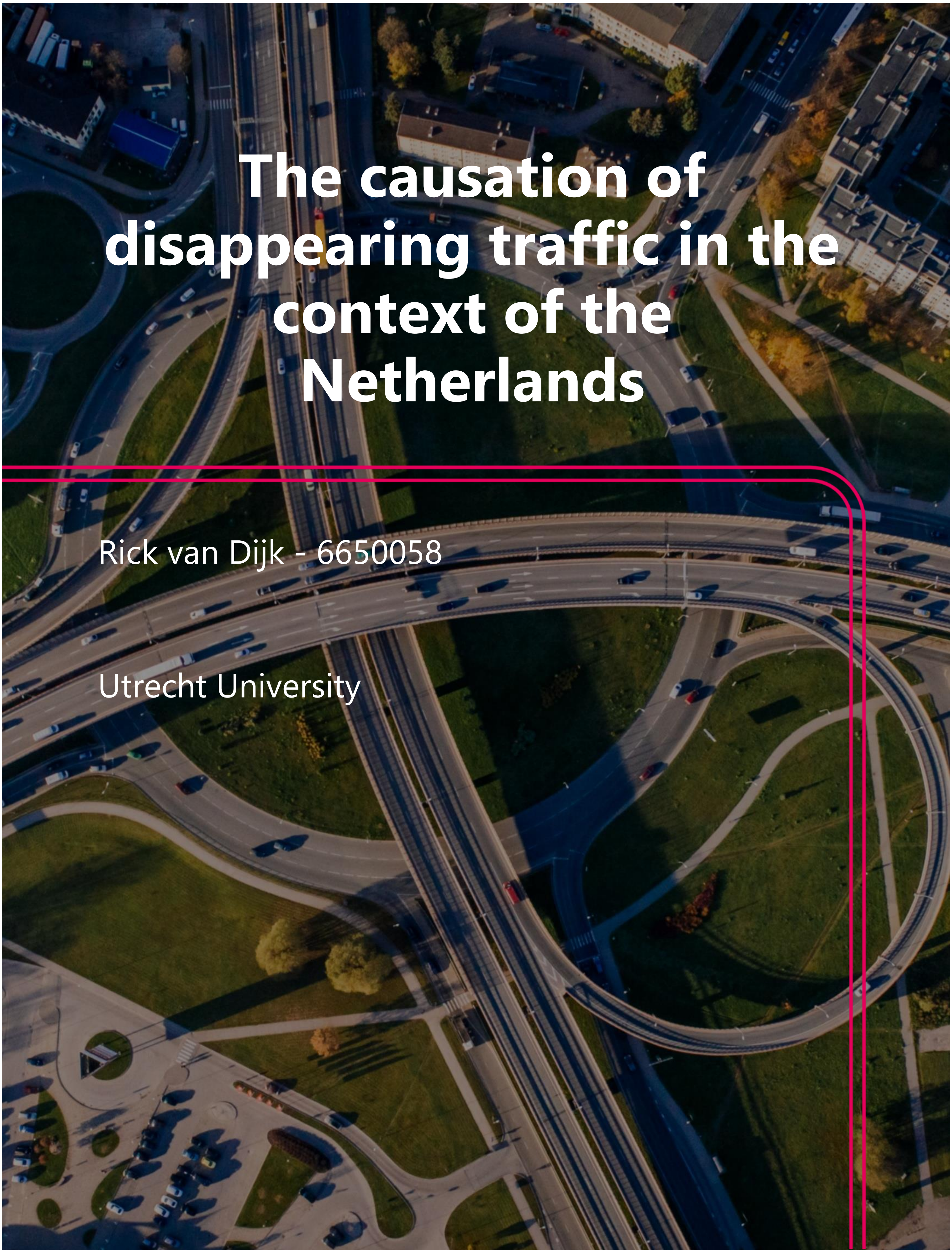

The causation of disappearing traffic in the context of the Netherlands

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''The causation of disappearing traffic in the context of the Netherlands''

Master thesis Human Geography
by Rick van Dijk

A RESEARCH INTO THE EFFECTS OF DISCOURAGING MEASURES TOWARDS THE CAR CAUSING TRAFFIC TO DISAPPEAR

Author: Rick van Dijk
Date: 15-8-2022

Preface

Dear reader,

Before you read this research on disappearing traffic, fit a short word beforehand. This research was not possible without the help of others. During the process of making this research, I was continually supported by Dick, Martijn, and other Goudappel colleagues. I want to thank Goudappel for the opportunity to conduct this research from within their organization. Special thanks to all the colleagues at Goudappel for making time to assist me when it was needed. Huge thanks to Martijn and Dick for their guidance throughout this research. Their quick, clear feedback and tips helped to keep making strides in this research.

With this research, I conclude my study period at the University of Utrecht. It was an instructive and enjoyable period. I will look back on it forever with a great feeling. Now I look forward to starting a new chapter in my life as I begin working in the field of Mobility.

Rick van Dijk

15 August 2022

Summary

Background
Cars became inseparable from the image of major, modern cities over the last decades. Cars aided by reducing travel times and increased economic mobility. Even today, the car is still an integral part of the street scene. However, car-dominated urban development has its downsides as they cause air pollution, traffic injuries, greenhouse gas emissions, and congestion. Cities on the other hand are nowadays looking to become more sustainable and want to increase the quality of life. Therefore, the attitude of city planners towards the car is changing because of the negative impacts of car-dominated urban development. It is not the car anymore that cities want to prioritize when (re-)developing road, but more sustainable modalities like the bike and public transport that receive more attention as the aim of many cities is to reduce the number of private cars in city centers. However, taking away infrastructure for the car is often predicted to cause problems in neighboring streets as the traffic diverts. Cairns, Atkins, and Goodwin (2001) beg to differ as they state that, depending on local circumstances, overall traffic levels significantly drop as people have a wider range of behavioral responses than predicted. This is also known as disappearing traffic. To this day there is little research done regarding disappearing traffic.

Research aim and questions
This research aims to provide insights into the effects of discouraging measures towards the car on the travel behavior of car drivers. To following main research question is used;

Under what circumstances are car drivers changing their travel behavior and how do they cause traffic to disappear?

To further direct this research, the following sub-questions were formulated;

- What aspects come into play concerning change in travel behavior in the case of road removal or road reallocation?
- To what extent do these aspects impact the travel behavior of car drivers?

This research helps by gaining a better understanding of what to expect when (re)designing with confined space for the car and to be able to give better advice to firms/ municipalities in the future regarding disappearing traffic.

Methods
A few steps were taken in order to answer the research questions. A literature review provided insight into what factors play a role in modal choice, multiple travel behavior theories, and trip generation. Based on these insights, an online stated preference survey was created. Respondents faces multiple scenarios regarding extra travel time in which they had to answer what they would do in that situation. The survey was distributed through the use of PanelClix to people who live in a city with more than 25.000 and have used the car multiple times in the three months before the survey was released. Ultimately, the survey was filled in by 414 respondents. Descriptive statistics showed under what circumstances people would change their travel behavior and how. The Chi-square test of independence showed which other factors contribute to whether people would change their travel behavior or not.

Results and conclusions
Taking a look at under what circumstances people change their travel behavior, it is found that at +5 minutes extra travel time on the respondents' current travel time causes 7.2% of the traffic to disappear which rises to 32.5% at +20 minutes. The disappearing traffic consists of people who either indicated they would switch modalities as well as respondents who indicated that they would not make that trip anymore if a certain amount of minutes was added up to their current travel time. However, a more realistic extension of the travel time would be between five and ten minutes. Based on the results of this research, around 10% of the traffic would disappear.

Multiple factors influence whether respondents change their travel behavior. First, it depends on the travel motive. Results show that people are more bound to the car for the travel motive ''Social and Recreative'' in comparison to the travel motives ''Work & Study'' and ''Household & Services''. The average distance for this travel motive is also longer compared to the other travel motives, so the effect on travel behavior of extra travel time is less. On top of that is this a less common trip, making people less likely to deviate from their current travel behavior.

Other results show that extra travel time towards the car has a bigger impact on whether people choose their travel behavior in comparison to extra travel time in the car. More people state that they would change their travel behavior when their travel time would be increased by 5 minutes compared to an extra five minutes on the road. Therefore is it more alluring to focus on increasing the travel time towards the car instead of taking measures that increase the travel time in the car.

Having an alternative is an important factor in whether people change their travel behavior or not. This is obvious, but it does highlight the importance of having good facilities for alternative modalities. Also, education plays a role in whether people switch. Results show that higher-educated people are more likely to step out of the car in comparison to lower-educated people. This might be due to income making it easier for higher-educated people to afford other modalities but many high-educated people also work in the service sector. Offices in the service sector are often located in easily accessible places making it easier to take public transport or the bike.

Regarding how people cause traffic to disappear showed the results that more respondents indicated for all the travel motives and scenarios that they would not make the trip anymore compared to the number of respondents that indicated that they would switch modalities. Especially for the travel motive ''Work and Study'' is this the case where almost double the amount of respondents indicate that they would not make that trip anymore (24.4% vs. 13.4%). In the case that people switch modalities, the bike is the most chosen alternative, especially for the travel motives ''Household & Services'' and ''Work & study''. Some respondents do choose public transport but not as much as the bike. Public transportation is mainly seen as a good alternative for the travel motives ''Social & Recreative'' and ''Work & Study''.

Recommendation / consulting

For further research is it recommended to observe the effects of measures taken by municipalities more closely. There is data available that car intensities drop when those measures are applied. However, to get more insights, it is recommended to distribute a survey before a measure was applied and after. This way it becomes clear what the real effect was of those measures regarding disappearing traffic as with stated preference it cannot be stated with certainty that respondents would make these choices in reality as well. Disappearing traffic is location-dependent so multiple kinds of measures have to be observed to see what the effects are on different kinds of areas. Also, if this research is to be repeated, it is recommended to increase the number of respondents to make it easier to run statistical tests.

The following advice can be given when consulting firms and municipalities regarding disappearing traffic. In the case that cities want to become more car-free is it recommended to take a look at the parking policy first. As this research has shown is the impact of extra travel time towards the car bigger in comparison to extra in-car travel time. Secondly to take a good look at what kind of area is affected by the measure and what kind of travel motive is most common. Extra travel time does affect behavior differently based on what the travel motive is for that trip. Finally, before taking any measure, the facilities of the alternatives should be well regulated. Once again, this research showed that having an alternative plays a big role when it comes to changing travel behavior.

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1. Introduction

1.1 Flip side emergence of the car

At the end of world war two, the automobile started to rise as a new form of modality. Automobiles were at the time seen as the future of transportation, aiding by reducing travel times and increasing economic mobility. Because of the success of the car, cities started to reconstruct to accommodate cars. Cars became inseparable from the image of major, modern cities. Even in today's cities, the car is still an integral part of the street scene. However, car-dominated urban development has its downsides, certainly in combination with the growth of cities which results in higher intensities on the road network. Additional air pollution, noise, traffic injuries, greenhouse gas emissions, and congestion are some of the ramifications. Congestion generates major economic, social, and environmental costs. Car-dominated urban development also leads to adverse social inequalities, health outcomes, and oil dependence. Not every ramification can be solved through technological improvements to motorized vehicles.

1.2 Sustainable developments

There are few concepts these days, that are more popular than sustainability. As the environmental debate continues, cities are looking for ways to become more sustainable and increase the quality of life. Because of the negative impacts of car-dominated urban development and a thrive to make cities more sustainable, the attitude of city planners to the car is changing. On many occasions, it is not the car anymore that is being prioritized when redesigning roads but more sustainable/ active modalities as cities tend to become more car-free. Hamburg, Oslo, and Helsinki recently announced their plans to become (partly) private car cities (Nieuwenhuijsen & Khreis, 2016). They mainly focus on a reduction of private cars in city centers. A reduction in motorized traffic complemented by increases in active transport is likely to benefit public health, both long and short-term (De Nazelle et al., 2011). Also, because cars take in a lot of space, reallocating road space generates more space to improve conditions for cyclists, pedestrians, and greenery, which leads to an increase in the spatial quality of the public space.

1.3 Disappearing traffic

However, redeveloping streets by taking away infrastructure for the car, is often predicted to cause congestion and pollution problems in neighboring streets as the traffic diverts. Transport models are often used to predict these impacts. Cairns, Atkins, and Goodwin (2001) researched the impact of reallocating road space from general traffic in relation to disappearing traffic, based on the examination of 70 case studies in over 11 countries. Their findings suggest that the transport model predictions of car intensities on the road network are often too high and unnecessarily alarmist. Depending on local circumstances, overall traffic levels significantly drop as people have a wider range of behavioral responses than predicted. The results of this study indicate that in half of the cases, about 11% (median) of the traffic disappeared with an average of 21.9%. In other words, in half of the case studies, more than 10% of the vehicles disappeared where road space was reduced for traffic. Reallocating road space does not just lead to a shift of traffic from one place to another but also reduces the intensity on the road network. This is especially relevant for cities that are trying to become more car-free like Hamburg, Oslo, and Helsinki.

1.3.1 Definition disappearing traffic

Cars that are not traceable on the road network after the redevelopment of a street, can be referred to as disappearing traffic. TNO (Toegepast Natuurwetenschappelijk Onderzoek, 2017) defined disappearing traffic as follows; . *''Disappearing traffic means that a number of cars that disappear are not traceable (or just partly) on alternative routes. It shows that there is a visible change in travel behavior; people do not move or choose another modality (PT, cycling, or walking*)''. This definition is visualized in the following figure.

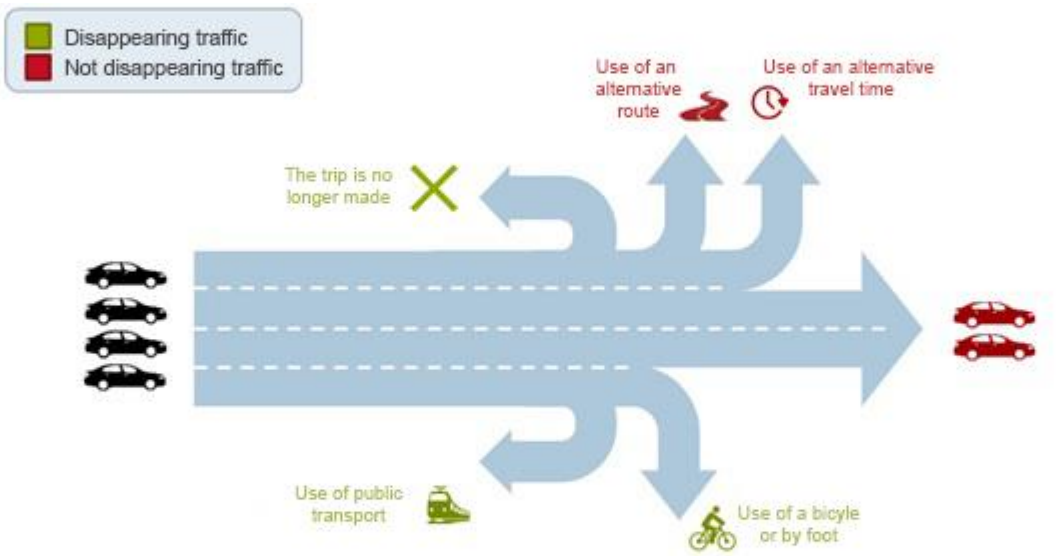


Figure 1 Definition 'Disappearing traffic' (TNO, 2017)

Figure 1 shows that TNO speaks of disappearing traffic if the movement isn't made at all or if car users switch to public transport, the bike, or make the movement by foot. There is no question of disappearing traffic when people change their route or change their departure time. The definition given by TNO will be used in this research as this definition distinctly demarcates when to speak of disappearing traffic.

1.4 Research background

1.4.1 Research Aim / Knowledge gap

This research provides insights into the impact of redeveloping streets with confined space for the car on travel behavior. To date, only a few papers assess the topic of disappearing traffic. Most writers refer to the article of Cairns et al. (2001) when mentioning disappearing traffic or traffic evaporation (Currie et al., 2007; Zhu et al., 2010). Disappearing traffic is also visible in Dutch cities. However, to what extent, what factors are causing the disappearance, and how people change their travel behavior isn't exactly clear as they haven't been measured. Cairns et al. (2001) state that in more than half of the case studies, more than 10% of the vehicles disappear. The question remains what this 10% consists of. Are people changing modes or did they make the decision not to travel anymore. Therefore, this research aims for a better understanding of what to expect from road users. This can be taken into account in traffic models as well as decision-making.

1.4.2 Research Questions and Methods

To gain a better understanding of the effects of redeveloping streets with confined space for the car on travel behavior, the following main question has been drawn up;

Under what circumstances are car drivers changing their travel behavior and how do they cause traffic to disappear?

In order to further direct the research, the following sub-questions were answered:

- What aspects come into play concerning change in travel behavior in the case of road removal or road reallocation?
- To what extent do these aspects impact the travel behavior of car drivers?

1.5 Reading guide

This report begins in chapter two with are review of the available literature related to travel behavior theories, modal choice, and trip generation. The methodology chapter describes the research methods used and why these methods were chosen. Chapter four presents the results of the analysis. This concerns both the general findings of this research and the statistical analysis. This report concludes with the conclusions of this research in chapter five. In the same chapter are also the results linked to the existing literature and the limitations, and recommendations (for further research) elaborated. They survey and the results of the statistical tests can be found in the appendix.

2. Literature review

2.1 Literature review

A literature review was used to answer the following question;

'' What aspects come into play concerning change in travel behavior in the case of road removal or road reallocation?''

The literature review is executed through the use of multiple search engines. The search engines that are used in this research are 'Google Scholar', 'Scopus', 'Worldcat', and the regular Google search engine. The main search terms that were used are; disappearing traffic, (changing) travel behavior, travel behavior theories, modal choice, trip generation, reducing road capacity, confined car space, and (re-) designing urban space. All the sources from reviews have been checked to make sure the source isn't used in the wrong context.

2.2 Transition to sustainable cities

This section describes the need for a transition to a sustainable car system. It indicates the importance of car use reduction which leads up to the motive of this research.

2.2.1 A change of mind about mobility developments

At the time that the automobile was introduced into society, it was seen as the future of mobility aiding by reducing travel times and increasing economic mobility. Because of the success of the car, cities started to (re-)construct to accommodate cars. The car made it possible for people to live further away from work and the crowded city centers resulting in suburbanization and urban sprawl. Cars became, and are still to this day, inseparable from the image of major, modern cities. Cities avail from the car as economic growth and the development of the cities are induced by mobility (Bertolini, 2017). Although cities have benefitted in the field of social affairs and economy, the increasing mobility or car-dominated urban development came with ramifications.

"Over the last 50 years, it has become more apparent that there are also severe problems related to the emerging transport system, such as air pollution, noise nuisance, and increasing road traffic casualties"(van Wee et al., 2013, p. 164).

Other negative impacts are climate change because of the extra emission of greenhouse gasses, oil dependency, and congestion, which can partly be reduced through technological developments (van Wee et al., 2013). For example through the design of a more sustainable car results in a decrease in emissions of pollutants and less use of fuel. Also, advanced cars assist drivers through sensors that can prevent accidents. However, many ramifications cannot be solved completely or not at all through technology. The European Environment Agency (2013) distinguished these ramifications as follows;

- ***Economic costs***: productivity loss due to traffic congestion, disproportionate budget claims for building infrastructure, acquiring and operating vehicles
- ***Environmental costs***: depletion of fossil fuels and other limited sources, production of waste, emission of greenhouse gasses, disruption of ecosystems,
- ***Social costs***: traffic accidents, health and livability impacts of air pollution and noise, obesity because of lack of physical activity, severance of communities, encroachment of public space.

Jane Jacobs (1961) tried to warn cities about the possible drawbacks for cities because of the increasing ubiquity of cars in her book ''The Death and Life of Great American Cities''. Despite the warning, most cities kept on developing for the car. Yet, a change of mind is visible. Because of the negative impacts of car-dominated urban development and a thrive to make cities more sustainable, the attitude of city planners to the car is changing. On many occasions, it is not the car anymore that is being prioritized when redeveloping roads. Nowadays the focus relies more on sustainable and active modalities as cities tend to reduce car usage. Hamburg, Helsinki, and Oslo announced their plans to become partly private car-free cities (Niewenhuisen & Khreis, 2016). They mainly focus on a reduction of private cars in city centers. In addition, several municipalities in the Netherlands aim to create low-traffic urban areas (e.g. Gemeente Enschede, 2021; Gemeente Utrecht, 2021). A reduction in motorized traffic complemented by increases in active transport is likely to benefit public health, both long and short-term (De Nazelle et al., 2011). One of the ways to achieve a more car-free city is through road reallocation which hopefully results in fewer people taking the car. However, cities are still dependent on whether people are willing to change their travel behavior.

2.3 Travel behavior

Changing travel behavior is a hard thing to accomplish. This section describes multiple travel behavior theories and the difficulty of changing travel behavior.

2.3.1 Travel behavior theories

There are multiple psychological theories on travel behavior.

2.3.1.1 Habit formation

One of them is habit formation (Verplanken et al., 1997). For many people, it has become a habit to travel a certain way. They do not consider which mode they are going to use or which route they are going to take today as it became a standard choice. A repeated choice is referred to as a habit (Ronis et al., 1989). Bargh (1997) suggests that habit formation is adaptive in that it prevents overload on information processing. Habits are influenced by positive and negative hedonic feedback and thus, habits are adaptive in that they attain set goals (Verplanken et al., 1997). The stronger the habit becomes, the less likely it is that people change their travel behavior. A change in behavior requires thus a break of habit. To achieve a break in habit, changes in travel options must be salient and have positive outcomes. Car drivers must be made aware of the possible change in order to break the habit (Fujii and Gärling, 2005)

2.3.1.2 Norm activation theory & theory of planned behavior

Another theory is the Norm activation theory by Schwartz (1997). The norm activation theory drives on personal norms. These personal norms are related to feelings of moral obligation. Moral obligation drives people to show pro-social behavior. For example; ''*If I use a car instead of a bike to go to school, which is 1km away, I get a moral stomachache.*'' The personal norms can also be found in Ajzen's theory of planned behavior (1991). Ajzen states that intention is the most important factor regarding planned behavior. Intention derives from three factors being Attitude, Subjective norm, and Perceived behavioral control.

2.3.1.3 Random utility theory

Each trip is the result of several choices made by transport system users (Cascetta, 2009). In the case of personal transport, that choice is made by the traveler and for goods transport that choice is made by the operator. Some choices don't need to be made often such as where to work or to reside. Other choices are more frequent and made for each trip like what mode to use, which path to take, and whether to make the trip at all. Each choice context, defined by evaluating factors, decision procedures, and the available alternatives, is known as a ''choice dimension'' (Cascetta, 2009). The random utility theory is the richest and most used theoretical paradigm for modeling transport-related choices and choices among discrete variables.

The random utility theory is based on the hypothesis that every individual is a rational decision-maker, maximizing utility relative to his or her choices (Cascetta, 2009). The theory is based on a few basic assumptions. First of all, the generic decisionmaker considers mutually exclusive alternatives that constitute her choice set. The choice set differs for each based on the decision-maker. Secondly, for each of the alternatives in the choice set, the decisionmaker assigns a perceived utility or ''attractiveness''. It is expected of the decision-maker to select the alternative that maximizes this utility. Thirdly, multiple measurable characteristics of the alternative and the decision-maker determine the utility assigned to each of the choice alternatives. The last assumption is that the utility, which is assigned by the decision-maker, is not known with certainty by an external observer or analyst who is trying to model the decision-maker's choice behavior.

Although it is not possible to predict with certainty that the generic decision-maker will choose a certain alternative, it is possible to express the probability that the decision-maker will select a certain alternative based on her choice set.

2.3.2 Changing travel behavior

Changing people's travel behavior is a tough assignment. Cities are trying to get people out of their cars but not always with success. There are two types of structural methods for changing car use to non-automobile modalities which are pull measures and push measures (Steg, 2003; Vlek and Michon, 1992). Pull measures are measures that increase the attractiveness of other modalities than the car. Examples of pull measures are constructing new bicycle roads, increasing the quality of the public transport network through a reduction of travel time, increasing the number of seats, and improving the quality of stations. Pull measures always incur monetary costs which might go beyond a city's budget. Because of budget constraints, pull measures can't always be implemented (Gärling & Fujii, 2009).

Push measures decrease the benefits of the car. Examples are (among others) gasoline taxation and road pricing. Push measures also include physical measures such as a reduction in the number of parking spots and reducing road capacity. These measures will impact even those with a strong car habit as it directly hits their behavior. However, according to Jakobsson et al. (2000) is the public attitude towards these measures generally negative. This may prevent politicians to apply push measures even if desirable (Gärling & Schuitema, 2007).

Combining push and pull measures increases the effectiveness of each of the measures. For example, downgrading a motorway in combination with an upgrade of the bicycle infrastructure leads to a greater effect than if these measures are taken separately.

2.4 Trip generation

Disappearing traffic is affected by changes in the modal split, choice of destination, and trip generation. To map the effects of making cities more car-free and the causation of disappearing traffic, it is necessary to gain more insight into these concepts. The emphasis in this research is mainly on mode choice. The next two paragraphs describe the multiple aspects that influence modal choice, trip generation, and destination choice. These sections form the basis for the survey questions.

Trip generation is the first step in the conventional four-step model. The four-step model is used to forecast travel demands originating in or destined for a particular zone. It is the central column of transportation planning throughout the world (Mladenovi´c & Trifunovi´c, 2014). The four steps to forecast travel are (1) trip generation, (2) Trip distribution, (3) Modal split, and (4) Traffic assignment. In this case it can be used to forecast the effects of the multiple measures, municipalities apply to decrease the usage of automobiles. The steps of trip distribution and traffic assignment are less relevant to this research as this research focuses more on the number of trips made and whether people change their modality hence these steps are not explained in more detail.

The first step ''trip generation'', aims at estimating the number of trips originating in, and/or ending in a given zone. The trips are often considered as the production of a particular land use and the attraction of other specified land uses (Levinson, 2002). Trip generation is generally analyzed at both disaggregated and aggregated levels.

Socioeconomic variables such as vehicle ownership, occupation, and income play a significant influence at the disaggregated level. At the aggregate level, land use and built environment measures are taken into account (Mukherjee & Kadali, 2022). Several studies concluded that to understand daily travel behavior, socio-demographic characteristics must be included as they influence trip rates (Ma et al., 2014; Hong and Thakuriah, 2018). Built environment factors also heavily influence trip rates (Rashidi et al., 2010). Wang et al. (2018) found that trip intensity is much higher in urban areas as compared to suburban areas. Better street connectivity and destination accessibility are generally better in urban areas which results in higher trip rates. Chang et al. (2017) state that accessibility is one of the most important determinants in understanding travel patterns. Trip generation is thus dependent on land use which consists of two broad categories; residential and non-residential. For residential land use, trip generation is merely based on the social and economic attributes of households like household composition and car ownership.

Almost all people engage in activities. The activities are the purpose of the trip. Major activities are work, home, recreating, socializing, and eating out. The trips are categorized by these purposes. These purposes are the reason why we leave our houses. Without a purpose, people wouldn't travel, and thus would the intensity on the street be zero. In regards to disappearing traffic, when a purpose lapses, then someone will not make that trip anymore. For example, previously people would go to the office to have meetings with customers. Nowadays most of these meetings take place online. Therefore, the main purpose for that trip elapses, which is why someone could choose not to make that trip anymore. Resulting in trip suppression.

2.5 Modal Choice

2.5.1 Aspect influencing modal choice

Travelers take many aspects into consideration when it comes to modal choice. Zhou (2012) categorized the factors which influence mode choice of the general population into six groups based on a desktop literature search being; *(1): Physical environment and urban factors* (e.g.) Population density; *(2): Mode-specific factors* (e.g.) Travel time, and costs; *(3): Trip-Makers' personal attributes* (e.g.) Age, and gender; (*4): Trip characteristics* (e.g.) Trip purpose, and time of travel; (*5): Presence of Travel Demand Management (TDM)* (e.g.) Parking costs, and transit pass subsidy; and (*6): Psychological factors* (e.g.) attitude, and habit.

A different approach to categorize these factors is given by De Witte et al. (2013). De Witte et al. distinguish three types of determinants constituting the options to make a modal choice based on a comprehensive literature review (see fig. 2). This framework is based on a multi-disciplinary approach where transport geography, social psychology, and economics come together.

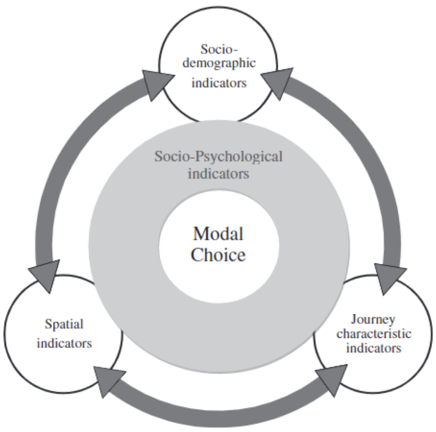


Figure 2 Framework modal choice determinants

As shown in the framework are there three indicators that influence modal choice, being socio-demographic indicators, spatial indicators, and Journey characteristics. The outer circle covers the skills and possibilities travelers have when it comes to modal choice. The second circle represents the socio-psychological indicators like previous experiences, habits, and perceptions. Modal choice is then a result of interactions between the indicators that are situated in the outer circle in combination with the influence of socio-psychological indicators. The sociodemographic, spatial, journey characteristics, and socio-psychological indicators consist of multiple aspects.

Even though the framework of de Witte et al. (2013) covers most of the common indicators, one indicator is being overlooked. ICT play's a big role when it comes to modal choice and mobility in general, which role is only growing. With new online services at a traveler's disposal like route planners, GPS, and Mobility as a Service, more and more people are relying on ICT when it comes to their travel plans. The factors influencing modal choice are worked out in more detail below according to De Witte et al. (2013) framework as the framework gives an uncluttered view of all the aspects that influence modal choice.

2.5.2 Socio-demographic indicators;

2.5.2.1 Age

Age determines the social status and the physical ability to travel. As we grow older, our physical capabilities tend to decline making it more difficult to cover bigger distances by foot or bike. Multiple studies indicate that older people are increasingly less likely to select walking or biking compared to automobiles as their age increases (Nurul Habib et al., 2009; Kim and Ulfarsson, 2008). Although, Wang, Ettema & Helbich (2021) beg to differ stating that compared to young adults, older adults prefer to walk more. The results of Nurul Habib et al. (2008) and Kim and Ulfarsson (2008), are in line with the results from Schwanen et al., (2001). They indicate that seniors in the Netherlands are more likely to choose the car for leisure trips the older they get. However, De Palma and Rochat (2000) conclude that seniors are more committed to PT for work commutes in contrast to young commuters who are more likely to choose the car. Nevertheless, at this time, elder people in the Netherlands are staying more vital (65plus, 2018) which will result in more displacements by foot/ bike. The car will also be used more often as more seniors have a driver's license in the future (Schwanen et al., 2001).

2.5.2.2 Car availability

Having a car at your disposal is of great influence on your modal choice. Not having a car within your household is strongly related to transit dependency (Cervero, 2002). In addition, Limtanakool et al. (2006) state that car availability has a strong negative influence on the likelihood of using the train on medium- and longer-distance commuting trips. Also, there is less competition between household members for a car if they have multiple cars at their disposal. This results in a lower tendency to make use of shared modes and public transport (Nurul Habib, 2009). Choosing to drive the car is also greatly influenced by the ownership of a company car. Results from De Witte et al. (2008) research show that the odds of using the train to commute decrease by 96.6% when households are in the possession of a company car. This result is in line with the findings of O'Fallon et al. (2004). Further results from De Witte et al. (2008) show that the odds of train use decrease by 52% for each unit increase in the number of cars.

2.5.2.3 Education

Income, social status, and occupation are determined by education. Based on the national travel survey in the Netherlands, Limtanakool, Dijst & Schwanen (2006) state that highly educated people show the highest propensity to travel by train. This might be correlated with their jobs, as their offices are often located in the center of the city, making it more interesting to travel by public transport. However, Pickery (2005) begs to differ. Based on a survey among Flamisch households (2001), Pickery indicates that higher educated people use the car more often and lower educated people go by foot and cycle more often. Once again, there is no real consensus about what role education plays. It does remain context-dependent whether someone takes the car or not, just like it is the case for (e.g.) taking the bike.

2.5.2.4 Gender

There is no real consensus on what role gender plays in modal choice. Brown et al. (2003) indicate that females are less likely to abandon their car as they do more domestic chores in conjunction with their commutes, such as driving their children to school, and shopping. This may make it less convenient for females to travel by transit. However, Bhat (1998) suggests that women are more predisposed toward transit-use than men when it comes to shopping trips. In addition, over longer distances (>50km) men are more likely to choose the car in comparison to their respective counterparts (Limtanakool, Dijst & Schwanen, 2006).

2.5.2.5 Household composition

As the number of household members increases, the higher the probability is that people travel by car (as passenger or driver) (Cirillo & Axhausen, 2002). Rubin, Mulder & Bertolini (2014) found that living with a partner and having a child under six years old, is negatively associated with the likelihood of using public transport for family visits. In contrast to Cirilo & Axhausen (2002), they also concluded that there is no linear association between the number of children and mode choice. In the case of the presence of children within the household, the utility of the car increases which has a negative impact on other modes like the bike, or public transport (Limtanakool et al., 2006). Especially in combination with trip changing is it more appealing for parents to take the car (e.g. bringing their child to school and going to work after).

2.5.2.6 Occupation & Income

Income is dependable on someone his occupation. People with a lower income are more influenced by the price of public transport (Hine & Scott, 2000). Multiple researches show that as personal income increases, the probability of people choosing a car increases (Hensher & Rose (2007); Pucher & Renne (2005). Arbués et al. (2016) looked more into the data from the 2007 Spanish National Mobility Survey. They concluded that in comparison to the low-income group, the medium- or high-income group the odds decreased of the traveler choosing a bus over the car. They also indicate that a higher disposable income also discourages the use of trains over cars. When money plays a minor role in your modal choice, you are more likely to choose the mode with the highest utility.

Sometimes the occupation has a great influence on the modal choice for commuting trips as a consequence of the mobility policy (De Witte, Macharis & Mairesse, 2008). It might be the case that a company has the intention to become more sustainable. To reach their goal they might reward employees to come by bike, public transport, or by foot making it more compelling for people to leave their cars at home.

***2.5.3* Spatial indicators;**

2.5.3.1 Density

Whether people live in urban or rural areas makes a great difference in their modal choice. Low-density areas tend to be associated with average high trip distances and scarce presence of public transport which results in more use of the car. The opposite applies to high-density areas where the average trip distance is short and the supply of public transport is high. Therefore it is more appealing for commuters to make use of public transport or go by foot or cycle. Because of the improved public transport in higher-density areas, more people make use of it compared to lower-density areas (Limtanakool et al., 2006).

2.5.3.2 Diversity

Diversity relates to the extent of mixed land use within a neighborhood in terms of commerce for day-to-day purposes (e.g. supermarkets and schools), residence, green space, and transport infrastructure. It is likely that more destinations of people reside within the neighborhood when the diversity is high. This results in more movements by foot and bike as people do not have to travel over a great distance. Cervero (2002) argues when there is a land-use mixture at both origin and the destination, the probability of taking public transport increases in contrast to shing a ride or driving alone.

2.5.3.3 Proximity & frequency of public transport

Proximity to public transport is related to density and diversity. Limtanakool et al. (2006) state that the availability of a public transport stop increases the use of public transport. However, the proximity to the stop is of greater importance for the modal choice at the destination than the origin. According to Van de Walle & Steenbergen (2006), public transport will not be used if there is insufficient public transport available for only one trip within the trip chain.

The frequency of public transport is of great importance when it comes to modal choice. Higher frequencies increase the efficiency of PT. Transfers are shorter and trips become less unpredictable. Especially within cities functions public transport on frequency whilst intercity movements are more dependent on arrival times (Cascetta & Papola, 2003). Fewer people will make use of public transport in the case of poor service (Vasconcellos, 2005).

2.5.3.4 Parking

Parking is an important factor when it comes to modal choice. If you can't park nearby your destination, it becomes inconvenient to take the car. According to O'Fallon et al. (2004) and Ye et al. (2007), people are stimulated to take their car in the case of a guaranteed parking spot at their work. Other research shows that, during the Olympics in Salt Lake City, lowering the number of parking lots raises the use of transit in relation to car use (Brown et al., 2003).

2.5.4 Journey characteristic indicators

2.5.4.1 Travel motive

Three types of travel motives are most commonly used within the literature regarding modal choice being leisure trips, commuting trips, and business trips. As the travel motive is strongly linked to the cause of a trip to happen in the first place, it is an important factor for modal choice. The results of O'Fallon et al. (2004) show that the use of private cars is prominent when it comes to business-related travel. For commuting trips applies that the share of public transport is higher in comparison to other modalities (Pucher & Renne, 2003). Kim and Ulfarsson (2008) suggest that the propensity towards walking is higher for non-work trips including school, and social/recreational trips. However, walking trips are negatively associated with shopping trips as people may be discouraged by carrying heavy bags. Longer leisure trips are merely done by car (Van de Walle & Steenberghen, 2006).

2.5.4.2 Trip distance

It is more appealing to use active transportation modes like cycling or walking for short distances. However, as the distance increases, quick transport modes like the car and public transport will be used more often. According to De Witte et al. (2008) becomes train use more likely for distances further than 30km for commuting. In Brussels is the car the most dominant transport mode for commuting till 30km (Pickery, 2005). Based on the findings from a longitudinal analysis of the German nationwide travel survey ''KONTIV'' for the period 1976-2002, Scheiner (2009) concluded that car owners are more inclined to walk given any distance in the cities than in small towns, even more so if they live in a central urban area. His results also showed that the use of PT and the bicycle is more prevalent in the cities than in smaller towns for trips over two kilometers. This is also related to the amount of cycling and PT facilities, as they are better organized in cities than in small towns.

2.5.4.3 Travel time

Travel time is an important factor relating to modal choice (Bhat, 1997). Travel time is related to the theory of utility maximization in the sense of when the travel time between modalities differs too much, a traveler is expected to choose the one with the lowest travel time. However, when the travel motive of a person is more leisure-related, a person might judge this differently as travel time play's a lesser role in comparison to (e.g.) comfort. Research by Bhat (1998) on the joint nature of mode and departure time of urban shopping trips also shows that travelers are more sensitive to out-of-vehicle time rather than in-vehicle travel time. Not having a parking spot nearby the destination might make the difference between going by bike or taking the car. Also, the importance of a good network is emphasized by Bhat's results. If people have to wait too long to be able to switch modalities, the attractiveness of PT decreases.

The departure time also influences the modal choice. It is more attractive to take the car during off-peak hours as there is less congestion making travel times shorter. However, during peak times PT might be a bit overcrowded which makes people use their car or people might switch to PT because of congestion.

2.5.4.4 Travel cost

For many people do travel costs play a role in the choice of their modality. Many people do not have the luxury to choose whatever modality they want to use as they can't afford it. However, the influence of travel costs on modal choice is determined by multiple factors like the travel motive (Litman, 2004). Travelers might be prepared to spend more money on their modality to reach more comfort when the trip is more leisure related. To reduce the costs of PT, people might consider buying a subscription. According to Ye et al. (2007), transit pass subscribers are more likely to be more transit-oriented which is completely logical. Nonetheless, the less it costs to drive alone relative to commuting with PT, the more people are going to commute by car (Cervero, 2002).

2.5.4.5 Trip chaining

Trip chains do have a great influence on modal choice. Primerano et al. (2008) defined trip chaining as the mixture of one or more intermediate activities with the main activity, where home is the start and end of trips. When some destinations are hard to reach with alternatives any other than the car, people are more or less forced to take the car. Delbosc and Currie (2011) studied the trip chaining behavior of PT users in Melbourne. Their results show that it was generally found that chains with public transport are more complex than those undertaken by car. This result explains why the car is more attractive when making a trip chain. Concluding, the more tortuous the trip chain is, the more the car will be used.

2.5.4.6 Weather

The weather conditions determine for many people which mode they will use. When it is sunny outside, it is more appealing to make use of active modalities like walking or cycling. However, as Kim and Ulfarsson (2008) indicate, cycling might not be a good alternative when the weather conditions are bad, which results in more people making use of PT and the car.

2.5.5 Socio-psychological indicators

2.5.5.1 Experience

Travelers consider modalities based on past experiences. For example, when the first experience with public transport was to be found unsuccessful because of waiting times, not being able to sit, etc., people are less likely to make use of public transport in the future. Therefore is it so important that when people make use of alternative modalities, the facilities are well-organized, resulting in a good first impression. Network experience also influences modal choice. De Palma and Rochat (2000) suggest that the higher the user's road network experience, based on the length of time the user has used the main route to go to work, the higher the chance is of them using a private mode to go to work. This result is strongly related to familiarity. As de Witte et al. (2013) state; *''familiarity is related to the knowledge users have developed of the various means of travel at their disposal, which facilitated the use of the considered means of travel''*. According to Last and Manz (2003) ensures higher familiarity with the transport network for lower mental barriers to use other modalities on long distances (>100km).

2.5.5.2 Perceptions

Perceptions influence the preference of travelers for a certain mode. The perceptions of travel time can differ for people between the different kinds of modalities. For instance, for many people, public transport travel time is perceived as worse than travel time in a car. The perception of waiting time for public transport is found to be even worse (Nurul Habib et al., 2009). Perceptions can also be linked to the theory of planned behavior by Ajzen where attitude and subjective norms play a big role in the decision-making process to choose a certain travel mode. For example, when someone thinks that the car is bad for the environment, he or she will prefer to take a mode that is better for the environment like the bike. Also, feeling the pressure from others around you to not take the car because it is bad for the environment will make you switch faster as it gives you the feeling you're doing the wrong thing.

2.5.6 ICT

In recent years, ICT use has received increasing attention (Elldér, 2020) as the role of ICT on mobility is growing. Especially in these times of COVID-19, many people are teleworking which results in no commuting at all. The same applies to shopping, as many people buy all their groceries and clothes online. Singh et al. (2013) concluded that living in urbanized areas was positively associated with teleworking because employers who allow teleworking are mostly concentrated in urban areas and the ICT network is of higher quality in urbanized areas.

2.6 Conclusions

As the environmental debate continues, cities are looking for ways to become more sustainable and increase the quality of life. One of the measures cities are taking is by becoming more car-free through development with a focus on active and sustainable transport modes. However, getting people out of the car is a tough assignment as modal choice is influenced by many factors. Some factors do have a greater influence on modal choice and travel behavior like car availability, parking travel time, and travel cost in comparison to weather, and gender. Nonetheless, most of the factors are interrelated like travel costs depend on travel time, which in turn depends on travel distance.

The measures that are taken by municipalities to lower the intensity of motorized vehicles on the road which are examined in this research are related to travel time. Travel time is the most important factor of the journey characteristics as travelers are most likely to choose the mode with the least travel time in accordance with the random utility theory and is, therefore, a good basis for the survey to see what the impact is of this factor on disappearing traffic. However, as this chapter showcased, are there many factors that influence modal choice and travel behavior. As not all the factors have such a big impact on mode choice/travel behavior or are not interesting to examine in regards to disappearing traffic, not all factors will be examined in this research.

To look at whether it is possible to create personas in regards to disappearing traffic, all of the socio-demographic factors will be examined. Although there is no real consensus on what role some of the socio-demographic factors play in mode choice like gender, it is clear from this literature review that other factors within this group are of great influence on modal choice like income and car availability which determine which travel options travelers have to their availability. Other interesting factors that will be looked into in this research are;

- *travel motive* (e.g. are people more likely to change their travel behavior when traveling for work in comparison to a leisure trip?)
- *Parking* (are respondents more likely to change their travel behavior if they have to walk further toward their vehicle?)

2.7 Conceptual model

The research questions from paragraph 1.4.2 and the literature described in chapter 2 are an incentive to research some interesting relations. These relations are schematically shown in the conceptual model (fig. 3). In short, changes to the external environment through policies let people deliberate whether they stick to their current travel behavior or change their behavior which can lead to disappearing traffic. Changes to the external environment can be lowering the maximum speed or (re-) designing streets with confined space for the car. The deliberation of people about their travel behavior is accompanied by their personal characteristics and the characteristics of the built environment they live in. In this research, the effects of multiple measures, or changes to the external environment, are investigated in relation to travel behavior. In addition, this research examines factors that impact the decision to change travel behavior causing traffic to disappear. This ultimately led to multiple recommendations regarding disappearing traffic. The next chapter describes how these relations were examined.

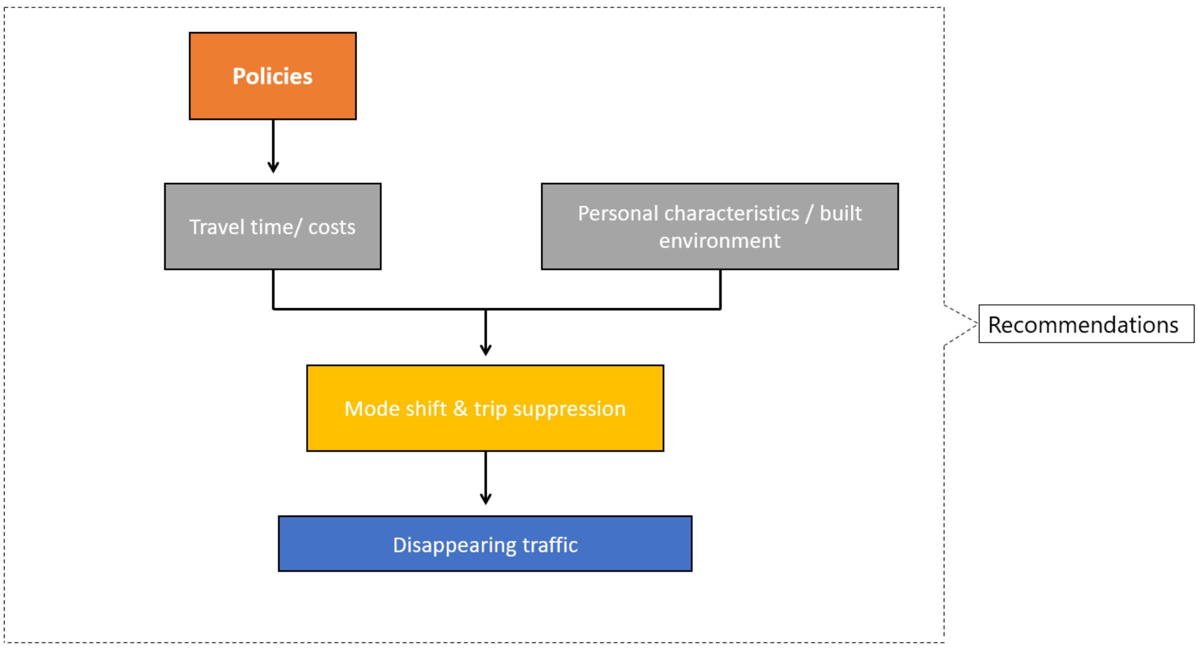


Figure 3 Conceptual model ''disappearing traffic''

3. Methods

3.1 Quantitative research

To map the effects of development with the priority on cyclists, public transport, and pedestrians instead of the car, there has been chosen for a quantitative research. There are multiple reasons why this is the case. First of all, there is almost no literature regarding the causation of disappearing traffic and the people who decide not to take the car when the travel times by car increase. Therefore it is preferable to gain as much data as possible regarding disappearing traffic to be able to make statements about a bigger population instead of a smaller group. Secondly, it may be argued that the best way to give insights into disappearing traffic is to execute a case study in which some sort of measure is taken to reduce the number of cars. Although this might be the best possible way to gain insight into disappearing traffic, this method will only give insight into one specific location and one measure that is taken by the municipality to reduce the car intensities on the road. These results cannot be generalized and therefore the conclusions are bound to that specific area and areas that look alike where possibly the same measure is taken. Also, limiting this research to one specific area means that it will be tougher to gain enough respondents to be able to run statistical tests. This is also the main reason why a stated preference survey was used in this research as a revealed preference survey would be limited to a specific area.

Stated preference (SP) surveys are surveys in which hypothetical choices are provided. This means that respondents should imagine themselves undertaking a trip, given the sketched scenario obtaining the respondent's choice responses (Stinson & Bhat, 2003). There are multiple advantages of using a stated preference survey, which include;

- Have the ability to obtain a large sample size due to the low cost of data collection,
- Potential to avoid multicollinearity among attributes, and
- Pre-specification of the choice set.

Regarding this research, SP makes it possible to put respondents in different scenarios in which different measures are taken to reduce the amount of motorized traffic. Therefore it gives a more general insight into who the people are that distance themselves from the car. This can also be related to the different kinds of measures that can be taken by municipalities to achieve a lower car intensity on the road. It also gives more insight into the general effects of different kinds of measures like increasing the walking distance towards the car and increasing travel time inside the car.

3.2 Layout survey

The questionnaire used in this research consisted of six parts namely;

1) Current travel behavior (general)
2) Scenarios travel motive *''Work & study''*
3) Scenarios travel motive *''Household & Services''*
4) Scenarios travel motive *''Social and recreative''*
5) General statements
6) Personal information

3.2.1 Current travel behavior (general)

The first questions in the survey gave insight into the current travel behavior. Respondents were asked to fill in how many times they made use of different types of modalities, how many times they used the car for different kinds of travel motives, and to which other modalities they had access beside the car. It also gave insight into how long they had to walk towards the car. Based on the questions of how many times they used the car for different kinds of travel motives, it was determined whether the respondent would be able to fill in the answers for the different kinds of travel motives. E.g., if a respondent indicated that he or she did not make use of the car in the last three months for the travel motive of ''Work & Study'', he or she would not be able to fill in the questions related to this travel motive and would automatically skip to the next travel motive which in this case is ''Household and Services''.

3.2.2 Scenarios travel motives

Multiple kinds of travel motives were used in the questionnaire to identify whether respondents react differently to measures for multiple motives. To include as many trips as possible in this research, the decision was made to include three kinds of travel motives which are ''Work and Study'', ''Household and Services'', and ''Social and Recreative''. These motives are a combination of the travel motives which are used in the ODiN 2020 (Onderweg in Nederland) report (CBS, 2021). The ODiN report provides adequate information about the daily mobility of the Dutch population, described by place of origin, destination, time at which the transport takes place, means of transport used, and the motives for the trips. A total of nine motives are used in the ODiN consisting of the travel motives from and towards work, business and professional, services and care, (grocery) shopping, following education or course, visit and lodging, going out & sports and hobby, touring and walking & other motives. Asking the same questions for each of these travel motives would give the most precise results. However, filling in the questionnaire would take way too long for a respondent if every travel motive would be discussed. Therefore, the decision was made to include only three motives that would capture most of the travel motives (which were also used in the ODiN), so most trips were included/covered in this research namely ''Work and Study'', ''Household and Services'', and ''Social and Recreative''.

Most physical measures that municipalities take result in an increase in the travel time by car. Examples are;

- Road removal
- Taking away parking places
- Giving priority to pedestrians and cyclists in streets and at intersections/ creating more shared space.

For this matter, the scenarios in the questionnaire are mainly focused on an increase in the travel times by car. For each of the travel motives, respondents are asked to fill in their normal travel behavior for the destination they visit the most by car. These questions give insight into the normal travel times to (e.g.) work or study, if they ever use other transport modes for this trip, with how many people they make the trip, and an estimation of the travel times by bike and public transport. Subsequently, respondents were asked whether they would still make use of the car when their travel times in the car would increase by +5,+10,+15, and +20 minutes. At each of the extra travel times, respondents could indicate whether they would still make use of the car, make use of an alternative (and which), or that they wouldn't make the trip anymore. The same sequence of questions applies to extra travel toward the car (walking to the parked car). Only this time the extra travel time towards the car would be +3 and +5 minutes.

3.2.3 General statements

Shortly before the end of the questionnaire, respondents were asked to give their opinion on some general subjective statements regarding mobility in their area. The statements were related to whether respondents suffered from the negative effects of mobility (e.g. noise), the number of transport facilities, and the safety of different kinds of modalities. Respondents were able to respond on a scale from 1 to 5 with 1 being ''totally disagree'' and 5 ''totally agree''. These questions give a general idea of what respondents think on mobility matters and what possibly needs to be changed.

The general statements were;

- I accept a longer journey time to ensure a safer and more liveable city
- I think that the safety of pedestrians in my area is not guaranteed enough
- I think there should be more parking facilities in my area
- I am affected by traffic noise
- I think there is too much traffic driving through my city
- I think people drive too hard in my area
- I think there should be more public transport facilities in my area
- I think that the safety of cyclists is my area is not guaranteed enough

3.2.4 Personal information

At the end of the questionnaire, respondents were asked to fill in some personal information. This information included gender, education level, current work situation, and age, This information was useful to examine whether a specific target group would change their travel behavior based on the scenarios that were given.

3.3 Gathering the data

The data is gathered through PanelClix. PanelClix is an online platform on which people are compensated to fill in surveys. The advantage of this platform is that a specific group of people can be targeted to fill in a survey, resulting in the best possible results. This way the investigator does not have to pay for respondents that do not fit the research.

The target audience for this research consist of people that are 18+, live in a city with more than 25.000 inhabitants, are in the possession of a driver's license, and make use of the car every week. Disappearing traffic mainly occurs when people have alternatives available to them. This is mainly the case in cities with a high density resulting in smaller distances for people to walk or cycle to public facilities. Also, most cities offer high-quality public transport making it easier for people to decide to leave their car behind. For this reason, people were targeted who live in bigger cities where the facilities of the alternative are well organized.

Also, to make sure every socio-demographic group was sufficiently represented, PanelClix was asked to make a representative distribution on the criteria; age, education, and gender. This made it possible to run a statistical test with each of the variables age, education, and gender as the sample size for each of the variables was sufficient enough.

The complete sample size of this research is particularly important for the representativity of this research. The total response of the survey should give a representative image of all car users who live in a city. In 2015, just the cities of Amsterdam, Rotterdam, The Hague, Utrecht, and Eindhoven accounted for 10% of all registered vehicles in the Netherlands which at that moment was 720.000 (CBS, 2016). As the sample size of a survey doesn't get higher when working with a big population, the amount of 720.000 was used to calculate the number of respondents that were needed to make this research representative. With an intended confidence level of 95% and an error margin of 5%, gives the following minimum sample size (Israel, 1992).

$$n_0 = \frac{Z^2 * \hat{p}(1-\hat{p})}{e^2} = \frac{1{,}96^2 * 0.5(1-0.5)}{0.05^2} = 384{,}16$$

n_0 = Sample size

Z^2 = Desired confidence level (Z value)

e = Desired level of precision

p = proportion of an attribute that is present in the population

In total 547 respondents (partially) filled in the survey. However, after filtering out the non-completes and the illogical answers, the total amount of complete surveys amounted to 414. Therefore the sample size is big enough to make statements about the whole population when all the surveys are used. Because the total amount of respondents differs between the travel motives, is it not possible to make statements with a 95% confidence level for just one travel motive.

3.4 Cleaning the data

Multiple steps were taken to make the data valid for this research. To make certain that every respondent met all the requirements for this research, screening questions were placed in the questionnaire. The screenings questions related to whether they used the car every week and how many inhabitants their city counted. If a respondent filled in that they either lived in a city with less than 25.000 inhabitants or did not make use of the car every week, they would get a message that they could not take part in this research.

Once all the data was collected, it appeared that many respondents had given unreasonable answers. To make the data valid, the data was filtered on illogical answers. The illogical answers were found in the category of age and mainly in the travel times respondents indicated and their response to the given scenarios. For the travel times applied that the travel time by car did not match the travel time of the alternatives of the respondent. For example, a respondent had a travel time of 2 minutes by car but indicated that it would take 30 minutes by bike to get to that same destination. The most illogical answers were found in the response to the given scenarios. Respondents were given multiple scenarios in which the travel by car was increased. However, on many occasions, the answers did not add up. For example, a respondent indicated that they would not make use of the car anymore when their travel time by car was increased by 5 minutes but would make use of the car when the travel time was increased by 15 minutes. Because this happened in tens, the decision was made to filter these answers out per travel motive as it could be possible that it was just a mistake. Another reason for this decision was that these cases were always related to the group of respondents that indicated that they would not make use of the car anymore. This group was for each of the travel motives a minority. Filtering out the respondents that had given illogical answers for one travel motive but would be filtered out for all travel motives, would make this group more of a minority which results in less trustworthy results.

3.5 Analysis of the found data

The possible relationships between ''change in travel behavior'' and personal, spatial & journey factors have been analyzed through the use of Pearson's chi-square test. This statistical hypothesis test can be used to see whether there is a relationship between two categorical variables (Fisher, 1922; Pearson, 1900). The test is based on the simple idea of comparing the frequencies that are observed in certain categories to the frequencies that can be expected to get in those categories by chance. Therefore, a chi-square test is an excellent choice to help us better understand and interpret the relationship between two categorical variables. Most of the variables that are examined in this research are categorical variables. That being the case, the chi-square test is for this research a good choice to gain a better understanding of what factors play a role regarding a change in travel behavior, possibly to create personas of which people are more likely to leave the car behind and which are not.

The variable which was continuously used for Pearson's chi-square of independence was whether people had indicated that they would get out of the car when their travel time would be increased. If a respondent indicated that he or she would use another transport mode or that they would not make the trip anymore in any of the extra travel time scenarios, they would be labeled as (0) ''changes behavior''. The people that did indicate that they wouldn't change their behavior are labeled as (1).

To determine whether there is a relationship between having an alternative transport mode and a change in travel behavior, a new variable was made. The variable ''Has an alternative transport mode'' is based on the travel times respondents answered for each of the travel motives. In this case, they include the travel times to work or study by bicycle, public transport, and car. Whether a transport mode can be seen as an alternative is based on the ''VF waarde'' or ''verplaatsingstijdfactor''. The ''VF waarde'' indicates the relationship between the travel time by car and the travel time by the alternative. The travel time of the alternative is divided by the travel time by car. If the ''VF waarde" is below 1 it means that the alternative is faster than the car and if it is above 1 the other way around. Figure (4) shows the connection between VF-waarde and the share of public transport for commuter traffic on several regional/urban-regional relationships in the Randstad. As the figure shows, 60% of the trips are made by public transport when the VF waarde is 0.9 and only 20% when the VF waarde reaches 2.0. In this research, a VF waarde of 1.5 is used to determine whether public transport is an alternative at which still 40% of the trips are made by public transport. The VF waarde for the bike is set on 1.25. Also, every bike ride that is within 20 minutes is seen as an alternative as the ''VF waarde'' can give a distorted picture when people have a short travel time. That way when people have indicated they only have to travel two minutes by car and 4 minutes by bike, the bike will still be seen as an alternative despite having a VF waarde of 2. The 20 minutes lay within the maximum travel time by a normal bike which is 30 minutes or 7.5 kilometers (Fietsberaad CROW, 2009).

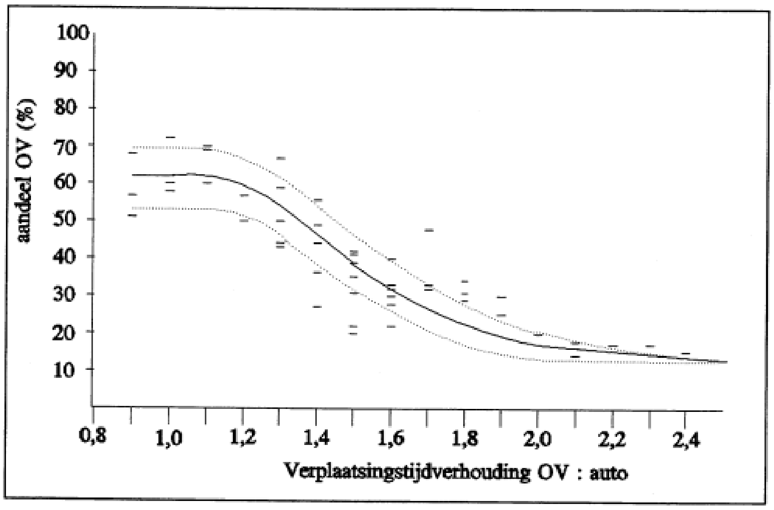


Figure 4 Connection between VF-waarde and the share of public transport (VF-curve) for commuter traffic on a number of regional/urban-regional relationships in the Randstad (Projectbureau Integrale Verkeers- en Vervoerstudies, 1995)

In the case that a variable showed no significance in regard to the variable ''Changes travel behavior'', categories would be combined to see whether that would have an impact on the significancy. The original variables are shown in the analysis when that did not impact the significance. An example of a combination of categories is the variable ''education''. The variable ''Education'' is combined into two categories high-educated (Havo/vwo secondary grades, higher vocational education (propaedeutic year) & university degree). At first, the variable showed no significancy. However, after combining the categories, the variable was significant in relation to ''changes travel behavior''.

4. Findings

This chapter describes the results of the stated preference survey. The section is divided into five parts in which each of the three travel motives get elaborated individually, compared, and the general results.

4.1 General results

4.1.1 Respondents

In total 414 respondents filled in the survey of which are 49% male and 51% female (see figure x). As people did not have to fill in the questions which were not relevant to their travel behavior, the number of respondents differ in their travel motives. As table 1 shows, 239 respondents used the car for either work or their study. 341 people use the car for household and services and 376 respondents indicate that they use the car for social/recreative purposes.

Total respondents	*414*
Work and Study	*239*
Household and Services	*341*
Social/recreative	*367*

Table 1 Amount of respondents per travel motive

Gender	
Male	*49%*
Female	*51%*

Table 2 Percentual amount of respondents per age

The difference between the number of respondents for work and study and the other categories can partially be explained by the target audience of the survey as age, gender, and education level were divided almost equally, meaning that a part of the target audience was already retired as they are 67+. This is also visible in table 3, where it is observable that the age group of 60-89 is only 15% in comparison to the motives household and services (31%) and social and recreative (31%).

Age group	*Work and study*	*Household and Services*	*Social and Recreative*
18-29	*23%*	*18%*	*18%*
30-44	*28%*	*21%*	*22%*
45-59	*34%*	*30%*	*29%*
60-89	*15%*	*31%*	*31%*

Table 3 Crosstab Age groups & Travel motive

Of all the respondents is 41.8% high-educated and 58.2% low-educated (table 5). Looking at their current situation is the largest part of the group employed or self-employed (67.4%) (table 4). Also, 19.1% of the respondents indicated that they are retired. Once again can this be related to why the number of respondents for the travel motive ''Work & Study'' is lower in comparison to the other travel motives.

Current situation	
I am employed or self-employed	67.4%
I am (partially) unfit for work or unemployed	6.5%
I am retired	19.1%
I am studying (or going to school, doing an internship)	2.7%
I am a housewife/houseman	2.9%
I do volunteer work	1.2%
I don't know	0.2%

Table 4 Current situation respondents

Education	
High-educated	*41.8%*
Low-educated	*58.2%*

Table 5 Respondents' education level

4.1.2 Current travel behavior

Respondents were asked to fill in the number of times they drove a car in the last three months (see figure 5). Of all the 414 respondents, 51% use the car 4 or more times a week, 39% 1 to 3 times a week, 4% 1-3 a month, 5% 1 or two times maximum in those months, and 1% indicated they did not use the car as a driver. All 6 respondents did indicate that they used the car multiple times as a passenger.

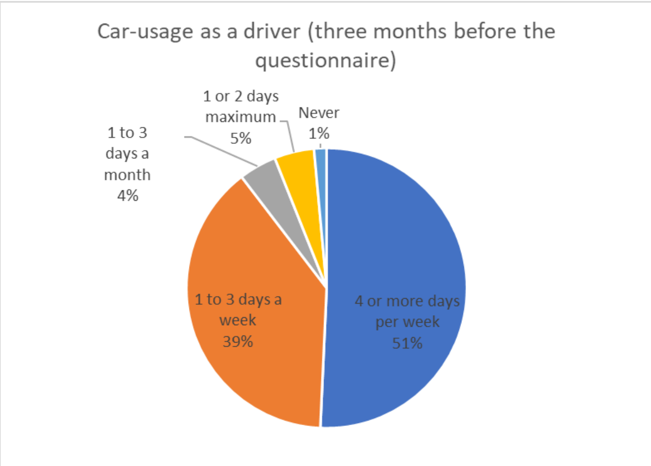


Figure 5 Car-usage as a driver

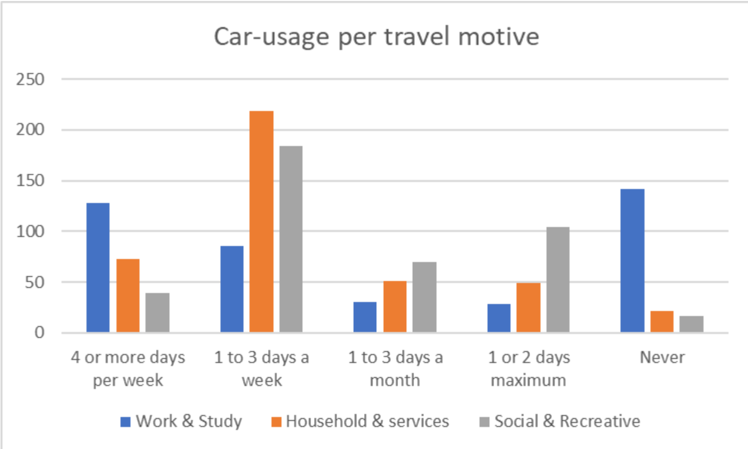
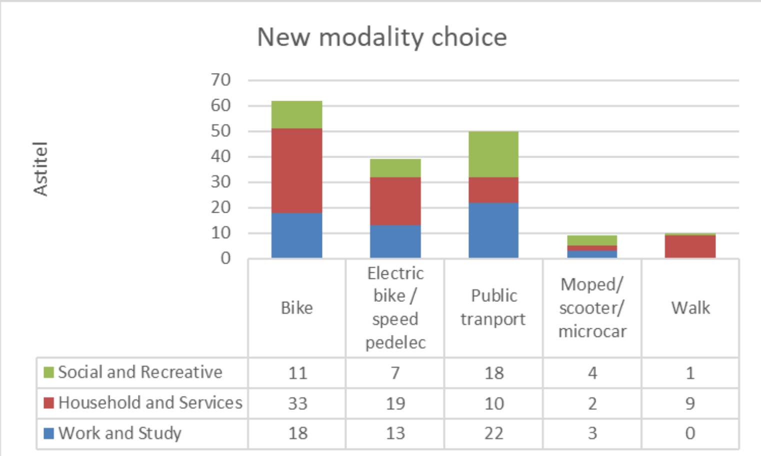


Figure 6 Car-usage per travel motive

Figure 6 shows the amount of times respondents used the car for each of the travel motives. The car is mostly used 1 to 3 days per week tfor the categories Household & Services and Social & Recreative. Noticeable is that many respondents never use the car for work. As mentioned earlier can that partially be explained by the age of the respondents. 30.9% of the respondents do indicate that they use the car for 4 or more days per week for the travel motive Work & Study.

4.1.3 New modality

In total 131 (31.6%) respondents indicated that they would make the trip with a different modality in case the travel time by car was increased by +20 minutes. For the travel motive ''Work & Study'', a total of 32 (13.4%) respondents indicated that they would make use of a different modality, Household & Services 60 (17.6%), and 39 (10.6%) respondents for the motive Social and Recreative. After respondents indicated that they would switch to another modality they were asked to indicate which modality they preferred in that situation. Figure 7 shows the results for each of the travel motives. The category bike relates to normal city bikes only.



	Bike	Electric bike / speed pedelec	Public tranport	Moped/ scooter/ microcar	Walk
Social and Recreative	11	7	18	4	1
Household and Services	33	19	10	2	9
Work and Study	18	13	22	3	0

Figure 7 New modality choice

As the table shows, is the bike the most chosen alternative for people when the in-car travel time increases especially when the categories bike and electric bike/ speed pedelec are combined. This applies to the motives of work and study and household and services. For the travel motive social and recreative is public transport equal to the bike. Only 10 respondents indicated that they would make use of public transport for the travel motive household and services. This can be explained by the low average travel time in comparison to the other motives and the car is more of a necessity for doing groceries.

4.1.4 General Statements

In the questionnaire, people were asked to give their opinion on some general statements relating to mobility in their area. The results of these statements are shown in figure 8. As the figure shows is the response in most of the cases divided equally. Things that stand out are;

- 54% of the respondents indicate that they totally agree or agree that they are affected by traffic noise. 23% of the respondents are neutral on this statement. The high amount of respondents that indicate that they are affected by traffic noise can be explained by the location of the residences of the respondents as all of the respondents live in a city with more than 45.000 inhabitants.
- Many respondents think that too much traffic drives through the cities. Of all the respondents 16% indicate they totally agree and 31% agree.
- Respondents were divided equally on the statements whether there should be more public transport and parking facilities and that safety is guaranteed enough of cyclists and pedestrians in the area.
- The most interesting statement beforehand relating to this research is whether people accept are longer journey time to ensure a safer and more liveable city. The answers to this statement indicate slightly how fast people are willing to change modalities or do not travel at all. 13% of the respondents imply that they totally agree with this statement, 33% of the respondents agree and 36% of the respondents are neutral. Of the group that (totally) agree with this statement can be expected that their will is the highest to adjust their travel behavior when the car is made less attractive. Only 7% of the respondents indicate that they totally disagree with the statement to accept a longer travel time for a safer and more liveable city. These respondents are most likely to choose for the quickest and most convenient travel mode. A

significant relationship has been found between the variable ''Changes travel behavior'' and ''Willingness to travel longer for a safer and more liveable city'' for the motives of work and study (*X^2 (4, N=239) = 8.387, p = .078)) and household and services (X^2 (4, N=341) = 8.026, p = .091 whilst using a confidence interval of 10%. This result confirms what was expected beforehand when observing the response to this statement.*

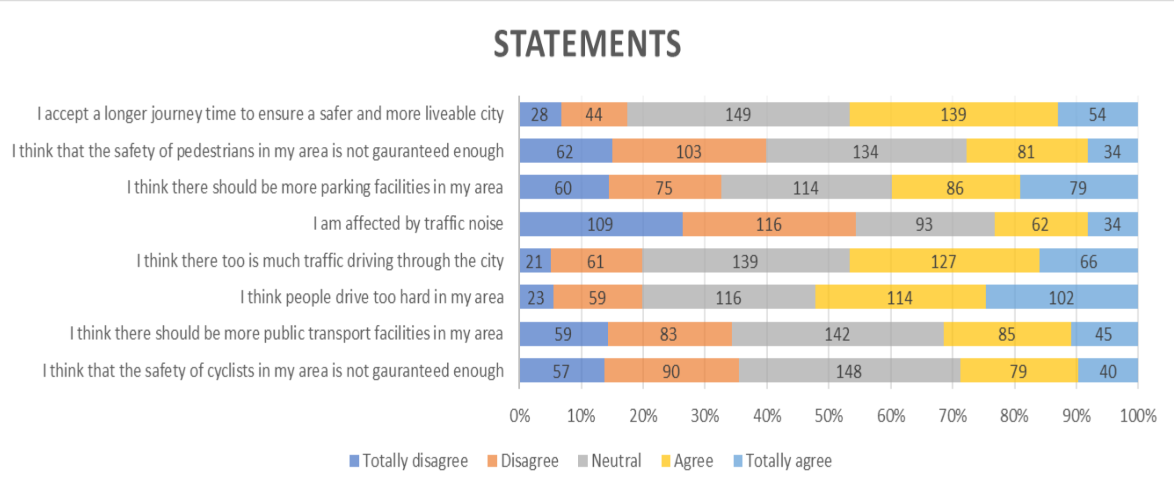


Figure 8 General statements

4.2 Work & Study

In total 239 respondents indicated that they used the car for either their work or their study. The average travel time to work or study of the respondents amounts to 25.6 minutes. This average corresponds with the average travel time to work in the Netherlands being 25 minutes (van Dijk, 2020).

4.2.1 Changing travel behavior

The travel motive work and study is the least flexible travel motive as most of the time the activity is fixed. Fixed activities relate to activities where you need to be at a certain time, such as work or going to university (Neutens, Schwanen & Witlox, 2010). When asked what the respondents would do if their travel time by car would increase by 5 minutes, only 7.5% of the respondents indicated that they would change their travel behavior. As figure 9 shows, increases the number of people that change their behavior steadily as the in-car-time increases. Ultimately at +20 minutes, 36.8% of the respondents indicate that they won't make their trips anymore by car of which 13.4% switch modalities and 23.4% of the respondents do not make this trip anymore.

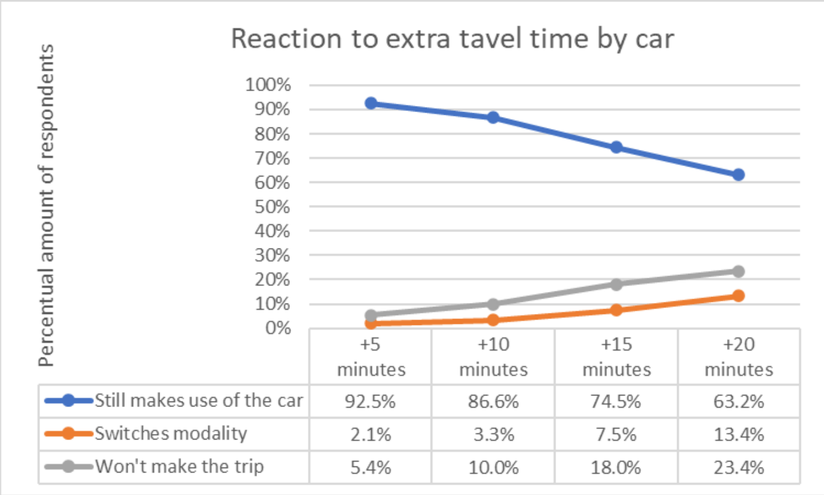


Figure 9 Reaction to scenario's extra travel time ''Work & Study''

However, when we compare the extra travel times in the car and the extra travel times outside the car (walking towards the car), it is visible that 11.7% of the respondents won't make use of the car if they have to walk an extra three minutes towards the car (see table 4). At +5 minutes there are even 44 respondents (18,4%) who declare that they won't make use of the car. If we compare the extra walking time towards the car and the extra in-car travel time, it is visible that that walking time has a bigger impact on the respondent's choice of whether to take the car or not.

Parking (walking time towards the car)	**+3 minutes**	**+5 minutes**
Still makes use of the car	88.3%	81.6%
Switches modality	3.3%	3.8%
Won't make the trip	8.4%	14.6%

Table 4 Respondents' reaction to extra walking time toward the car

The average extra travel time when respondents start to switch to another modality or do not make this trip anymore is 0.789 meaning that on average people do not make the trip by car anymore when they have a percentual increase of in-car travel time of around 80%. This number only accounts for the people that have implied that they will change their travel behavior in those +20 minutes which is 36.8% of the respondents (see figure 9). When we take a deeper look into the percentual extra travel time before respondents indicate that they won't make use of the car anymore (figure 10), it is visible that it slowly builds up towards 34% indicating that 34% percent of all respondents indicated that they wouldn't make use of the car after a certain extra travel time (34% remains after excluding the outliers). It appears that at as well as 50% and 100% percentual extra travel time the line flattens, meaning that at those percentages more people change their travel behavior. Especially at 100% around 5% of the respondents indicate that they won't make use of the car anymore.

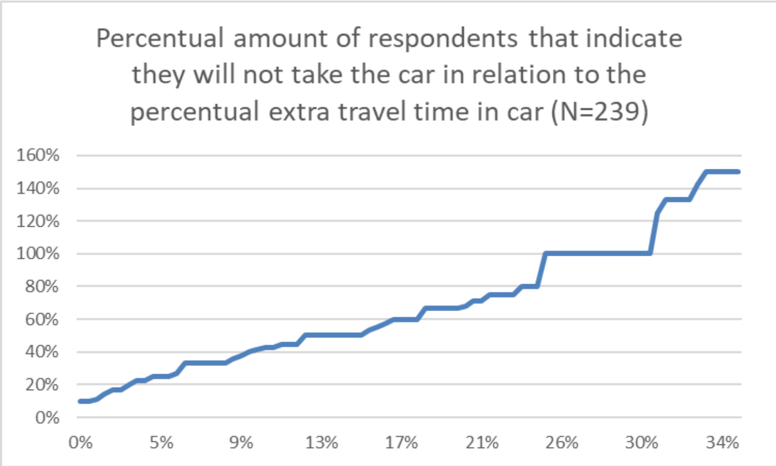


Figure 10 Percentual amount of respondents that indicate they will not take the car anymore in relation to percentual extra travel time for the travel motive ''Work & Study''

The average travel time to work by car for people that change their behavior is ($\bar{x}$ =25.52) and people that still take the car ($\bar{x}$ =25.68). Looking at the difference between those averages, it is noticeable that the two averages are close to each other. As the extra travel time from the scenarios has a relatively bigger impact on lower travel times, it is expected that respondents with a lower travel time would switch their travel behavior earlier. The expectation is that the average travel time of that group to work would be significantly lower in comparison to the group that does not show any change in their behavior.

4.2.2 Target audience analysis

The results of the Chi-square tests for the travel motive work and study show that there are two variables that are significant concerning whether people change their travel behavior. There is a significant relationship between the variables ''Changes travel behavior'' and ''Has an alternative transport mode'', $X^2(1, N=239) = 6{,}566$ $p = .010$.

Changes travel behavior * Alternative Crosstabulation

% within Changes travel behavior

		Alternative		
		Has an alternative	No alternative	Total
Changes travel behavior	Changes	60.2%	39.8%	100.0%
	Doesn't change	43.0%	57.0%	100.0%
Total		49.4%	50.6%	100.0%

*Table 7 Crosstabs ''Change in travel behavior'' * ''Alternative''*

This result is logical as respondents can't switch modalities if they do not have an alternative. However, the variable ''changes travel behavior'' does also include the people that indicated that they wouldn't make the trip anymore. Table 7 shows the crosstabulation of the variables alternative and change in travel behavior. The cross-tabulation show that a larger portion of the people that indicated that they would change their travel behavior does have an alternative (60.2% vs. 39.8%). The same accounts for respondents who indicated that they are not changing as most of them do not have an alternative (43% vs 57%).

Secondly, there is a significant relation between the variables ''Changes travel behavior'' and ''Education'', $X^2(1, N=239) = 8.247$, $p = .004$ (High-educated (41.4%) and people with lower education (58.6%) (see table 8).

Changes travel behavior * Education Crosstabulation

% within Changes travel behavior

		Education		
		Low education	High education	Total
Changes travel behavior	Changes	46.6%	53.4%	100.0%
	Doesn't change	65.6%	34.4%	100.0%
Total		58.6%	41.4%	100.0%

*Table 8 Crosstabs ''Change in travel behavior'' * ''Education''*

Of that total, 65.6% of the lower-educated respondents indicated that they wouldn't switch in comparison to the 34.4% of the higher-educated respondents (see table 8). Thus, a larger part of the lower-educated respondents indicated that they wouldn't change their travel behavior. There are multiple possibilities why this is the case. For example, education can be linked to income. Higher-educated people earn in general more money, making it easier to switch to an alternative that might be more expensive. Another possibility is related to the location of offices. Many offices are located nearby train stations, making it easier for higher-educated to switch to public transport.

Other variables that were tried to make potential personas showed no significance. Table 9 shows the list of the variables that showed no significant relationship with the variable ''Changes travel behavior''. The reason to test the following variables are as follows; For age can be argued that elderly people are less vital and thus are more likely to stick to the car. Respondents who own a company car are in this case not more likely to stick to the car as the opposite might be expected. Respondents who own a (lease) company car, can most of the time tank for free therefore making it more attractive to stick to the car as it doesn't cost as much. Having several passengers in your car on that trip doesn't affect the chance of leaving the car as well. Having several passengers in the car does make it harder to switch to another mode, as the other people might be dependent on you driving to that destination. Also the variable ''city inhabitants'' does not have a relation with ''changes travel behavior''. Cities with a higher amount of inhabitants tend to have a better public transport network and higher densities making it easier to switch to another modality.

Variable	Sig.
Age	.531
Gender	.972
City inhabitants	.568
Owns a company car	.572
Usual amount of passengers	.941

Table 9 Not significant variables ''Work & Study''

4.3 Household & services

The travel motive of household and services was filled in by a total of 341 respondents. Respondents traveled on average 15.60 minutes by car on their most common trip for the travel motive ''Household and Services''.

4.3.1 Changing travel behavior

In contrast to the travel motive work & study, consists the travel motive ''Household and Services'' of many possible destinations. To avoid as much confusion as possible, respondents were asked to fill in the survey for their most common trip. As figure 11 shows is a big proportion (75%) of the most common trips made for the travel motive ''Household & Services'' to buy groceries. Looking at the reaction to extra travel time (Figure 12), it is visible that there is a steady decrease in car usage in relation to the extra travel time. At 5 minutes only 32 of the 341 (9,4%) respondents indicate that they won't make use of the car anymore. This amount steadily increases to 133 (39% of all respondents) when there is an extra travel time of 20 minutes.

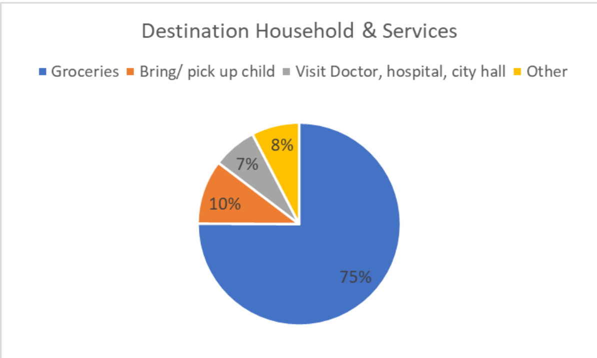


Figure 11 Most common trip destination

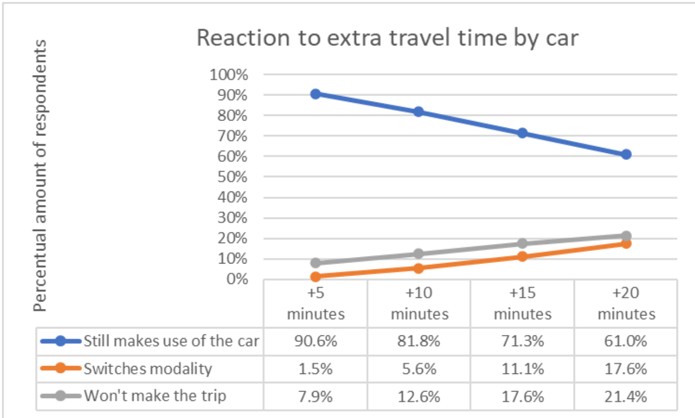


Figure 12 Reaction to scenario's extra travel time ''Household & Services''

Comparing the reaction to extra travel in the car with extra travel time outside the car again shows a significant increase of respondents who are changing their travel behavior. Where only 9.4% of respondents indicated that they would not make use of the car anymore when the extra travel time was applied to when they were in the car, indicated 21.1% of the respondents that they would not make use of the car anymore when they had to walk for 5 more minutes towards their car (see table 10). This implies once again that the in-car extra travel time has less of an impact on behavioral change in comparison to extra travel time outside of the car.

Parking (walking time towards the car)	+3 minutes	+5 minutes
Still makes use of the car	89.4%	78.9%
Switches modality	2.6%	7.6%
Won't make the trip	8.%	13.5%

Table 10 Respondents reaction to extra walking time towards the car

The average percentual extra travel time when people start to switch to another modality or do not make the trip anymore for the motive household and services amounts to 137% (N=132 or 38.7% of all the respondents). The height of this number can partially be explained by the average travel time of respondents for this travel motive. As the average travel time amounts to only 15.60 minutes, the impact of the extra travel time in the scenarios is much higher. Also, because many respondents take the car usually to buy their groceries and pick up/ bring their child somewhere, respondents are less likely to distance themselves from their car because it is a necessity as they are trip chaining. Figure 13 shows the percentual amount of respondents that indicate they will not take the car in relation to the percentual extra travel time in the car. In total 39% percent of the 341 respondents indicate that they won't make use of the car anymore after the extra travel time in the car. At especially 100% extra travel time flattens the line indicating that at double the travel time, many respondents (10.3%) won't make use of the car anymore. At a percentual extra travel time of 200%, 6.3% of the respondents indicated that they would not make use of the car anymore.

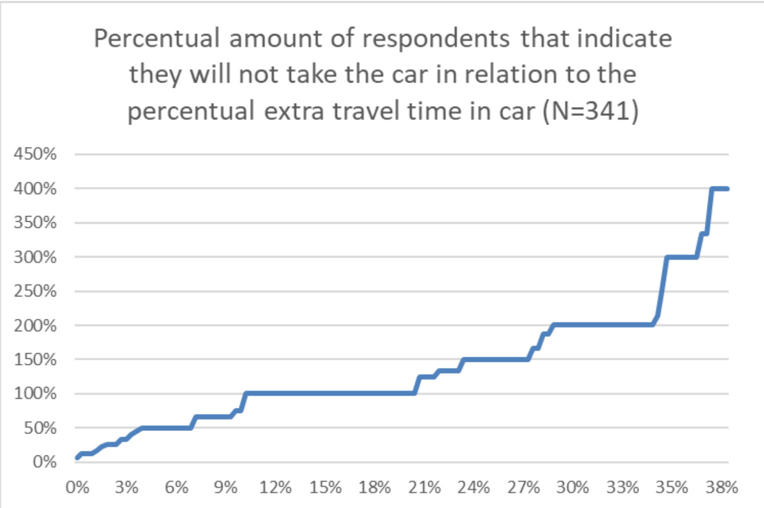


Figure 13 Percentual amount of respondents that indicate they will not take the car anymore in relation to percentual extra travel time for the travel motive ''Household & Services''

The average travel time of the respondents that change their travel behavior $\bar{x}$ =14.86 minutes is lower in comparison to respondents who indicate that they won't change their travel behavior $\bar{x}$ =16.07. This is expected as people with a lower travel time are impacted more by the extra travel time.

4.3.2 *Target audience analysis*

The results of the Chi-square tests for the travel motive household and services show that there are once again not many variables that are significant in relation to whether people change their travel behavior. There is a significant relationship between the variables ''Destination'' and the variable ''Changes travel behavior'', $X^2(3, N=341) = 7.213, p = .065$. The variable ''Destination'' refers to respondents' most common destination for the travel motive household & services. The variable is only significant when using a ten percent confidence interval.

Destination * Changes travel behavior Crosstabulation

% within Destination

		Changes travel behavior		
		Changes	Doesn't change	Total
Destination	Groceries	36.3%	63.7%	100.0%
	Bring/ pick up child	45.7%	54.3%	100.0%
	Visit doctor, hospital, city hall, etc.	62.5%	37.5%	100.0%
	Other	34.6%	65.4%	100.0%
Total		39.0%	61.0%	100.0%

*Table 11 Crosstabs Change in travel behavior*Destination*

Even when the travel time is increased by 20 minutes, 61% of the respondents still make use of the car, making it clear how important the car is to respondents to buy groceries as they can't bring the groceries easily on a bike or other transport mode. This is also visible in table 11 as 63,7% of the respondents who use the car the most to do the groceries, do not change their travel behavior. The destination where most people do change their travel behavior is visiting the doctor, hospital, city hall, etc. (62.5% vs. 37.5%).

A ten percent confidence interval also applies to the relationship between the variables ''Has an alternative transport mode'' and ''Changes travel behavior''. Once again, there is a significant relationship between the two variables when a confidence interval of 10% is applied, $X^2(1, N=341) = 3.008, p = .083$. In addition, there is a significant relationship between the variables ''Education'' and ''Changes travel behavior'', $X^2(1, N=341) = 7.812, p = .005$. The same applies to the variables ''Has an alternative transport mode'' and whether respondents change their travel behavior if they have to walk longer towards their car X^2 (1, N=341) = 20.711, p = <.001.

Other variables showed no significance for the travel motive household and services (see table 12)

Variable	*Sig.*
Age	.463
Gender	.583
City inhabitants	.324
Owns a company car	.354
Usual amount of passengers	.520

Table 12 Not significant variables ''Household & Services''

4.4 Social & Recreative

The travel motive social and recreative is the travel motive with the most respondents. In total 367 respondents indicated that they used the car for this travel motive. The average travel time by car in minutes for this motive is 47.9 minutes.

4.4.1 Changing travel behavior

The motive ''Social and Recreative'' is the motive with the highest average travel time by car. Possible explanations for the high average travel time might be family visits who live far away and a common day trip. In total, 36% of the respondents indicated that they travel more than an hour towards their most common destination for this travel motive. Analyzing the reaction to the extra travel time for this motive, it becomes clear that many respondents do not distance themselves from the car for this travel motive. This can partially be explained by the high average travel time, which, in effect, means that the impact of the extra travel time has less of an impact. Also, only 19.6% of all the respondents stated that they usually make this trip alone. At 5 minutes, only 4.6% of the respondents indicated that they won't make use of the car anymore which steadily builds up to 21.8% at 20 minutes (see figure 14).

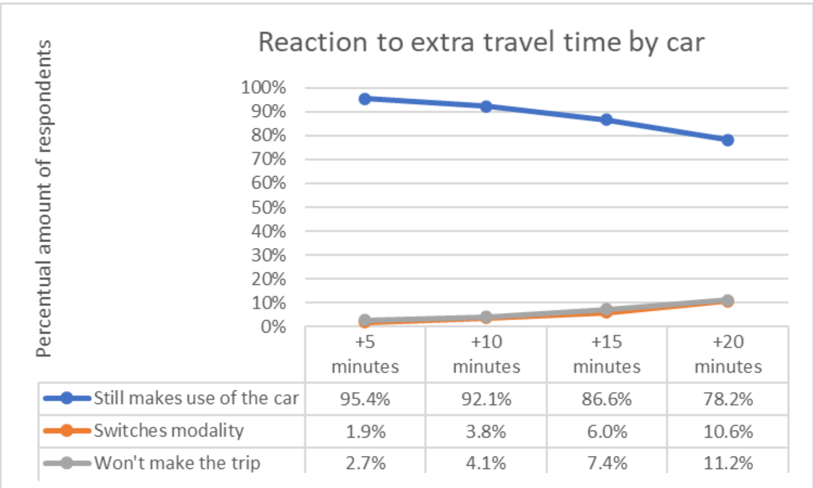


Figure 14 Reaction to scenario's extra travel time ''Social & Recreative''

Parking (walking time towards the car)	**+3 minutes**	**+5 minutes**
Still makes use of the car	95.4%	90.7%
Switches modality	2.5%	5.2%
Won't make the trip	2.1%	4.1%

Table 13 Respondents reaction to extra walking time towards the car

This result is also visible when looking at the number of respondents that indicated they won't take the car anymore when they have to walk to the car (table 13). Although 4.7% more respondents stated that they won't make use of the car when they have to walk 5 minutes to the car, a total of 9.3% of all respondents remains a small amount of the total number of respondents in comparison to the other motives.

Taking a deeper look at what percentual extra travel time respondents start to change their travel behavior for this motive, the average percentual extra travel time before respondents changed their travel behavior is 68% (N = 80). This is the lowest average in comparison to the other travel motives. As figure 15 shows increases the number of people who decide to not take the car steadily with a few outliers above 200%. These can be explained by their low travel time by car for this category, hence the impact of the extra travel time is way bigger.

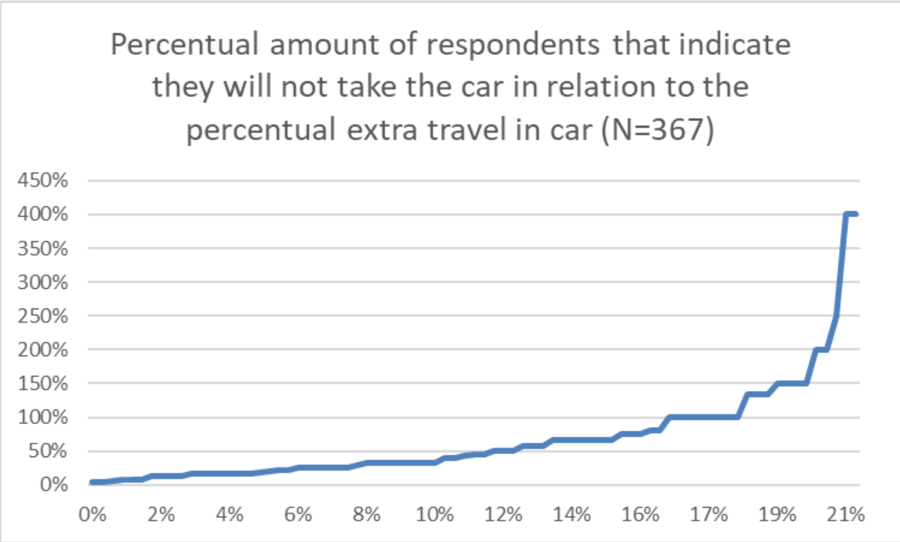


Figure 15 Percentual amount of respondents that indicate they will not take the car anymore in relation to percentual extra travel time for the travel motive ''Social & Recreative''

Looking at the average travel time of the people who distance themselves from the car ($\bar{x}$ =39.9) and the respondents who do not ($\bar{x}$ =50.1), there is a gap of 10.2 minutes on average. It is noticeable that the average of the people that do distance themselves from the car is 39.9 minutes which is on the high side. However, the average travel time for this motive amounts to almost 48 minutes, which partly declares why this number is on the higher side.

4.4.2 Target audience analysis

The tests showed no significant relationships between the variable ''Changes travel behavior'' and almost all the other variables for the travel motive ''Social and recreative''. However, a significant relationship has been found between the variables ''Changes travel behavior'' and ''Has an alternative transport mode'', X^2 (1, N=367) = 16.569, p = <.001. The same applies to the variable ''Has an alternative transport mode'' in combination with the variable whether people still make use of the car when they have to walk longer towards their car, X^2 (1, N=367) = 12.214, p = <.001.

The variables that showed no significance can be found in figure 14.

Variable	*Sig.*
Age	.967
Gender	.952
City inhabitants	.829
Owns a company car	.483
Usual amount of passengers	.682
Education	.244

Table 14 Not significant variables 'Social & Recreative''

4.5 Comparing travel motives

Multiple differences are visible between the travel motives when comparing the results of the analysis.

4.5.1 Travel times

First of all, the average travel time for a trip for the travel motive social & recreative (47.86 minutes) is much longer in comparison to the travel motives ''Work & Study'' (25.6 minutes) and ''Household & Services'' (15.6 minutes). Therefore, the impact of the extra minutes on the average travel time for the travel motive ''Social & Recreative'' is less in comparison to the other travel motives. This explains partly why the average extra travel time before respondents indicate that they change their travel behavior is the lowest for the travel motive ''Social & Recreative''.

4.5.2 Change in travel behavior

Taking a look at the number of respondents that indicates that they would change their behavior based on the scenario of +20 minutes, it is clear that respondents stick more to the car for the travel motive ''Social & Recreative''. In total 21.7 percent of the respondents indicated that they would change their travel behavior. For the travel motive ''Work & Study'' 36.8 percent indicated that they would change their travel behavior and for ''Household & Services'' 38.7%.

4.5.3 Parking

The travel time to walk to the car does have more impact than in-car travel time. This is the case for the travel motives ''Work & Study'' (10.9% more disappearing traffic) and ''Household & Services'' (11.7% more disappearing traffic). However, for the travel motive ''Social & Recreative'' is the impact less in comparison to the other travel motives (4.6% more disappearing traffic). This can be explained by the fact that many people do not make this trip alone and that the average travel time is way longer in comparison to the other travel motives.

5. Conclusion and discussion

5.1 Causation Disappearing traffic

Through the use of an online survey among car users who live in cities with more than 25.000 inhabitants, information was obtained on how respondents (N=414) would react to different scenarios regarding extra travel time. Descriptive analytics showed whether they would change their behavior and how they changed their travel behavior. The chi-square test of independence subsequently showed which (mainly) personal factors have a significant relationship with the variable of whether people change their travel behavior. This research into the effects of car interfering measures answers the question of under what circumstances car drivers are changing their travel behavior and in what way, causing traffic to disappear.

The first part of the question regarding under what circumstances car drivers change their travel behavior is in this research mainly related to extra travel time. Combining the averages for a measure that with an extra travel time of +5 minutes, comes down to an average of 7.2%. This percentage increases to an average of 32.6% for +20 minutes when all the travel motives are combined. 7.2% regarding the +5 minutes travel time is below what Cairns et al. (2001) showed in their research wherein more than half of the cases, 10% of the traffic disappeared with a median of 11%. However, as the minutes of extra travel time increases, more respondents are willing to change their travel behavior and step out of the car. At +10 minutes this average amounts to 13.2% which is more in line with the median of Cairns et al. (2001) research. The average amount of their research however was 21.9%. In this study, this equates to an additional travel time of 15 minutes. At +15 minutes 22.5% of the respondents indicate on average over all the travel motives to change their travel behavior. Examining these averages, it does seem that measures that increase travel time the most, are the most attractive to get people out of the car. However, it is not very likely that a measure increases the travel time by more than 10 minutes unless a measure was applied on a big scale and in multiple locations. A more realistic extension of the travel time would therefore be between five and ten minutes which comes down to around 10% disappearing traffic based on the results from this research.

Analyzing the percentual extra in-car travel time before people change their travel behavior, it is visible that at 100% travel time many people change their travel behavior for all travel motives.

The analysis of the data showed also other factors that impact whether people change their travel behavior or not.

Travel motive

Looking at the differences between the travel motives ''Work and Study'', ''Household & Services'', and ''Social & Recreative'', it appears that people are less likely to step out of the car and change their travel behavior for the travel motive ''Social & Recreative''. People are more bound to the car as the travel time towards their most common destination is longer in comparison to the other travel motives. Therefore the impact of extra travel time is less for this travel motive. Also, these destinations are more common to be at places which are not that accessible with alternatives like the bike or by public transport e.g. for family visits.

Parking

Travel time towards the car has a bigger impact on whether people choose to change their travel behavior in comparison to extra travel time in the car. Therefore it can be stated that measures that increase the walking time towards the car are more effective in comparison to increasing the in-car travel time. It is more attractive for municipalities to focus on parking measurements to lower the number of cars.

Alternative

One of the factors that impact whether people change their travel behavior the most is whether people have an alternative. Of course, this is not a surprise considering people would not be able to change their travel behavior regarding using a different modality if it is not available. However, it does mean that the facilities for other modalities like public transport should be in order before focusing on lowering the number of cars through measures on the road.

Education

Higher-educated people are more likely to step out of the car in the case of extra travel time in comparison to lower-educated people. Possible explanations are extra income. Higher educated people do earn more money making it easier for them to switch to an alternative that might cost a bit more money. Also, many high-educated people work In the service sector. Service sector offices tend to be in easily accessible locations for different types of modalities.

The second part of the main question related to in what way people tend to change their travel behavior. Analysis shows that people are more likely to not make the trip at all instead of choosing another modality. This is the case for every scenario the respondents encountered regarding increasing travel times and for each of the travel motives. Especially for the travel motive ''Work & Study'', many respondents choose to not make the trip anymore at +20 minutes (23.4% of the respondents) in comparison to change modalities (13.4%). This is also already the case at +5 minutes (2.1% change modality and 5.4% do not make the trip anymore). The same accounts for the travel motive ''Household & Services'' where 21.4% respondents indicate that they would not make the trip anymore in comparison to the 17.6% of the respondents who indicate that they switch modalities at +20 minutes. The only exception is the travel ''Social and Recreative'' where it is more 50/50. If respondents indicated that they would make use of another modality, most respondents indicated that they would switch to the bike. This is especially the case for the travel motive ''Household & Services'' and ''Work & Study'' whereas the distance to the destination is rather low in comparison to the travel motive ''Social & Recreative''. This indicated the importance of good cycling facilities as many it is the go-to alternative for many people. Public transport does not seem as a good alternative for the motive ''Household & Services'' in comparison to the bike. However, the use of public transport is relatively more common for the travel motives ''Social & Recreative'' and ''Work and Study''.

5.2 Discussion

More and more cities are looking to develop with confined space for the car. This development goes hand in hand with the trend of sustainable mobility and the realization of high-quality public space. This research was mainly focused on the objective to provide more insights into the impact of redeveloping streets with confined space for the car on travel behavior and to see in what way people would change their travel behavior. This research contributes to the limited information regarding disappearing traffic. There is limited research regarding disappearing traffic. The question remained who these people were that changed their travel behavior and in what way, especially in the context of the Netherlands. This research showed that there is not a specific target group that can be focused on regarding disappearing traffic. It does show under what circumstances people are changing their travel behavior mainly in relation to travel time and in what way people change their behavior, giving a bit more insight into what to expect when implementing car-restricting measures. The results of this research also seem to confirm some previous findings from the scientific literature.

Education

The results show that higher-educated respondents are more willing to change their travel behavior. This is in line with the findings of Limtanakool, Dijst & Schwanen (2006), who state that highly educated people show the highest propensity to travel by train. However, other researches beg to differ like the research from Pickery (2005). Pickery indicates that higher educated people use the car more often and lower educated go by foot more often. Therefore is there no real consensus on what the role of education is on modal choice.

Alternative

Results show also that having an alternative has a big impact on whether people change their travel behavior. This result confirms the results of the research of Limtanakool et al. (2006). They state that the availability of a public transport stop increases the use of public transport. They also state that car availability has a strong negative influence on the likelihood of using the train on medium- and longer-distance commuting trips. Therefore, it is of importance that when car drivers are facing extra travel time, and think of possible new ways to make that same trip, the quality of the facilities of the alternatives is well organized. Jiao, He & Zeng (2019) confirm this statement. They also state that other transport facilities of alternative modes like PT, need to be highly effective and well connected when the policy focuses on banning the private car.

Parking

Parking appeared to have a bigger impact on travel behavior than extra in-car travel time. The same result was found in the Research of Bhat (1998). Bhat researched the joint nature of mode and departure time of urban shopping trips. Results showed that travelers are more sensitive to out-of-vehicle time rather than in-vehicle travel time. This is also pursuant to the results of Brown et al. (2003). They found that lowering the number of parking lots raises the use of transit in relation to car use. Taking away parking spots increases the quality of public space when this space is redeveloped properly and lowers the number of cars. For that reason is this an attractive measure for municipalities to look at when they want to lower the car intensities on the road.

Another quite remarkable finding is to see how many people would not make the trip anymore in comparison to the number of people that indicated that they would change modalities. If a measure is taken to lower the car intensity, more traffic disappears than that would change to another modality. Especially to see that more people already indicated at +5 minutes that they will not make the trip anymore compared to people that switch modalities, is very interesting. Municipalities thus have to worry less about increasing intensities at other modalities as most of the people make the decision not to make that trip at all.

Definition disappearing traffic

The definition of disappearing traffic in this research was linked to whether people would leave their car to use an alternative transport mode or if someone did not make the trip at all. If someone would use an alternative route or travel at a different time it would not be disappearing traffic. However, this definition can be brought up for discussion. This definition is currently mainly focused on the car only. If someone would step out of the car, then we speak of disappearing traffic. However, it can be argued that when someone uses a different modality, it is not disappearing traffic. Cities are currently trying to lower the number of car intensities because it is better for the quality of life within the cities but also because the roads are silting up. Taking people out of the car and making them e.g. cycle, is sometimes just a displacement of the problem. For example, Utrecht is currently facing a problem where there are too many cyclists on the road making it unpleasant to cycle within the city center. If Utrecht takes measures to get people out of the car, it would only make the cyclists' problem worse. It depends on each city whether it is smart to take measures that will take people out of the car. Concluding, when speaking of disappearing traffic, this definition would be fine if the definition was related to ‘‘disappearing car traffic’’. However, when the car is not named explicitly, it would be better to say that people who are not changing modalities are not disappearing traffic.

5.3 Limitations and recommendations (for further research)

5.3.1 Recent developments Covid

During the effectuation of this research, the coronavirus was still spreading in the Netherlands. As a precaution to counter the rise of corona cases with the new Omikorn variant, The Netherlands went into a hard lockdown on the 19^{th} of December 2021. Multiple measures were already implemented beforehand in the months of November and December to make sure the Omikron variant would not spread fast throughout the Netherlands. These measures include the advice to work from home, events got canceled and people we're not allowed to invite more than two people over to their house making it harder to visit friends and family. People were also advised to keep their distance from other people and to wear face masks when they were near others. The implemented measures to prevent any more spreading of the Omikron variant did also affect the travel behavior of the Dutch people. A strong decline was visible in the number of trips made, the displacement distance, and a change of motives to relative more leisure trips like walking. Public transport saw also a strong decrease in the number of travelers because of the risk of infection with the coronavirus. At the end of January 2022, the policy around the corona measures relaxed, increasing the number of trips made as people were able again to go to the office. In the questionnaire, respondents were asked to fill in what applied to them in the last three months. During those months the Netherlands was still partly in lockdown which impacted the travel behavior of the respondents and therefore have a slight impact on the results of this research. The screening questions did reduce the impact of the change in travel behavior as all respondents made use of the car during those months. However, the car usage and the travel distance for certain motives might have been impacted during those months.

5.3.2 Questionnaire

During the analysis of the questionnaire, became clear that the design of the questionnaire could have been improved on some points.

5.3.2.1 Questions

First of all, a question was missing whether the car was a necessity for the trips that the respondents made. When determining whether people had an alternative based on travel time, it was assumed that they had an alternative if the travel time of the alternative was under a certain VF-waarde. However, it could have been the case that the respondents' car was a necessity. For example, in the case when a respondent needs a car to visit multiple companies a day. This would have improved the variable ''Has an alternative''.

Secondly, the question of where people lived based on their four-number postal code disappeared during the process when putting the survey online. This question would have made it possible to determine whether respondents from certain cities reacted differently in comparison to other cities. By analyzing the mobility amenities of those cities, it (e.g.) could have been concluded that perhaps respondents who lived in a city with metro and tram, changed their travel behavior earlier in comparison to respondents who lived in cities that did not have these amenities.

5.3.2.2 Design

For the number of respondents that filled in this survey, it would have been better to make use of scenarios that were the same for every respondent. When the survey was created, it was expected that it would be easier for respondents to determine what impact the extra travel time had on their travel behavior when they applied this to their normal daily travels. Although this might have been the case, it would have been easier to compare the motives and analyze the data if every respondent filled in their answers for the same scenarios which increase the number of respondents per travel motive. In this case, the number of respondents differs between the motives, and the number of people that indicated that they would have changed their travel behavior was low which is mainly due to the number of respondents. Because of this, it was harder to compare the travel motives and not possible to create personas based on the respondents that had indicated that they would not make use of the car anymore which was the intention of this research.

5.3.3 Use of PanelClix

Respondents were gathered through the use of PanelClix. PanelClix is an online platform on which people are compensated to fill in surveys. PanelClix has many members throughout the country varying in all socio-demographic factors. Because people were compensated to fill in the survey, it could have been the case that respondents filled in the survey less precisely in comparison to someone that voluntarily fill in surveys. The time used to fill in the survey wasn't visible in the data so therefore it wasn't possible to filter the respondents who had filled in the survey way faster In comparison to the average time to fill in the survey. Therefore, it is recommended for further research to check whether it is possible to get insight into the time it took each respondent to fill in the survey, so it becomes possible to filter out the respondents who were too fast with filling in the survey just because they could claim their money.

5.3.4 Amount of respondents

In total 414 respondents filled in the survey regarding disappearing traffic. However, because respondents only had to fill in the questions for the motives they used the car, a big proportion of the total amount of respondents was left out at some motives. For the motive of Work and Study, almost half of the respondents indicated that they did not take the car for that motive harmed the validity of the data. Also, because of the number of respondents who indicated that they wouldn't make use of the car anymore, it became hard to run a statistical test for that group to see what the precise effect was of each of the variables that were applied. In this case, most of the statistical tests showed no significance. Having a bigger sample size does increase the likeliness of finding a significant relation.

5.3.5 Stated preference

This research was carried out through the use of a stated preference survey, which provides hypothetical choices. This means that respondents should imagine themselves undertaking a trip, given the sketched scenario. As literature shows, are many trips habitual for which not every time all alternatives are weighed. It is also not sure if respondents normally take all the attributes in cooperation for their travel mode choice. Therefore it cannot be stated with certainty that respondents would make these choices in reality as well.

5.3.6 Location dependent

To gain the best understanding of disappearing traffic, it is recommended to observe the effects of measures taken by municipalities to reduce the amount of motorized traffic more closely. There is data available that shows that the intensities of motorized traffic reduce in these cases, however, the intensities of cyclists, public transport, and people that stayed home because of these measures have not been observed before in a specific location in the Netherlands. Therefore it is recommended to apply a zero measurement of all the different modalities before the measure was introduced and afterward. Another way to gain more insight into the behavioral change of people is to question people in the neighborhoods that were affected by that measure and whether they changes their travel behavior through the use of a revealed preference survey. In contrast to the stated preference survey, it can be stated with certainty from the revealed preference survey that people show the behavior that they have indicated.

The amount of disappearing traffic isn't the same for each location a measure will be applied too. Therefore, it is necessary to observe the effects of multiple locations where municipalities applied measures to reduce the number of motorized vehicles. One can think of different kinds of city densities, different kinds of neighborhoods varying in socio-demographic factors, the proximity towards public transport, etc.. The same applies to the different measures that can be taken to reduce the number of motorized vehicles like blocking a street for motorized vehicles, reducing maximum speed, or taking away more parking places and thus extending the walking distance of people towards their parking place.

5.3.7 Consulting

Based on the results of this research, the following advice can be given when consulting firms and municipalities regarding disappearing traffic. First of all, it is more interesting to look at taking away parking facilities as that causes more people to get out of the car compared to taking measures that will increase the in-car travel time. So when municipalities aim to lower the car intensity, it is recommended to look at increasing the travel time towards the car first. This can be done by (e.g.) taking away parking facilities, moving parking facilities, and regulating parking. Secondly, as this research has shown does travel motive matter when it comes to changing travel behavior. Especially for the travel motive ''Social and Recreative'' are people less willing to step out of the car. Baring this in mind, it is advisable to take a good look at the areas that are being affected by a certain measure to see what kind of trips are most common. When many trips in that area are for the travel motive ''Social & Recreative'', it is expected that, based on the results of this research, the measures have less of an impact. Results also show that the measures have different kinds of effects on the three travel motives. For example, the travel motive ''Work and study'' indicated almost double the number of respondents that they would not make that trip anymore in comparison to the number of people that indicated that they would use another modality within this travel motive. So, if many of the trips are made for the travel motive ''Work & Study'', may be expected that more people are leaving the car behind than switching to another modality. Thirdly, before taking any measure, the facilities of the alternatives should be well regulated. The results of this research have once again shown that having an alternative play's a big role when it comes to changing travel behavior.

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7. Appendices

7.1 Survey

Unfortunately, the survey couldn’t be retrieved from the site anymore. The survey consists of 77 questions which took a respondent around 10-15 minutes to fill in. Respondents were informed about the scenarios and what was expected from them. The questions from the survey can be found below.

1. Over welke van onderstaande vervoermiddelen heeft u zelf de beschikking?
   - o (lease) auto in privé bezit
   - o (lease) auto van de zaak]
   - o [Bromfiets/ snorfiets/ scooter/ brommobiel]
   - o [Stadsfiets]
   - o [Elektrische fiets/ speed pedelec]
   - o [Ov-chipkaart / abonnement]
   - o [Geen van deze]

2. Hoe vaak heeft u de afgelopen drie maanden gebruik gemaakt van onderstaande vervoermiddelen?
   - o [Auto (als bestuurder)]
   - o [Auto (als passagier)]
   - o [Openbaar vervoer]
   - o [Fiets]
   - o [Elektrische fiets / speed pedelec]
   - o [Bromfiets/ snorfiets/ scooter/ brommobiel]

   - "4 of meer dagen per week"
   - "1 tot 3 dagen per week"
   - "1 tot 3 dagen per maand"
   - "1 of 2 dagen maximaal"
   - "Nooit".

3. Hoe vaak heeft u in de afgelopen drie maanden gebruik gemaakt van de auto voor de volgende doelstellingen?".
   - o [Werk / Studie]
   - o [Huishouden en diensten (Boodschappen, kinderen afzetten, bezoek aan gemeentehuis, etc.)]
   - o [Sociaal / recreatieve doeleinden (sporten, kapper, dagje uit, familie bezoeken, etc.)]

   - "4 of meer dagen per week"
   - "1 tot 3 dagen per week"
   - "1 tot 3 dagen per maand"
   - "1 of 2 dagen maximaal"
   - "Nooit".

4. Hoelang moet u momenteel lopen van uw huis naar uw auto?

   - ‘’Minder dan een minuut"
   - ‘’2-3 minuten"

- ">3 minuten"

5. Wat is uw reistijd met de auto voor uw verplaatsing richting werk? (in minuten)

6. Met hoeveel personen maakt u normaliter deze verplaatsing?
- "Alleen"
- "1 extra persoon"
- "2 extra personen"
- "Met meer dan 3 extra personen".

7. Bent u normaliter de bestuurder of passagier in deze rit?
- "Bestuurder"
- "Passagier"

8. Maakt u ook wel eens gebruik van een ander vervoermiddel voor deze verplaatsing?
- "Nee"
- "Maximaal 1x per week"
- "Ja, minimaal 2x in de week".

9. Van welk vervoermiddel maakt u dan gebruik?
- [Openbaar vervoer]
- [Stadsfiets]
- [Elektrische fiets/ speed pedelec]
- [Bromfiets/ snorfiets, scooter/ brommobiel]

10. Kunt u een inschatting maken van de reistijd met de (elektrische)fiets voor deze verplaatsing? (in minuten) (indien dit niet reëel is, graag 0 invullen)

11. Kunt u een inschatting maken van de reistijd met het openbaar vervoer voor deze verplaatsing? (in minuten)

12. In hoeverre heeft u de mogelijkheid om vanuit huis te werken/ studeren?
- "Niet"
- "Mogelijk om alles vanuit huis te doen"
- "Hangt ervan af wat mij te doen staat".

13. Wat zou u doen als uw reistijd voor de auto met 5 minuten toeneemt voor uw verplaatsing richting werk/ studie?
- "Ik maak nog steeds gebruik van de auto"
- "Ik maak deze verplaatsing niet meer (bijv. werk voortaan thuis)"
- "Ik stap over naar een andere vervoerswijze".

14. Naar welke vervoerwijze zou u dan overstappen?
- "Fiets"
- "Elektrische fiets/ speed pedelec"
- "Openbaar vervoer"
- "Bromfiets/ snorfiets/ scooter/ brommobiel"

15. Wat zou u doen als uw reistijd voor de auto met 10 minuten toeneemt voor uw verplaatsing richting werk/ studie?

- "Ik maak nog steeds gebruik van de auto"
- "Ik maak deze verplaatsing niet meer (bijv. werk voortaan thuis)"
- "Ik stap over naar een andere vervoerswijze".

16. Naar welke vervoerwijze zou u dan overstappen?
- "Fiets"
- "Elektrische fiets/ speed pedelec"
- "Openbaar vervoer"
- "Bromfiets/ snorfiets/ scooter/ brommobiel"

17. Wat zou u doen als uw reistijd voor de auto met 15 minuten toeneemt voor uw verplaatsing richting werk/ studie?
- "Ik maak nog steeds gebruik van de auto"
- "Ik maak deze verplaatsing niet meer (bijv. werk voortaan thuis)"
- "Ik stap over naar een andere vervoerswijze".

18. Naar welke vervoerwijze zou u dan overstappen?
- "Fiets"
- "Elektrische fiets/ speed pedelec"
- "Openbaar vervoer"
- "Bromfiets/ snorfiets/ scooter/ brommobiel"

19. Wat zou u doen als uw reistijd voor de auto met 20 minuten toeneemt voor uw verplaatsing richting werk/ studie?
- "Ik maak nog steeds gebruik van de auto"
- "Ik maak deze verplaatsing niet meer (bijv. werk voortaan thuis)"
- "Ik stap over naar een andere vervoerswijze".

20. Naar welke vervoerwijze zou u dan overstappen?
- "Fiets"
- "Elektrische fiets/ speed pedelec"
- "Openbaar vervoer"
- "Bromfiets/ snorfiets/ scooter/ brommobiel"

21. Wat zou u doen als u vanuit uw huis 3 minuten extra moet lopen naar uw auto voor uw verplaatsing naar werk / studie?
- "Ik maak nog steeds gebruik van de auto"
- "Ik maak deze verplaatsing niet meer (bijv. werk voortaan thuis)"
- "Ik stap over naar een andere vervoerswijze".

22. Naar welke vervoerwijze zou u dan overstappen?
- "Fiets"
- "Elektrische fiets/ speed pedelec"
- "Openbaar vervoer"
- "Bromfiets/ snorfiets/ scooter/ brommobiel"

23. Wat zou u doen als u vanuit uw huis 5 minuten extra moet lopen naar uw auto voor uw verplaatsing naar werk / studie?
- "Ik maak nog steeds gebruik van de auto"
- "Ik maak deze verplaatsing niet meer (bijv. werk voortaan thuis)"
- "Ik stap over naar een andere vervoerswijze".

24. Naar welke vervoerwijze zou u dan overstappen?
- "Fiets"
- "Elektrische fiets/ speed pedelec"
- "Openbaar vervoer"
- "Bromfiets/ snorfiets/ scooter/ brommobiel"

25. Wat is uw meest voorkomende type rit met het motief huishouden en diensten? ".
- "Boodschappen"
- "Brengen en halen van kinderen (school/ studie)"
- "Bezoek aan dokter/ ziekenhuis, gemeentehuis, etc."
- "Anders, namelijk; (Bij opmerking graag invullen)"

26. Wat is uw reistijd met de auto voor uw meest voorkomende verplaatsing met betrekking tot huishouden en diensten? (in minuten)".

27. Met hoeveel personen maakt u normaliter deze verplaatsing?
- "Alleen"
- "1 extra persoon"
- "2 extra personen"
- "Met meer dan 3 extra personen".

28. Bent u normaliter de bestuurder of passagier in deze rit?
- "Bestuurder"
- "Passagier"

29. Maakt u ook wel eens gebruik van een ander vervoermiddel voor deze verplaatsing?
- "Nee"
- "Maximaal 1x per week"
- "Ja, minimaal 2x in de week".

30. Van welk vervoermiddel maakt u dan gebruik?
- o [Openbaar vervoer]
- o [Stadsfiets]
- o [Elektrische fiets/ speed pedelec]
- o [Bromfiets/ snorfiets, scooter/ brommobiel]

31. Kunt u een inschatting maken van de reistijd met de (elektrische)fiets voor deze verplaatsing? (in minuten) (indien dit niet reëel is, graag 0 invullen)

32. Kunt u een inschatting maken van de reistijd met het openbaar vervoer voor deze verplaatsing? (in minuten)

33. Wat zou u doen als uw reistijd met de auto 5 minuten toeneemt voor uw verplaatsing met het motief huishouden/ diensten?".
- "Ik maak nog steeds gebruik van de auto"
- "Ik maak deze verplaatsing niet meer (bijv. werk voortaan thuis)"
- "Ik stap over naar een andere vervoerswijze".

34. Naar welke vervoerwijze zou u dan overstappen? ".

- "Fiets"
- "Elektrische fiets/ speed pedelec"
- "Openbaar vervoer"
- "Bromfiets/ snorfiets/ scooter/ brommobiel"

35. Wat zou u doen als uw reistijd met de auto 10 minuten toeneemt voor uw verplaatsing met het motief huishouden/ diensten?".
- "Ik maak nog steeds gebruik van de auto"
- "Ik maak deze verplaatsing niet meer (bijv. werk voortaan thuis)"
- "Ik stap over naar een andere vervoerswijze".

36. Naar welke vervoerwijze zou u dan overstappen? ".
- "Fiets"
- "Elektrische fiets/ speed pedelec"
- "Openbaar vervoer"
- "Bromfiets/ snorfiets/ scooter/ brommobiel"

37. Wat zou u doen als uw reistijd met de auto 15 minuten toeneemt voor uw verplaatsing met het motief huishouden/ diensten?".
- "Ik maak nog steeds gebruik van de auto"
- "Ik maak deze verplaatsing niet meer (bijv. werk voortaan thuis)"
- "Ik stap over naar een andere vervoerswijze".

38. Naar welke vervoerwijze zou u dan overstappen? ".
- "Fiets"
- "Elektrische fiets/ speed pedelec"
- "Openbaar vervoer"
- "Bromfiets/ snorfiets/ scooter/ brommobiel"

39. Wat zou u doen als uw reistijd met de auto 20 minuten toeneemt voor uw verplaatsing met het motief huishouden/ diensten?".
- "Ik maak nog steeds gebruik van de auto"
- "Ik maak deze verplaatsing niet meer (bijv. werk voortaan thuis)"
- "Ik stap over naar een andere vervoerswijze".

40. Naar welke vervoerwijze zou u dan overstappen? ".
- "Fiets"
- "Elektrische fiets/ speed pedelec"
- "Openbaar vervoer"
- "Bromfiets/ snorfiets/ scooter/ brommobiel"

41. Wat zou u doen als u vanuit uw huis 3 minuten extra moet lopen naar uw auto voor uw verplaatsing met het motief huishouden en diensten?
- "Ik maak nog steeds gebruik van de auto"
- "Ik maak deze verplaatsing niet meer (bijv. werk voortaan thuis)"
- "Ik stap over naar een andere vervoerswijze".

42. Naar welke vervoerwijze zou u dan overstappen?
- "Fiets"
- "Elektrische fiets/ speed pedelec"
- "Openbaar vervoer"

- "Bromfiets/ snorfiets/ scooter/ brommobiel"

43. Wat zou u doen als u vanuit uw huis 5 minuten extra moet lopen naar uw auto voor uw verplaatsing met het motief huishouden en diensten?
- "Ik maak nog steeds gebruik van de auto"
- "Ik maak deze verplaatsing niet meer (bijv. werk voortaan thuis)"
- "Ik stap over naar een andere vervoerswijze".

44. Naar welke vervoerwijze zou u dan overstappen?
- "Fiets"
- "Elektrische fiets/ speed pedelec"
- "Openbaar vervoer"
- "Bromfiets/ snorfiets/ scooter/ brommobiel"

45. Hoe lang is uw meest voorkomende autorit die u maakt voor sociaal/ recreatieve doeleinden (winkelen, dagje efteling, familiebezoek, etc.)? (in minuten)

46. Met hoeveel personen maakt u normaliter deze verplaatsing?
- "Alleen"
- "1 extra persoon"
- "2 extra personen"
- "Met meer dan 3 extra personen".

47. Bent u normaliter de bestuurder of passagier in deze rit?
- "Bestuurder"
- "Passagier"

48. Maakt u ook wel eens gebruik van een ander vervoermiddel voor deze verplaatsing?
- "Nee"
- "Maximaal 1x per week"
- "Ja, minimaal 2x in de week".

49. Van welk vervoermiddel maakt u dan gebruik?
- o [Openbaar vervoer]
- o [Stadsfiets]
- o [Elektrische fiets/ speed pedelec]
- o [Bromfiets/ snorfiets, scooter/ brommobiel]

50. Kunt u een inschatting maken van de reistijd met de (elektrische)fiets voor deze verplaatsing? (in minuten) (indien dit niet reëel is, graag 0 invullen)

51. Kunt u een inschatting maken van de reistijd met het openbaar vervoer voor deze verplaatsing? (in minuten) ".

52. Indien uw verplaatsing voor een recreatief doeleinde is, wat zou u doen als uw reistijd met de auto 5 minuten toeneemt?"
- "Ik maak nog steeds gebruik van de auto"
- "Ik maak deze verplaatsing niet meer (bijv. werk voortaan thuis)"
- "Ik stap over naar een andere vervoerswijze".

53. Naar welke vervoerwijze zou u dan overstappen?
- "Fiets"
- "Elektrische fiets/ speed pedelec"
- "Openbaar vervoer"
- "Bromfiets/ snorfiets/ scooter/ brommobiel"

54. Indien uw verplaatsing voor een recreatief doeleinde is, wat zou u doen als uw reistijd met de auto 10 minuten toeneemt?"
- "Ik maak nog steeds gebruik van de auto"
- "Ik maak deze verplaatsing niet meer (bijv. werk voortaan thuis)"
- "Ik stap over naar een andere vervoerswijze".

55. Naar welke vervoerwijze zou u dan overstappen?
- "Fiets"
- "Elektrische fiets/ speed pedelec"
- "Openbaar vervoer"
- "Bromfiets/ snorfiets/ scooter/ brommobiel"

56. Indien uw verplaatsing voor een recreatief doeleinde is, wat zou u doen als uw reistijd met de auto 15 minuten toeneemt?"
- "Ik maak nog steeds gebruik van de auto"
- "Ik maak deze verplaatsing niet meer (bijv. werk voortaan thuis)"
- "Ik stap over naar een andere vervoerswijze".

57. Naar welke vervoerwijze zou u dan overstappen?
- "Fiets"
- "Elektrische fiets/ speed pedelec"
- "Openbaar vervoer"
- "Bromfiets/ snorfiets/ scooter/ brommobiel"

58. Indien uw verplaatsing voor een recreatief doeleinde is, wat zou u doen als uw reistijd met de auto 20 minuten toeneemt?"
- "Ik maak nog steeds gebruik van de auto"
- "Ik maak deze verplaatsing niet meer (bijv. werk voortaan thuis)"
- "Ik stap over naar een andere vervoerswijze".

59. Naar welke vervoerwijze zou u dan overstappen?
- "Fiets"
- "Elektrische fiets/ speed pedelec"
- "Openbaar vervoer"
- "Bromfiets/ snorfiets/ scooter/ brommobiel"

60. Wat zou u doen als u vanuit uw huis 3 minuten extra moet lopen naar uw auto voor uw verplaatsing met een sociaal/ recreatief doeleinde?
- "Ik maak nog steeds gebruik van de auto"
- "Ik maak deze verplaatsing niet meer (bijv. werk voortaan thuis)"
- "Ik stap over naar een andere vervoerswijze".

61. Naar welke vervoerwijze zou u dan overstappen?
- "Fiets"
- "Elektrische fiets/ speed pedelec"

- "Openbaar vervoer"
- "Bromfiets/ snorfiets/ scooter/ brommobiel"

62. Wat zou u doen als u vanuit uw huis 5 minuten extra moet lopen naar uw auto voor uw verplaatsing met een sociaal/ recreatief doeleinde?
- "Ik maak nog steeds gebruik van de auto"
- "Ik maak deze verplaatsing niet meer (bijv. werk voortaan thuis)"
- "Ik stap over naar een andere vervoerswijze".

63. Naar welke vervoerwijze zou u dan overstappen?
- "Fiets"
- "Elektrische fiets/ speed pedelec"
- "Openbaar vervoer"
- "Bromfiets/ snorfiets/ scooter/ brommobiel"

64. Ik vind dat de veiligheid van fietsers bij mij in de buurt, te weinig wordt gewaarborgd] In hoeverre bent u het eens met onderstaande stellingen? (geef een rapportcijfer van 1 tot 5, 1= zeer mee oneens, 5= zeer mee eens".

65. Ik vind dat er meer openbaar vervoer voorzieningen moeten komen bij mij in de buurt] In hoeverre bent u het eens met onderstaande stellingen? (geef een rapportcijfer van 1 tot 5, 1= zeer mee oneens, 5= zeer mee eens".

66. [Ik vind dat er te hard word gereden bij mij in de buurt] In hoeverre bent u het eens met onderstaande stellingen? (geef een rapportcijfer van 1 tot 5, 1= zeer mee oneens, 5= zeer mee eens".

67. [Ik vind dat er teveel verkeer door de stad rijdt] In hoeverre bent u het eens met onderstaande stellingen? (geef een rapportcijfer van 1 tot 5, 1= zeer mee oneens, 5= zeer mee eens".

68. [Ik heb last van geluidsoverlast door verkeer] In hoeverre bent u het eens met onderstaande stellingen? (geef een rapportcijfer van 1 tot 5, 1= zeer mee oneens, 5= zeer mee eens".

69. [Ik vind dat er meer parkeervoorzieningen moeten komen bij mij in de buurt] In hoeverre bent u het eens met onderstaande stellingen? (geef een rapportcijfer van 1 tot 5, 1= zeer mee oneens, 5= zeer mee eens".

70. [Ik vind dat de veiligheid van voetgangers bij mijn in de buurt, te weinig wordt gewaarborgd] In hoeverre bent u het eens met onderstaande stellingen? (geef een rapportcijfer van 1 tot 5, 1= zeer mee oneens, 5= zeer mee eens".

71. [Ik accepteer een langere reistijd om te zorgen voor een veiligere en meer leefbare stad] In hoeverre bent u het eens met onderstaande stellingen? (geef een rapportcijfer van 1 tot 5, 1= zeer mee oneens, 5= zeer mee eens".

72. Wat is uw geslacht?".
- "Man"
- "Vrouw"
- "Anders"
- "Zeg ik liever niet".

73. Wat is uw leeftijd?".

74. Uit hoeveel mensen bestaat uw huishouden? ".

- "1"
- "2"
- "3"
- ">4".

75. Wat is uw hoogst voltooide opleiding?".

- "Geen onderwijs;"
- "Basisonderwijs"
- "LBO/ VBO/ VMBO (Kader- en beroepsgerichte leerweg)"
- "MAVO/ eerste 3 jaar HAVO en VWO/ VMBO (theoretische leerweg)"
- "MBO"
- "HAVO en VWO bovenbouw/ WO en HBO propedeuse"
- "HBO/ WO-bachelor of kandidaats"
- "weet ik niet/ wil ik niet zeggen"

76. Welke situatie is het meest van toepassing op u?"

- "Ik ben werkzaam (in loondienst of als zelfstandig ondernemer)"
- "Ik ben (gedeeltelijk) arbeidsongeschikt of werkloos"
- "Ik ben gepensioneerd"
- "Ik studeer (of ga naar school, loop stage)"
- "Ik ben huisvrouw/huisman"
- "Ik doe vrijwilligerswerk"
- "Weet ik niet".

77. Wat is uw persoonlijk maandelijks netto inkomen (het bedrag dat u per maand ontvangt)?"

- "Minder dan €1000,-"
- "€1000,- tot €2500,-"
- "€5000,- of meer"
- "Zeg ik liever niet".

7.2 Chi-square analysis

Multiple chi-square tests were executed for this research. Below you will find all the tests per travel motive.

7.2.1 ''Work & Study''

Changing travel behavior * Age

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.204[a]	3	.531
Likelihood Ratio	2.193	3	.533
Linear-by-Linear Association	1.236	1	.266
N of Valid Cases	239		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 12.89.

Changing travel behavior * Gender

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.001[a]	1	.972		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.001	1	.972		
Fisher's Exact Test				1.000	.539
N of Valid Cases	239				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 40.87.

b. Computed only for a 2x2 table

Changing travel behavior * amount of household members

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.913[a]	3	.178
Likelihood Ratio	4.972	3	.174
N of Valid Cases	239		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 11.41.

Changing travel behavior * Private (lease)car

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.034[a]	1	.853		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.034	1	.854		
Fisher's Exact Test				.850	.498
Linear-by-Linear Association	.034	1	.854		
N of Valid Cases	239				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 12.52.

b. Computed only for a 2x2 table

Changing travel behavior * Company car

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.319[a]	1	.572		
Continuity Correction[b]	.133	1	.715		
Likelihood Ratio	.324	1	.569		
Fisher's Exact Test				.691	.362
Linear-by-Linear Association	.317	1	.573		
N of Valid Cases	239				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 11.41.

b. Computed only for a 2x2 table

Changin travel behavior * Owning PT-card

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.003[a]	1	.958		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.003	1	.958		
Fisher's Exact Test				1.000	.537
Linear-by-Linear Association	.003	1	.958		
N of Valid Cases	239				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 22.83.

b. Computed only for a 2x2 table

Changing travel behavior * City inhabitants

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.938[a]	4	.568
Likelihood Ratio	3.339	4	.503
N of Valid Cases	239		

a. 2 cells (20.0%) have expected count less than 5. The minimum expected count is .37.

Changing travel behavior * Usual amount of passengers

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.394[a]	3	.941
Likelihood Ratio	.404	3	.939
N of Valid Cases	239		

a. 4 cells (50.0%) have expected count less than 5. The minimum expected count is 1.10.

Changing travel behavior * Alternatives

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	6.566[a]	1	.010		
Continuity Correction[b]	5.896	1	.015		
Likelihood Ratio	6.600	1	.010		
Fisher's Exact Test				.011	.007
N of Valid Cases	239				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 43.45.

b. Computed only for a 2x2 table

Changing travel behavior * Education

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	8.247[a]	1	.004		
Continuity Correction[b]	7.484	1	.006		
Likelihood Ratio	8.216	1	.004		
Fisher's Exact Test				.004	.003
Linear-by-Linear Association	8.213	1	.004		
N of Valid Cases	239				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 36.45.

b. Computed only for a 2x2 table

Changing travel behavior * Accept a longer travel time for a safer environment

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	8.387[a]	4	.078
Likelihood Ratio	8.489	4	.075
Linear-by-Linear Association	3.987	1	.046
N of Valid Cases	239		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.63.

ANOVA's

Some ANOVA's were executed. However, none of the variables showed significance in relation to the extra travel before switching to another modality or not making the trip and are therefore deliberately left out of the main research. Examples are shown below

Age

ANOVA

Exrewe

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.008	3	.336	.837	.477
Within Groups	33.694	84	.401		
Total	34.702	87			

Education

ANOVA

Exrewe

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.160	1	.160	.398	.530
Within Groups	34.542	86	.402		
Total	34.702	87			

7.2.2 ‘Household & Services’’

Changing travel behavior * age (4 categories)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.463[a]	3	.927
Likelihood Ratio	.462	3	.927
Linear-by-Linear Association	.303	1	.582
N of Valid Cases	338		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 23.22.

Changing travel behavior * age (2 categories)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.424[a]	1	.515		
Continuity Correction[b]	.288	1	.591		
Likelihood Ratio	.423	1	.515		
Fisher's Exact Test				.567	.295
Linear-by-Linear Association	.423	1	.515		
N of Valid Cases	338				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 51.15.

b. Computed only for a 2x2 table

Changing travel behavior * Usual amount of passengers

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.259[a]	3	.520
Likelihood Ratio	2.533	3	.469
N of Valid Cases	341		

a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is 2.73.

Changing travel behavior * City inhabitants

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.324[a]	3	.956
Likelihood Ratio	.321	3	.956
N of Valid Cases	341		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 18.33.

Changing travel behavior * Gender

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.302[a]	1	.583		
Continuity Correction[b]	.192	1	.661		
Likelihood Ratio	.302	1	.583		
Fisher's Exact Test				.657	.330
N of Valid Cases	341				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 65.52.

b. Computed only for a 2x2 table

Changing travel behavior * Company car

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.892[a]	1	.345		
Continuity Correction[b]	.569	1	.451		
Likelihood Ratio	.916	1	.339		
Fisher's Exact Test				.447	.227
Linear-by-Linear Association	.890	1	.346		
N of Valid Cases	341				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 12.48.

b. Computed only for a 2x2 table

Changing travel behavior Parking * Alternative

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	20.711[a]	1	<.001		
Continuity Correction[b]	19.417	1	<.001		
Likelihood Ratio	24.762	1	<.001		
Fisher's Exact Test				<.001	<.001
N of Valid Cases	341				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 21.75.

b. Computed only for a 2x2 table

Changing travel behavior * Education

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7.812[a]	1	.005		
Continuity Correction[b]	7.197	1	.007		
Likelihood Ratio	7.796	1	.005		
Fisher's Exact Test				.007	.004
Linear-by-Linear Association	7.789	1	.005		
N of Valid Cases	341				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 56.55.

b. Computed only for a 2x2 table

Changing travel behavior * Destination

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	7.213[a]	3	.065
Likelihood Ratio	7.031	3	.071
N of Valid Cases	341		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.36.

7.2.3 'Social & Recreative'

<u>Changing travel behavior * Age</u>

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.263[a]	3	.967
Likelihood Ratio	.259	3	.967
Linear-by-Linear Association	.082	1	.775
N of Valid Cases	364		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 14.51.

<u>Changing travel behavior * Education</u>

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.355[a]	1	.244		
Continuity Correction[b]	1.074	1	.300		
Likelihood Ratio	1.347	1	.246		
Fisher's Exact Test				.253	.150
Linear-by-Linear Association	1.351	1	.245		
N of Valid Cases	367				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 34.44.

b. Computed only for a 2x2 table

<u>Changing travel behavior * Usual amount of passengers</u>

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.502[a]	3	.682
Likelihood Ratio	1.530	3	.675
N of Valid Cases	367		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 11.12.

<u>Changing travel behavior * Company car</u>

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.492[a]	1	.483		
Continuity Correction[b]	.236	1	.627		
Likelihood Ratio	.518	1	.472		
Fisher's Exact Test				.667	.323
Linear-by-Linear Association	.491	1	.484		
N of Valid Cases	367				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 7.63.

b. Computed only for a 2x2 table

Changing travel behavior * Accept a longer travel time for a safer environment

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	5.804[a]	4	.214
Likelihood Ratio	5.872	4	.209
Linear-by-Linear Association	.040	1	.841
N of Valid Cases	367		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.23.

Changing travel behavior * City inhabitants

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.485[a]	4	.829
Likelihood Ratio	1.706	4	.790
N of Valid Cases	367		

a. 2 cells (20.0%) have expected count less than 5. The minimum expected count is .22.

Changing travel behavior * Alternative

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	16.569[a]	1	<.001		
Continuity Correction[b]	15.505	1	<.001		
Likelihood Ratio	15.948	1	<.001		
Fisher's Exact Test				<.001	<.001
N of Valid Cases	367				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 27.68.

b. Computed only for a 2x2 table

Changing travel behavior parking * Alternative

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	12.214[a]	1	<.001		
Continuity Correction[b]	10.927	1	<.001		
Likelihood Ratio	11.525	1	<.001		
Fisher's Exact Test				<.001	<.001
N of Valid Cases	367				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 11.77.

b. Computed only for a 2x2 table