
- o Strongly Disagree

56. I could easily reach the destination of my most recent leisure trip
    - o Strongly agree
    - o Agree
    - o Neutral
    - o Disagree
    - o Strongly Disagree

57. I felt safe when making my most recent leisure trip
    - o Strongly agree
    - o Agree
    - o Neutral
    - o Disagree
    - o Strongly Disagree

58. I worried about my road safety during my most recent leisure trip
    - o Strongly agree
    - o Agree
    - o Neutral
    - o Disagree
    - o Strongly Disagree

59. I could travel without experiencing negative health consequences during my most recent leisure trip
    - o Strongly agree
    - o Agree
    - o Neutral
    - o Disagree
    - o Strongly Disagree

60. My physical condition was suited for making my most recent leisure trip
    - o Strongly agree
    - o Agree
    - o Neutral
    - o Disagree
    - o Strongly Disagree

61. My most recent leisure trip caused problems which made me limit the number of activities i could attend
    - o Strongly agree
    - o Agree
    - o Neutral
    - o Disagree
    - o Strongly Disagree

General information

The last 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

62. What is your age category?
    - ○ 18-25
    - ○ 26-35
    - ○ 36-45

- 46-55
- 56-65
- 66-75
- 76-85
- 85+
- I don't want to share this information

63. What is your gender
    - Female
    - Male
    - I don't want to share this information

64. What is your ethnical background?
    - Western
    - Hispanic or Latino
    - Arab
    - African
    - Central Asian
    - Eastern Asian
    - African American
    - Multiracial
    - I don't want to share this information
    - Other:

65. What is your employment status?
    - Fulltime employee
    - Parttime employee
    - Seasonal employee
    - Entrepreneur/self-employed
    - Retired
    - Student
    - Stay-at-home-parent
    - Caregiver
    - Job Seeker
    - Unemployed
    - I don't want to share this information

66. What is your estimated individual netto monthly income?
    - 0-830
    - 830-1660
    - 1660-2500
    - 2500-3330
    - 3330-4160
    - 4160-8330
    - 8330-16660
    - 16660+
    - I don't know
    - I don't want to share this information

67. What is your highest completed level of education?
    - Primary education
    - Secondary education: VMBO, lower HAVO, lower VWO, MBO1
    - Secondary education: HAVO, VWO, MBO 2-4
    - Tertiary education: HBO-/WO bachelor
    - Tertiary education: HBO-/WO master, PhD

- I dont want to share this information

68. How many people live in your household?
[open answer] persons

69. What are the 4 numbers of your zipcode?
[open answer]

End of the survey
Thank you for filling in this survey! Your opinion on mobility is very valuable and shall be taken into account when formulating the conclusions of this study.

If you have any questions, or when you want to share feedback or remarks about this survey with the researchers, you can send an email to m.t.v.ardenne@student.tue.nl. The researchers will respond as soon as possible.

We wish you a good day!