INSIGHT INTO MODE CHOICE BEHAVIOR OF COMMUTERS TO EINDHOVEN AIRPORT

STATED CHOICE EXPERIMENT FOR SUSTAINABLE MOBILITY MODES WITH IMPLICATION OF INCENTIVES AND TRAVEL CONTEXTS

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Master Construction Management & Engineering

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Master Thesis

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PREFACE

Having lived and grown up in Tehran, a city with more than 8 million inhabitants, I have always dealt with air pollution and traffic congestion due to the huge number of private cars and limited alternative transport solutions. During my master courses in TU/e, I got introduced to the concepts of smart city and smart mobility, which got me inspired to do my graduation project topic in that field.

This thesis is the final outcome of my master education and I would like to thank my supervisors from TU/e. Gamze Dane, Tao Feng and Soora Rasouli, thank you for your support, feedback and guidance in the process of executing and writing this thesis. I would also like to thank my supervisor from Royal HaskoningDHV, Barth Donners, for the support, energy, and useful insights throughout the project. Moreover, the Transport and Planning team in Royal HaskoningDHV for being welcoming and helpful continuously. Additionally, I want to thank Jaap Verheijen and Eindhoven Airport for collaboration and contribution to this thesis.

At last but not the least, I would like to thank my family and friends for their continuing support during my studies.

I hope you enjoy reading this thesis!

Sina Khodabakhsh Reshad

Eindhoven, August 2020

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SUMMARY

Eindhoven Airport serves as an important air transportation hub for the Brainport Region Eindhoven and the south of The Netherlands, connecting the region directly to twenty capitals and economic regions within Europe. Eindhoven Airport has joined the Net-Zero 2050 agreement in 2019, which requires the airport to eliminate CO2 emissions by 2050. Already, the airport is working towards becoming an emission-free airport on the basis of an action plan within the framework of the Dutch national Climate Agreement ("Klimaatakkoord"). One of the main themes of this action plan is to stimulate and realize fast and sustainable transport to and from the airport. However, currently 80% of all travel to Eindhoven Airport takes place by private vehicle, with public transport having a modal share of only 15%. Therefore, the challenge for Eindhoven Airport is to reduce the modal share of private car use and implement new modes of transport that are sustainable, yet fast and efficient, in order to contribute to its overall climate goals.

New sustainable mobility concepts have the potential to bring about significant changes to urban mobility. As such, they may also contribute to Eindhoven Airport's climate goals. Trends such as electric cars and public transport, electric shared-mobility, autonomous vehicles, and demand-responsive transport are likely to reshape the future of sustainable urban mobility. Shared mobility options can complement public transport, especially in short distance trips. Moreover, the upcoming mobility concept MaaS ("Mobility as a Service") offers integrated mobility services using ICT technologies, which can reduce car ownership and increase public transport's modal share. MaaS is centered around subscribed mobility packages to maximize the benefits for both providers and users. Incidental trips without subscription or pay-as-you-go trips can also play a role as they allow users to experience traveling with MaaS and sustainable modes on a trial basis. Still, the change from conventional transport modes to new mobility concepts requires a change in travel behavior which individuals may be reluctant to make. A possible way to bring about such change is to use incentive policies, such as a bonuses. Therefore, this study examines new sustainable mobility concepts and the effect of incentives on the use of new forms of mobility for incidental travel to Eindhoven Airport.

This study aims to answer the following research question: *What are the decisive determinants influencing the sustainable travel mode choice of commuters to Eindhoven Airport?* To answer this question, a Stated Choice Experiment was designed. Respondents were presented existing and non-existing transport alternatives towards Eindhoven Airport. These alternatives were fi) car, ii) taxi, iii) E-carsharing, iv) bus, v) bus-hailing, vi) train+bus. Respondents were asked to choose among these alternatives and their attributes, which included: travel time, travel cost, parking cost, waiting time, number of transfers, and bonuses. Furthermore, each choice task that was given to the respondents was accompanied by a travel scenario that included travel purpose, travel company, number of pieces of luggage, and distance to the airport.

The study's target group was been recruited by placing QR banners inside the boarding area of Eindhoven Airport and through the network of Eindhoven University of Technology, as well as Royal HaskoningDHV. A total of 372 respondents took part in the survey, of which 137 were in the target group of the research. To obtain an complete understanding of the data, a

descriptive analysis and discrete choice models (Multinomial Logit model and Mixed Logit model) were carried out.

The outcome provides an insight in the factors that influence the mode choice behavior for travel to Eindhoven Airport. The results show that the majority of trips are for the purpose of holidays and visits to friends and family. Contrary to previous data, public transport was mentioned as the most used transport alternative by respondents. The analysis shows that the modal share of public transport drops drastically when the distance to the nearest hub is longer than 1.5 kilometers, resulting in an increase in the modal share of car and taxi. This suggests that the first-mile commute has a strong influence on travelers' mode choice. The analysis of the Likert scale questions shows that the reliability of transport mode was the most important factor for the majority of respondents. Surprisingly, environmental concerns are the least important factor in mode choice, even though the respondents' sample scored high on environmental awareness.

After the descriptive analysis, the data from the stated choice experiment were analyzed. The stated choice experiment focused on the choice behavior of individuals to establish which attributes are determining the respondent's travel mode decision to Eindhoven Airport. First, an MNL model was applied to the sample. Based on the results, multiple conclusions can be drawn for the different alternatives. For the base alternative of car, the estimations suggest that the parking price is the most important factor for individuals. The estimations for the alternative taxi show that traveling with more than one piece of luggage, and business as the trip purpose, increase respondents' preference for this alternative. At the same time, a longer travel time proves to have a negative effect on the preference towards taxi, which seems to suggest that travel time is a determining factor for choosing a taxi. Moreover, lower-income respondents show a negative preference towards the alternative taxi, which might be a result of the higher travel cost of this alternative. As regards the alternative of E-carsharing, the model estimation shows a positive preference towards this alternative in comparison with the base alternative of the car. Incentives, one of the focuses of this study, positively influence the overall utility of this alternative, which means that that offering a coffee discount at Eindhoven Airport may incline individuals towards the use of E-carsharing. However, higher travel times and travel costs negatively affect the utility of this alternative. Socio-demographic characteristics do not appear significant for choice behavior towards this alternative. As regards, the alternative bus, the estimation shows a general negative preference in comparison with the base alternative of the car. Younger, single people (under the age of 40) show a larger preference for this travel alternative. As regards the alternative of bus hailing, travel time proves to be an important factor in preference towards this alternative. Moreover, incentives show a positive effect in preference towards this alternative.

On the basis of these results, the following suggestions can be made to improve the sustainability of transport to Eindhoven Airport. These are:

i) the realization of E-carsharing service points in the airport parkings;
ii) the increase of parking costs for private vehicles and/or an entry charge for kiss & ride users;
iii) the use of incentives for alternatives E-carsharing and bus-hailing to trigger a behavior change in travelers;

iv) the realization of a bus-hailing service at the airport;
v) the integration of new mobility modes in a MaaS environment to bring together different modes of transport and the use of incentives under a single platform.

SAMENVATTING

Eindhoven Airport fungeert als een belangrijk luchttransportknooppunt voor de Brainport-regio Eindhoven en het zuiden van Nederland. De luchthaven verbindt de regio rechtstreeks met twintig hoofdsteden en economische regio's binnen Europa. Eindhoven Airport is in 2019 toegetreden tot de Net-Zero 2050-overeenkomst, waaronder de luchthaven zich eraan verbindt in 2050 CO2-uitstootvrij te zijn. Binnen het kader van een actieplan onder het Nederlandse Klimaatakkoord is luchthaven reeds op weg een emissievrije luchthaven te worden. Een van de hoofdthema's van het actieplan is het stimuleren en realiseren van snel en duurzaam vervoer van en naar de luchthaven. Echter, momenteel vindt 80% van alle reizen naar Eindhoven Airport plaats met een eigen auto, terwijl het openbaar vervoer een modaal aandeel heeft van slechts 15%. De uitdaging voor Eindhoven Airport is dan ook om het t modale aandeel van de personenauto te verkleinen en nieuwe vervoerswijzen te implementeren die duurzaam, maar ook snel en efficiënt, om zo bij te dragen aan de overkoepelende klimaatdoelstelling.

Nieuwe concepten voor duurzame mobiliteit hebben de potentie belangrijke veranderingen teweeg te brengen in stedelijke mobiliteit. Zo kunnen ze ook bijdragen aan de klimaatdoelstellingen van Eindhoven Airport. Trends als elektrische auto's en openbaar vervoer, elektrische deelmobiliteit, zelfrijdende voertuigen en vraag-responsief vervoer zullen naar verwachting nieuwe vorm geven aan stedelijke mobiliteit. Gedeelde mobiliteitsopties kunnen een aanvulling zijn op het openbaar vervoer, vooral bij korte afstanden. Daarnaast biedt het opkomend mobiliteitsconcept MaaS ("Mobility as a Service")geïntegreerde mobiliteitsdiensten met behulp van ICT-technologie, die het autobezit kunnen verminderen en het modale aandeel van het openbaar vervoer kunnen vergroten. MaaS is gebaseerd op mobiliteitspakketten voor abonnees die erop zijn gericht de voordelen voor zowel aanbieders als gebruikers te maximaliseren. Incidentele ritten zonder abonnement of ritten op basis van "pay as you go" kunnen ook een rol spelen, omdat zij reizigers in staat stellen op probeerbasis kennis te maken met MaaS en duurzame vervoerswijzen. Hoe dan ook vereist de omschakeling van conventionele vervoerswijzen naar nieuwe mobiliteitsconcepten een gedragsverandering die veel reizigers aarzelen te maken. Een mogelijke oplossing is het voeren van een stimuleringsbeleid, waaronder het geven van bonussen. Deze studie onderzoekt nieuwe concepten voor duurzame mobiliteit en het effect van prikkels ("incentives") op het gebruik van nieuwe vormen van mobiliteit voor incidenteel vervoer naar Eindhoven Airport.

Het doel van deze studie is een antwoord te geven op de onderzoeksvraag: *Wat zijn de doorslaggevende determinanten die de keuze voor duurzaam reizen van pendelaars naar Eindhoven Airport beïnvloeden?* Om deze vraag te beantwoorden werd een Stated Choice Experiment (gedwongen keuze-experiment) opgesteld. De respondenten werd een aantal bestaande en niet-bestaande vervoersalternatieven richting Eindhoven Airport voorgelegd. Deze alternatieven waren i) auto, ii) taxi, iii) e-carsharing, iv) bus, v) bushailing, vi) trein + bus. Respondenten werd gevraagd te kiezen uit deze alternatieven en hun attributen, waaronder reistijd, reiskosten, parkeerkosten, wachttijd, aantal transfers en bonussen. Verder werd

iedere keuzetaak vergezeld van een reisscenario met daarin: reisdoel, reisgezelschap, aantal stukken bagage en afstand tot de luchthaven.

De doelgroep voor het onderzoek werd geworven met QR-banners in de instapruimte ("boarding area") van Eindhoven Airport en middels het netwerk van de Technische Universiteit Eindhoven, als ook Royal HaskoningDHV. In totaal namen 372 respondenten deel aan het onderzoek, waarvan 137 tot de doelgroep van het onderzoek behoorden. Om een volledig begrip van de data te verkrijgen, werden een beschrijvende analyse en discrete keuzemodellen (Multinomial Logit-model en Mixed Logit-model) toegepast.

De uitkomsten bieden inzicht in de factoren die van invloed zijn op het moduskeuzegedrag ten aanzien van reizen naar Eindhoven Airport. De resultaten laten zien dat vakantie en het bezoeken van vrienden en familie het belangrijkste reisdoel is. In tegenstelling tot eerdere data, wordt openbaar vervoer het meest genoemd als vervoersalternatief. De analyse toont aan dat het modale aandeel van het openbaar vervoer drastisch daalt wanneer de afstand tot het dichtstbijzijnde knooppunt langer is dan 1,5 kilometer, waarna er een toename is van het modale aandeel auto en taxi. Dit suggereert dat de zogenaamde "first-mile commute",van grote invloed is op de keuze van de reismodus. De analyse van de Likert-schaalvragen toont aan dat voor de meeste respondenten de punctualiteit van de transportmodus de belangrijkste factor vormt. Verrassend genoeg zijn milieuoverwegingen de minst belangrijke factor bij de keuze van de modus, hoewel de selectie van respondenten hoog scoorde op milieubewustzijn.

Na de beschrijvende analyse, werden ook de data van het stated choice experiment geanalyseerd. Het stated choice experiment richtte zich op het keuzegedrag van individuen om te bepalen welke attributen van doorslaggevend belang zijn bij de beslissing voor vervoersmodus voor reizen naar Eindhoven Airport. Allereerst werd op de selectie van respondenten een MNL-model toegepast. Op basis van de resultaten kunnen meerdere conclusies worden getrokken voor de verschillende alternatieven. Voor het basisalternatief auto suggereren de schattingen dat de parkeerprijs de belangrijkste factor is voor individuen. De schattingen voor het alternatief taxi laten zien dat het aantal stukken bagage en een zakelijk reisdoel de voorkeur van respondenten voor dit alternatief vergroten. Tegelijkertijd heeft een langere reistijd een negatief effect op de voorkeur voor taxi, wat erop zou kunnen wijzen dat reistijd een bepalende factor is bij de keuze voor een taxi. Daarnaast laten respondenten met een lager inkomen een negatieve voorkeur voor het alternatief taxi, wat mogelijk een gevolg is van de hogere reiskosten van dit alternatief. Wat betreft het alternatief E-autodelen, toont de modelschatting een positieve voorkeur voor dit alternatief in vergelijking met het basisalternatief van de auto. Stimuleringsmaatregelen, een van de speciale aandachtsgebieden van dit onderzoek, vergroten de kans dat een respondent voor dit alternatief kiest. Dit betekent dat het aanbieden van koffiekorting op Eindhoven Airport particulieren er toe kan bewegen gebruik te maken van E-carsharing. Echter, hogere reistijden en reiskosten hebben een negatief effect op de keuze voor dit alternatief. Socio-demografische kenmerken lijken niet significant te zijn voor keuzegedrag ten opzichte van dit alternatief. Met betrekking tot het alternatief bus vertoont de schatting een algemene negatieve voorkeur ten opzichte van het basisalternatief van de auto. Jongere, alleenstaande mensen (onder de 40) tonen een grotere voorkeur voor dit alternatief. Met betrekking tot het alternatief bus op afroep (ook wel "flex service" of "bus hailing") blijkt reistijd een belangrijke factor te zijn in de keuze voor dit alternatief. Bovendien laten prikkels ("incentives") een positief effect zien op de keuze voor dit alternatief.

Op basis van deze resultaten kan een aantal aanbevelingen worden gedaan om de duurzaamheid van het vervoer naar Eindhoven Airport te verbeteren. Dit zijn:

- i) het realiseren van E-carsharing servicepunten op de parkeerplaatsen van de luchthaven;
- ii) het verhogen van de parkeertarieven en/of het instellen van een inrijdtarief voor kiss & ride;
- iii) het gebruik van prikkels voor de alternatieven E-carsharing en Bus op afroep om een verandering in reisgedrag te bewerkstellingen;
- iv) het realiseren van een Bus op afroep servicepunt op de luchthaven;
- v) het integreren van nieuwe mobiliteitsconcepten in een MaaS omgeving om zo verschillende vormen van vervoer, als ook het gebruik van prikkels binnen één platform samen te brengen.

ABSTRACT

Eindhoven Airport has joined the Net-Zero 2050 agreement that obliges the airport to bring down emissions to zero by 2050. The current modal share of travel to Eindhoven Airport consists of more than 80% private vehicles. Therefore, the airport aims to invest in sustainable transport to and from the airport, which is both fast and efficient. New mobility concepts such as car-sharing, demand-responsive transport, and technologies such as Mobility-as-a-Service (MaaS) can reduce private vehicle dependency and work as a supplement to existing public transport. As a result, the airport needs to move towards these solutions to provide sustainable and convenient travel solutions to and from the airport. A knowledge gap exists on the preferences regarding infrequent travel behavior such as trips to the airport in relation to alternative sustainable mobility options. Therefore, the goal of this study is to gain insights into the influential factors in the mode choice behavior of travelers to Eindhoven Airport to switch to more sustainable alternatives. Hence, the main reach question: *To what extent is the willingness of travelers to Eindhoven Airport to switch to sustainable modes of transport?* This research provides insights into the determinants of mode choice behavior of travelers with a focus on travel incentives as a trigger for more sustainable behavior adaptation. A Stated Choice experiment using an online survey has been conducted, and the data of respondents in Eindhoven Airport and social media. Several discrete choice models have been adopted using statistical software NLogit to evaluate the determining factors for travelers to Eindhoven Airport.

Results showed that there is a strong preference for car-sharing service compared to the base alternative (private vehicle). Travel time and travel cost showed to be the most important factors influencing the choice of travelers to the airport. Additionally, incentives showed to have significant positive influence on triggering the travel change towards sustainable mobility alternatives. Finally, realizing the car-sharing services in Eindhoven Airport, increasing the parking prices and allocating incentives can make a trigger in the travel behavior towards sustainable mobility.

ABBREVIATIONS

ACI	Airports Council International
AV	Autonomous Vehicle
DRT	Demand Responsive Transit
EV	Electrical Vehicle
GPS	Global Positioning System
HOV	Hoogwaardig Openbaar Vervoer (high qulity public transport)
IATA	International Air Transport Association
IIA	Independence from Irrelevant Attributes
MaaS	Mobility-as-a-Service
ML	Mixed Logit
MNL	Multinomial Logit
OV	Openbaar Vervoer (public transport)
RUM	Random Utility Maximization
SAV	Shared Autonomous Vehicle
SC	Stated Choice
THM	Theory of Human Motivation
TPB	Theory of Planned Behavior
TRB	Theory of Repeated Behavior
UN	United Nations
VKT	Vehicle Kilometer Traveled

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1 INTRODUCTION

This chapter introduces the topic of this graduation research project by defining the research problem, constructing the research questions, presenting the research model, explaining the research model, as well as the scientific and societal relevance, and, finally, providing a reading guide for the research.

1.1. CURRENT SITUATION AND PROBLEM DEFINITION

According to a recent report from the United Nations, in 2018, 55% of the world's population was concentrated in urban areas (United Nations, 2018). This number is expected to increase to 68% by 2050. This transition has many consequences, amongst increasing congestion and air pollution as a result of traveling within the urban environment. Addressing these negative effects of urban mobility is a challenge that many metropolitan areas are trying to solve (Demazeau, An, Bajo, Eds, & Goebel, 2018). It is estimated that transportation generates about 25% of global CO_2 emissions and urban mobility produces 40% of all CO_2 emissions of road transport and up to 70% of other pollutants from transport (Semanjski, Aguirre, De Mol, & Gautama, 2016). Hence, domestic as well as international regulatory initiatives are focusing on making the transport sector completely emission-free over the next three decades.

This goal is reflected also in the Dutch Climate Agreement (*Klimaatakkoord*), which is a part of Dutch climate policy. With regards the mobility sector, the agreement has been divided in different themes: sustainable energy carries, sustainable electric mobility, sustainable logistic, shipping, aviation, and finally, sustainable personal mobility (Ministerie van Economische Zaken en Klimaat, 2019). Because these sectors affect all levels of government and society, provinces, and municipalities, as well as semi-public organizations in the Netherlands have also subscribed to the Dutch Climate Agreement. The Municipality of Eindhoven, in the province Noord-Brabant, has set the goal to reduce CO_2 emissions by 55% in 2030 and 95% in 2050. Furthermore, Eindhoven Airport has joined an agreement during the annual ACI Europe Congress in 2019 that obliges the airport to eliminate CO_2 emissions by 2050 (Eindhoven Airport, 2019b). The Airport has made an action plan to achieve these climate goals, amongst others by realizing sustainable, fast, and efficient mobility from and to the airport (Eindhoven Airport, 2019a).

Currently, 80% of all travel to Eindhoven Airport takes place by private vehicle, mostly car, with public transport having a modal share of 15% (Donners & Van Genugten, 2018). Speed and convenience are the two most important factors that are responsible for the high modal share of private vehicles (Netherlands Institute for Transport Policy, 2018). Hence, improving accessibility and travel time to reach the airport may help reducing private vehicle dependency and contribute to the climate goals. Feasibility studies on the accessibility of Eindhoven Airport have shown that although in the short term the new HOV3 (high quality public transport) bus line (upcoming bus line from Eindhoven Central to Eindhoven Airport) can improve the accessibility to the airport, constructing a light rail line and an inter-city train station do not score significantly higher in terms of speed and capacity compare to existing Airport Shuttle and 401 bus lines (Donners & Bos, 2018).

New sustainable mobility concepts may bring important changes to the future urban mobility. As such, they may also contribute to Eindhoven Airport's climate goals. Trends such as shared-mobility, electric cars/public transport, autonomous vehicles, and demand-responsive transport will be prominent in reshaping the future of sustainable urban mobility (Demazeau et al., 2018). Shared mobility options (e.g, car-sharing, bike-sharing) can play a significant role in the future as a complement to public transport especially in short distance urban areas (Katzev, 2003). Mobility-as-a-service (MaaS) is an upcoming mobility concept that can offer integrated mobility services using ICT technologies, which can reduce car ownership and increase public transport modal share. MaaS is centered around subscribed mobility packages to maximize the benefit of providers and users. However, incidental trips without subscription or pay-as-you-go trips can also play a role as a trial for the user to experience traveling with MaaS and sustainable modes

The aforementioned advancements in sustainable mobility result in new changes and developments (Lang & Mohnen, 2019). Among these changes, travel behavior can be considered a building block, whereas changes in travel behavior directly change travel demand and as a result changes in transport planning (Rojas López & Wong, 2018). Hence, it is crucial to investigate the effect of sustainable mobility on travel behavior and understand what can trigger the change.

A potential solution to trigger the travel behavior change is to use incentive policies as a bonus. Previous research has shown a positive effect in altering travel behavior when incentives are implemented, but has also emphasized that the effectiveness of incentives requires a case-to-case investigation.(Poslad, Ma, Wang, & Mei, 2015; Riggs, 2019; Zhang, Fujii, & Managi, 2014).

This thesis will examine to what extent implementing sustainable mobility modes of car-sharing and demand-responsive transport in combination with travel incentives can indeed help to make travel to Eindhoven Airport more accessible and sustainable. The outcome of this study will shed light on attitude, values, and motivation of individuals' infrequent travel decision making with the implementation of different travel incentives on sustainable travel modes. This research focusses on infrequent travel to Eindhoven Airport. It aims to look at different segments of travel behavior, in order to gain better understanding of the reasons underlying travelers' decision-making.

1.2. RESEARCH QUESTIONS `

New mobility concepts such as car-sharing and demand-responsive transport provide new opportunities for sustainable travel to Eindhoven Airport, which can contribute to achieving environmental goals. Incentives can be used to make sustainable mode more attractive for individuals. Currently available studies do not shed light on the travel behavior of incidental trips using sustainable modes accompanied by incentives. Hence, insights have to be obtained on what factors influence a traveler's decision in the context of traveling to Eindhoven Airport. This results in the main research question:

What are the decisive determinants influencing the sustainable travel mode choice of commuters to Eindhoven Airport?

The following sub-questions (SQ) have been composed to answer the main research question:

	Sub questions	Methodology
SQ1.	What is the effect of state-of-the art sustainable mobility concepts on travel behavior? • What are technological concepts in sustainable mobility? • What policies can be introduced to incentivize travelers to Eindhoven Airport to shift toward sustainable alternatives	Literature review, Expert interview
SQ.2	What influence the mode choice behavior of travelers to Eindhoven Airport?	Descriptive analysis, Literature review
SQ.3	To what extent can the travel behavior of visitors of Eindhoven Airport be influenced by incentives for sustainable alternatives?	Stated Choice experiment

Tab.1. 1 Sub research questions

1.3. RESEARCH DESIGN

Figure 1.1 demonstrates the research model for this study. The first phase of the study included explanatory research which is qualitative and is carried out through a literature study on the topics of sustainable travel, travel decision making theories, and behavior change. The literature study helped identifying and exploring the different factors that influence mode choice behavior in frequent commuting. Additionally, expert interviews helped to understand the current situation of travel to Eindhoven Airport.

The second phase concentrated on understanding the target group's preferences. Therefore, a Stated Choice (SC) experiment designed in combination with an extensive literature review to identify available alternatives and verify the necessary attributes. Consequently, the levels of attributes are conducted in a similar method. Thereafter, a questionnaire is generated, and the SC experiment and the questionnaire is implemented into Lime online survey system. SC experiment required a reasonable number of respondents to choose between different alternatives to collect the required data. Data is collected directly from travelers of Eindhoven Airport and the other respondents are selected only if they have visited Eindhoven Airport at least once within last twelve months. Modelling the collected data demanded a minimum required number of respondents. Estimation of the required number of respondents can be derived from a rule of thumb, which is explained in the methodology chapter.

The data collected based on the online survey is first be analyzed using the descriptive analysis to get insight into the respondent's socio-demographic and travel habits. Thereafter, a multinomial modeling approach is adopted, which is the most common method using a random utility function to reveal preferred alternatives. In addition, more advanced models such as Mixed Logit and Latent Class models are used to find similarities and variances in preferences among respondents. Finally, the outcome is used to answer the research question and draw conclusions for this research. The research model, visualizing the process described above, can be seen in Figure 1.1.

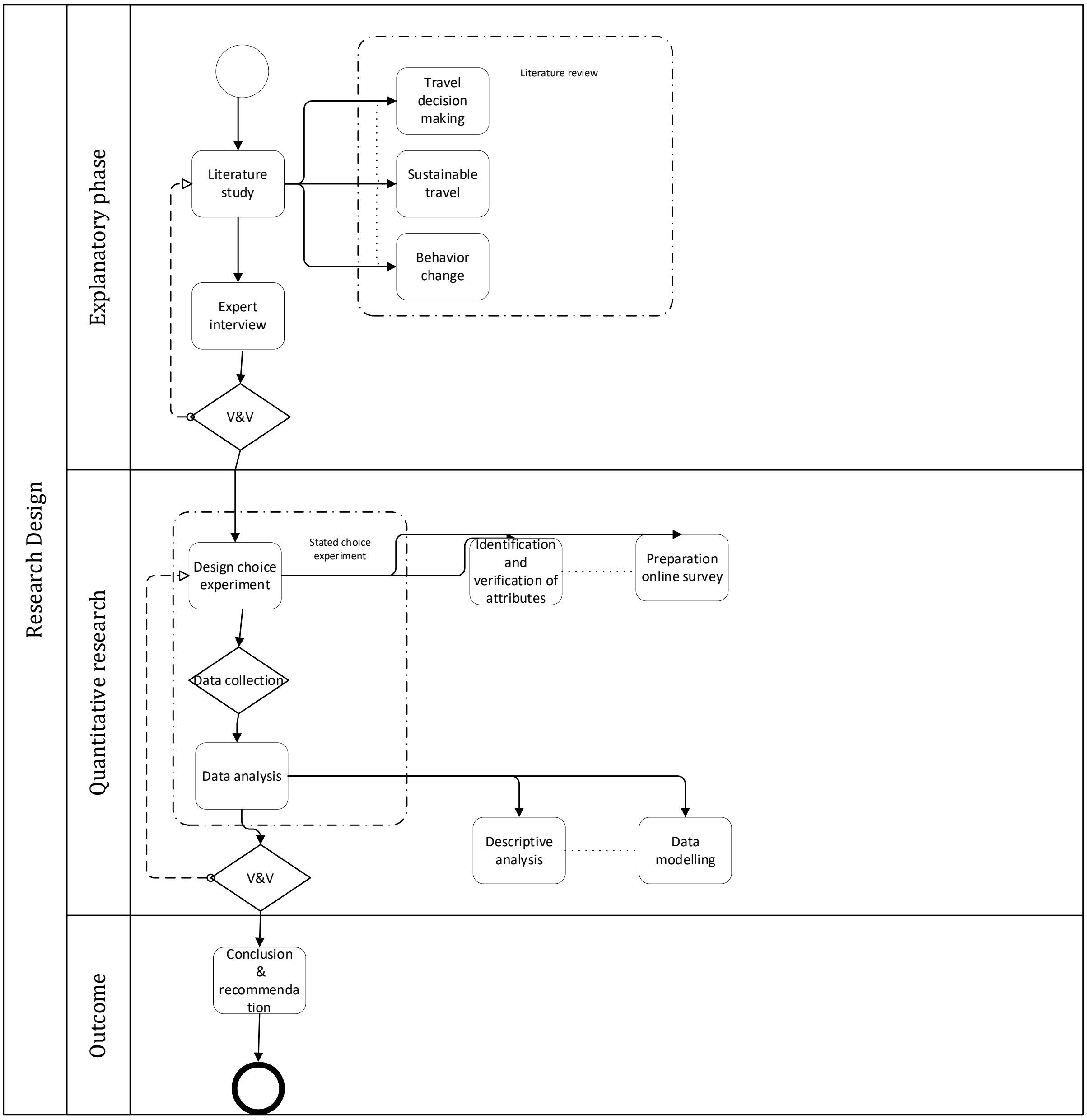


Fig.1. 1 Research model

1.4. SOCIETAL AND SCIENTIFIC IMPORTANCE

The relevance of this study is twofold.

As to the societal relevance it relates to the climate goals of Eindhoven Airport, aiming to become an emission-free airport, which includes more sustainable and accessible transportation to the airport. The study aims to provide Eindhoven Airport and Royal HaskoningDHV with insights in the travel and mode choice behavior of travelers to Eindhoven Airport with applying incentives for sustainable travel alternatives and travel contexts. Since the data will be collected at Eindhoven Airport itself, the analysis directly provides information on the travelers using this specific airport. Moreover, the study includes the most commonly used transport modes to Eindhoven Airport and can therefore provide information on the factors that influence the choice for alternative transportation to Eindhoven Airport.

As regards its scientific relevance, the research contributes to the academic understanding of infrequent mode choice behavior, focusing on using incentives to make sustainable alternatives more attractive. Previous Stated Choice experiments have focused on frequent travel behavior, but have overlooked incidental travel behavior such as airport travel. Moreover, there is only limited research on the applicability of incentives in sustainable mobility modes in the case of airport travels. In case of a positive impact, infrequent travel incentives could be included on the pay-as-you-go level in MaaS platforms, which can work as a trial for MaaS services. This research contributes to knowledge, which can be vital in changing the travel behavior of individuals to switch to more sustainable travel alternatives and reduce the private vehicle modal share. Finally, various discrete choice models are used to obtain a thorough knowledge of the data to investigate the applicability of incentives in the airport travel and as a MaaS solution.

1.5. READING GUIDE

This thesis consists of five chapters, which elaborate on different aspects of the topic. The first chapter introduced a summary of the subject of this research and provided information regarding the outlines. Chapter 2 discusses the literature on the topic, elaborated on the fundamentals of travel behavior, sustainable mobility concepts, and accessibility to Eindhoven Airport. Chapter 3 discusses the methodology of the research; a stated choice experiment designed for the travel to Eindhoven Airport. Chapter 4 introduces the data analysis and the results of this study. Chapter 5 concludes this thesis by introducing the main findings of the research's recommendations and discusses its scientific and societal relevance.

2 LITERATURE STUDY

This chapter explores the existing literature that forms the background knowledge related to the research questions and is divided into three sections (Figure 2.1). The first section introduces the fundamentals of travel decision theories and prominent parameters. The second section looks at sustainable mobility concepts and the influence on travel behavior. The third section focusses on the current accessibly of Airport of Eindhoven and existing initiatives for sustainable and shared mobility. Section 2.4 concludes the literature review by bringing together the three topics introduced.

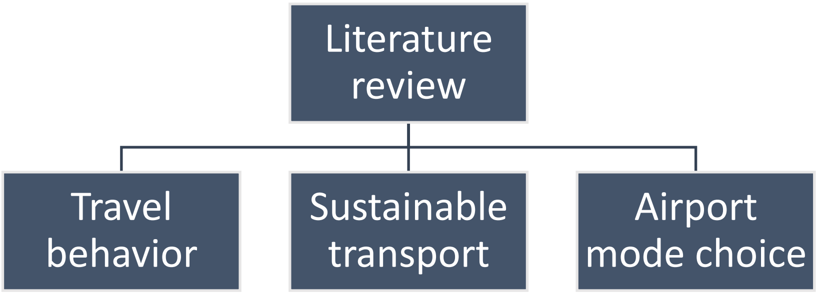


Fig.2. 1 Overview literature review topics

2.1. INTRODUCTION TO TRAVEL BEHAVIOR THEORIES

"Innovation, technology, and economic factors alone will not suffice to achieve the climate and environmental objectives set for the transport sector. Sustainable development also requires changes in our behavior and a development in which car travel decreases."(Andersson, Winslott Hiselius, & Adell, 2018)

Cities worldwide are constantly trying to improve the quality of life of their citizens. One of the means to reach this goal is to invest in sustainable transport options and increase the share of public/shared transport use and help reducing the congestion levels and CO2 emissions. Since private mobility is responsible for the high share of transport to Eindhoven airport, it is vital to understand the mechanisms that underlie the choice of individuals between the use a private car and alternative sustainable modes. Travel behavior is considered as a building block of travel demand and transport planning as can be seen in Figure 2.2 (Rojas López & Wong, 2018). Hence, understanding travel behavior is crucial to enable a shift from traditional modes, such as private car, to shared or public transport modes. This chapter reviews the relevant literature on travel behavior theories and the determinants of travel decision making.

Fig.2. 2 Transport planning building blocks

Literature has researched the travel behavior pattern from different theoretical perspectives which the most important ones are:

- **Psychological theories** have focused on preferences, attitudes, and beliefs of individuals and their influence on travel behavior.
- **Economic theories** have explained the travel decision-making process as a function in which individuals try to maximize their utility.
- **Geography theories** that examine the relationship between activity patterns and travel-time prisms.

Sections 2.1.1, 2.1.2, and 2.1.3 introduce the fundamental work on these theories.

2.1.1. Psychological theories

Psychological theories are at the root of most of the travel behavior researches (Rojas López & Wong, 2018). A notable advantage of psychological theories is that they are disaggregated, meaning that they investigate household or individual levels of analysis for demand instead of population-level demand (Allen Singleton & Allen, 2013).

The theory of human motivation (THM) introduced by Maslow in 1943 is one of the oldest in this line of research. Maslow argued that humans' basic needs (e.g safety, steam, and love) may motivate people for activity and hence for travel (Maslow, 1943). Despite its simplicity, this theory acted as a fundamental block for travel behavior studies. Another influential theory is the theory of planned behavior (TPB, Ajzen, 1991). Although it did not initially include transport in its scope, it has proven very useful in mobility domains (Allen Singleton & Allen, 2013; Lanzini & Khan, 2017). The theory suggests that intentions trigger the behavior, with three main indicators (Ajzen, 1991):

- **Attitude** as the general perception toward a concept. For instance, the use of public transport to go to the airport as environmentally friendly.
- **Subjective norms** as the outer push from society. For example, individuals may experience social pressure to act more sustainable, through commuting with public transport.

- **Behavioral intention** relates to how easy or hard an individual perceives certain behavior to be. For instance, individuals may wish to commute by public transport desirable, but fail to do so because they think it will be inconvenient in terms of planning or travel time.

Several studies have successfully applied TPB to travel mode choice. For instance, David Lois et al. (2015) developed a model based on TPB to predict cycling behavior. The result of that study was that attitude, subjective norms, and identity are correlated with the use of the private vehicle, public transport or cycling (Lois, Moriano, & Rondinella, 2015). Another study by C.I Noblet et al. (2013) examined an expanded TPB model across four transportation modes. The proposed extended model included two new parts of the socio-structural context and problem awareness of the TPB model (Figure 2.3). The result showed that socio-structural characteristics have a direct influence on travel behavior. (Noblet, Thøgersen, & Teisl, 2014). In addition, the extent to which individuals attempt to reduce their car use is shown to be directly influenced by their attitude.

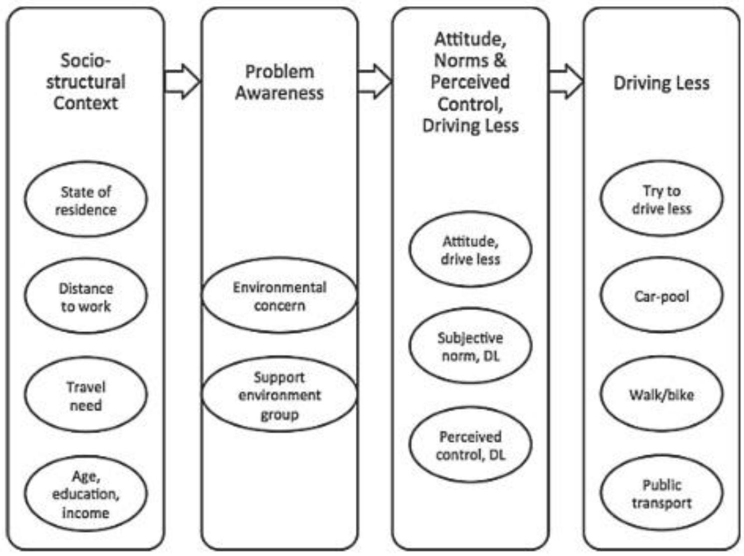


Fig.2. 3 Expanded TPB model, C.I Noblet et al. (2013)

Another strand of research in psychological travel behavior focuses on how habits and repeated tasks can form an individual's mode choice. In their theory of repeated behavior (TRB) , Ronis et al. (1989) argue that behavior can be determined primarily as a habit. It means that, although initial behavior was based on a trade-off and decision making, after repeated behavior it forms a habit, which individuals continue to do without repeating the decision-making process. For example, a person who uses private vehicles and lives in a neighborhood without public-transport modes may well continue using a private vehicle after public-transport modes have become available based on previous habits. Trinadis (1977) has also addressed this phenomenon in his theory of interpersonal behavior. According to this theory, a repeated behavior toward a goal (e.g commuting to work) generate habits that can be in contrast with the main determinants of TPB theory.

2.1.2. Economic theories

Economic theory has played a vital role in developing methods to predict travel behavior. The most prominent economic theory that is used in the field of travel and mode choice is the theory of random utility maximization (RUM) by Daniel McFadden (2001), which won the Nobel Prize in economics (Allen Singleton & Allen, 2013; Rojas López & Wong, 2018). RUM is based on the assumption that the decision-maker always selects an alternative with the highest utility. Hence, by knowing the attributes of different alternatives, the analyst may develop a discrete choice model to predict the future behavior of decision-makers. However, not all utilities are always known to analysts. Hence, RUM considers a random variable to include the unforeseen utilities into the model (Manski, C. F. 2001). RUM considers rational behavior, which means that the decision-maker will always choose the best alternative(Allen Singleton & Allen, 2013). However, as discussed in psychological theories, decision-makers may have different motives and habits that influence their behavior and they might not always choose the best alternative given the information and time available to them. The application of RUM in travel behavior studies have exploded after its emergence and is still popular in a diverse lines of studies (Allen Singleton & Allen, 2013).

2.1.3. Geography theories

The field of geography strongly influenced the concepts of travel behavior and methods of determining travel demand in the 1970s through the works of Hagerstand (1970) and Chapin (1974). Their contributions played a fundamental role in the development of activity-based travel demand models (Rasouli & Timmermans, 2014). Their seminal work made a shift from predicting travel patterns to investigating activity patterns that generate the travel demand. In 1970, Hagerstrand introduced the time-space prism and argued that an individual's behavior is closely related to the proximity of time and space and is limited by three kinds of constraints: capability, coupling, and authority constraints (Hägerstand, 1970).

Capability constraint is a time-space prism and acts as a spatial area in which an individual can travel and conduct daily activities and is limited to the daily schedule of individual and capabilities of transport modes. For instance, an individual using a private vehicle has a larger time-space prism than an individual on a bike or an individual walking (See Figure 2.4). Coupling constraints define how and where the paths of different individuals overlap to do a joint activity (Rasouli & Timmermans, 2014). For example, multiple individuals gather for the purpose ‘work’, which limits the remaining available space-time prism they have. Authority constraints are based on the law or institutes: an individual has to drive with a certain speed and in a certain direction (Allen Singleton & Allen, 2013).

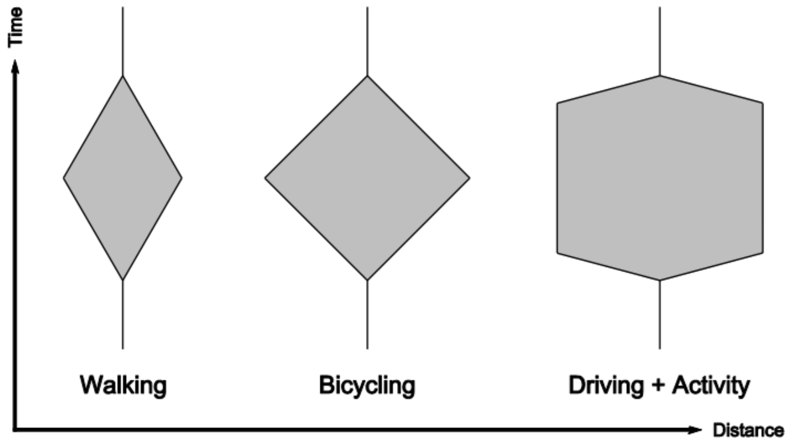


Fig.2. 4 Time-Space prisms, Hagerstrand. (1970)

Consequently, Chapin. (1974) explained travel behavior through an analysis of activity patterns to explain an individual's behavior. He suggested an activity pattern model in which an activity is influenced by 'opportunity' and 'propensity', which can be seen as demand and supply (Figure 2.5). His main contribution was to consider personal characteristics such as demographics and motivation in generating demand and considering environmental factors such as quality of transport facilities and services to influence activities and travel.

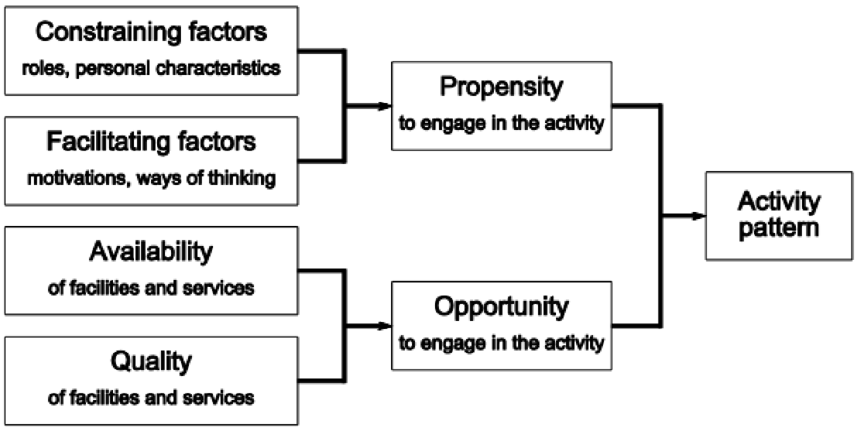


Fig.2. 5 Activity pattern model, Chopin. (1974)

These works made a major contribution to the design of activity-based travel demand models (Allen Singleton & Allen, 2013) by replacing the previous aggregate spatial interactions in previous theories (Rasouli & Timmermans, 2014).

2.1.4. Conclusion

As discussed, the fundamental blocks of travel behavior theories fall into three main categories: psychological, economical, and geographical theories. Psychological theories have introduced the essence of past habits and attitudes in generating behaviors, while economic theories paved the way for statistical modeling of behavior based on the idea that travelers always want to maximize their utility. Geographical models, on the other hand, have tried to find the link between activity pattern and travel behavior, which has contributed to developing modern activity-based models (Rasouli & Timmermans, 2014). Figure 2.6 shows the most influential factors that were identified in the travel behavior theories discussed above. Finally, current travel behavior theories and studies have engaged predominantly with frequent travel such as commute to work and engaging in activities such as shopping or visiting friends. Therefore, the question remains whether these elements will also influence travel behavior for infrequent travel that occurs only occasionally andat greater intervals.

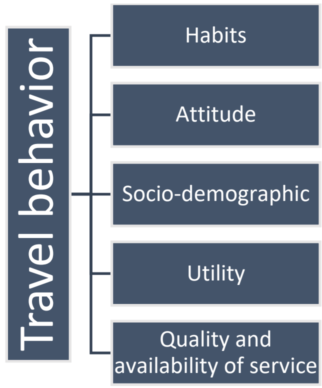


Fig.2. 6 Factors in travel decision theories

What is more, new concepts of transport may also play a vital role in an individual's travel decision making. Sustainable transport is a relatively new paradigm that can help to reduce the negative effects of mobility. The next section will elaborate on this concept and its role in travel behavior.

2.2. SUSTAINABLE DEVELOPMENT

"Sustainability is a vision of the future that provides us with a road map and helps us to focus our attention on a set of values and ethical and moral principles by which to guide our actions." Veiderman (1995)

Over the past decades, environmental deterioration as a result of human activity has convinced the world's nations (at least a portion of them) to reconsider the current development process. As early as the 1970s, a scientific committee from United Nations (UN) studied policies and practices, which at the time were primarily based on economic growth and neglected the environmental and social impact thereof (Sdoukopoulos, Pitsiava-Latinopoulou, Basbas, & Papaioannou, 2019). It concluded that the economic model as described above could not support economic growth in the long run and gravely harmed social equity and the environment. Hence, "sustainable development" became the new paradigm. The World Commission on Environment and Development (UN, 1987) has defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". However, this definition is ambiguous, as it does not make clear how to measure the future generations' needs and how not to compromise these. What is clear, is that moving towards sustainability demands a long-term approach and a comprehensive and multidisciplinary approach at national and international level. Moreover, this goal can only be achieved if all citizens change their behavior towards a sustainable lifestyle which includes all patterns of production, consumption, living standards, and mobility/transport (United Nations, 2002). The focus of this research is on sustainable mobility, which is an important factor in social and economic activity and has a significant impact on the environment (Sdoukopoulos et al., 2019). The next section elaborates on the topic of sustainable transport.

2.2.1. Sustainable mobility concept

Sustainable mobility can be defined as the reflection of sustainable development in the transportation and planning sector, which contains many aspects and stakeholders. Therefore, to succeed in achieving sustainable mobility, a combination of government policies, new technologies, infrastructure, and behavior changes (Toth-Szabo & Várhelyi, 2012). The literature identifies three pillars of sustainable transport: *economic*, *environmental,* and *social* (Fricker, 1998; Sdoukopoulos et al., 2019; Toth-Szabo & Várhelyi, 2012). Economic aspects of sustainable transport concern production processes, costs and prices, the functioning of transport providers, and the labor market. Environmental aspects of sustainable transport are diverse and include factors such as traffic noise, air pollutant emissions, deterioration of habitats and historical sites, mobility, and public transport. Social aspects refer to options such as health, accessibility, safety, and social equity (Gärling, Ettema, & Friman, 2015). A more detailed view of the pillars and their indicators is represented in Figure 2.7. It shows that many indicators are not related to one single pillar and that there are interdependencies among them, which highlights the complexity and diversity of sustainable transport.

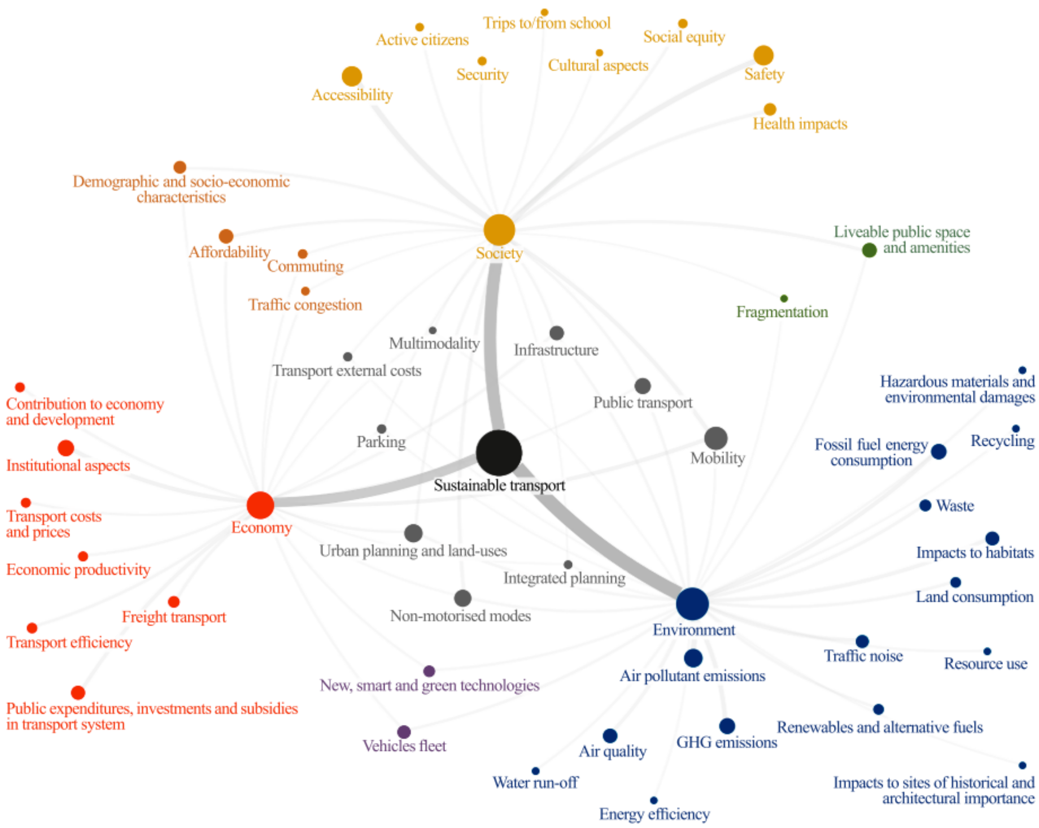


Fig.2. 7 Structure of sustainable mobility indicators, A. Sdoukopoulos et al. (2019)

Improving all the mentioned indicators is simply not a one-dimensional task and requires a interdisciplinary framework between authorities, planners and technological advancements. A handful of studies has looked into the fundamental elements involved in improving the indicators. Four main elements of enhancing sustainable mobility indicators have been identified:

- Government policies implementation,
  Using subsidies to make sustainable mobility more attractive, increasing fuel prices, and parking tariffs.
- New mobility concepts,
  Increasing energy efficiency, promoting technological innovations such as new apps and electric cars, and autonomous vehicles.
- Infrastructure enhancement and management,
  Build roads for low emission modes,
- Behavior adaptation
  Reducing the demand for private vehicle ownership.
  (Sdoukopoulos et al., 2019; Stephenson, Spector, Hopkins, & McCarthy, 2018; Toth-Szabo & Várhelyi, 2012).

Focusing on all the elements of sustainable mobility would requires extensive research from different disciplines and expertise. The scope of this study has been limited to new sustainable mobility concepts and user behavior adaptation (Figure 2.8).

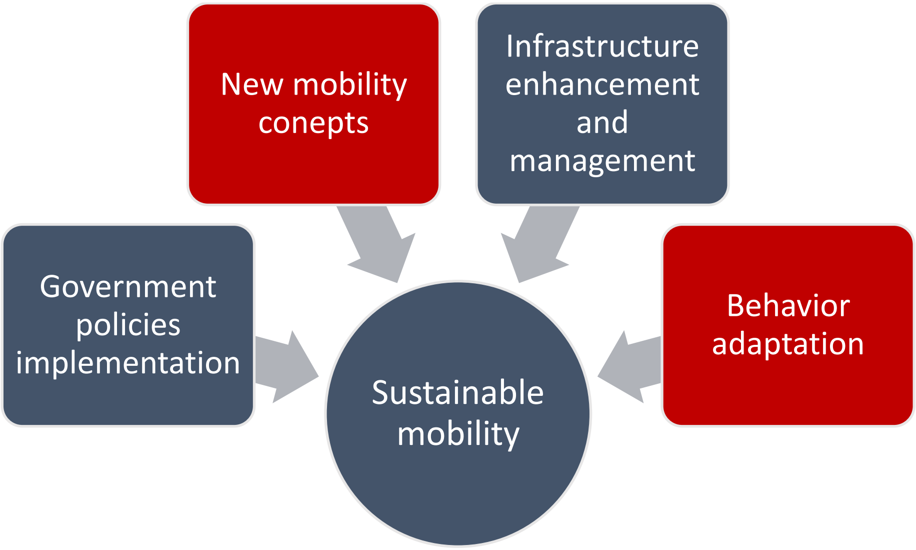


Fig.2. 8 Influential elements in sustainable mobility and the selection criteria for the research

Section 2.2.2 elaborates on new sustainable mobility concepts and their effects on travel behavior and adaptation.

2.2.2. Mobility transitions and travel behavior adaptation

"The use of digital technologies to economize the mobility sector, making it more efficient and intermodal, cannot be stopped. The automobile with its combustion engine was only the first-generation appliance" (Canzler and Knie, 2016, p.56)

In recent years, technological advancements and ongoing stricter environmental regulation have pushed researchers and manufacturers to invest in new mobility technologies (Bakker, Maat, & van Wee, 2014; Lang & Mohnen, 2019). The emergence of electric shared and autonomous vehicles and their integration with ICT technologies is bringing about a revolution in the mobility sector. These advancements result in the development of new mobility concepts and changes in individuals' travel behavior, moving from travel by private car trips to new modes of transportation. (Lang & Mohnen, 2019). This section elaborates on these new mobility concepts and their expected effect on travel behavior.

Electrical Vehicles

Investing in Electrical Vehicles (EV) models have become a trend among automobile manufactures in the recent decade in response to challenges of reducing the overall carbon footprint (Bakker et al., 2014). National and international regulation and initiatives, such as the European Commission 2050 roadmap, force transport and mobility sector to decrease carbon emissions by 60% compared to 1990 levels (European Commission, 2011). Previous research shows that the socio-demographic of EV users consists of more male individuals in their late 40s with higher income and higher education, who often have more than one car in their household (Haustein & Jensen, 2018; Klöckner, Nayum, & Mehmetoglu, 2013). The effect of EVs on travel patterns and behavior has been the topic of much research in the last decade. Some of these studies suggest that individuals will maintain their current travel behavior after switching to EV (Kim & Rahimi, 2014). However, other studies conclude differently. Langbroek et. (2018) performed a stated adoption experiment to investigate the behavioral change of EV adopters. The study showed that in general EV-adoption can result in more travel by car (Langbroek, Franklin, & Susilo, 2018). In this case, a rebound effect appeared which meant that a part beneficial gains of switching to EVs gets lost due to increased car use, which in turn may contribute to higher traffic congestion and road accidents. What is more, several other studies on the travel behavior of AV users confirmed the possibility of a rebound effect. Klockner et al. (2013) analyzed the data collected by the Norwegian Public Roads Administration. The results show that EV users travel by car more often in their everyday trips and the purpose of most trips is for work/school, shopping, and leisure trips. Another study by Haustein et al. (2018) shows that EVs are mostly used shorter trips, which could be made by foot and bike. Moreover, EV users traveled more using their EV compared to drivers with conventional cars. As a result, the adaptation of EVs may contribute to higher levels of congestion in urban areas and reduce the positive environmental effect of this mode.

Car-sharing

The second mobility concept focuses on car-sharing services. Modern car-sharing operators work with applications where users have to register and enter their payment details and driving license. After validation, users can locate the vehicles using GPS technology and start using them. The cost of the service is based on the distance driven and/or the time in which the vehicle is in use, and covers cleaning, fuel, insurance, and other costs (Baptista, Melo, & Rolim, 2014). This service is causing a shift in the transport decision making of individuals and is expected to become an important component of mobility in urban areas (Lang & Mohnen, 2019). Research shows that young and highly educated adults in urban areas, with moderate to high income, are most likely to shift to car-sharing services (Netherlands Institute for Transport Policy, 2018). This shift can influence changes in mobility patterns and individuals' behavior and as a result, have energy and environmental impacts. Baptista et al. (2014) found that car-sharing has a considerable effect on the behavior of users: 42% of individuals started managing their trips differently after 6 months, 21% of individuals started using other modes of public transport, and 8% stopped using their private car all together. In The Netherlands, several car-sharing operators such as Car2go, Amber, Greenwheels are already in operation (Amber, 2020; Car2go Nederland B.V., 2020; Greenwheels, 2020). Suiker et al. (2013) conducted a study in the Netherlands and found that in 2011, two years after the introduction of Car2go service in Amsterdam, 4% of its members reconsidered their car ownership and stated that they would no longer wish to own a car. Shopping, recreation, and visiting family and friends are the most popular purposes mentioned in literature for using car-sharing services (Baptista et al., 2014; Netherlands Institute for Transport Policy, 2018). Thus, most individuals seem to use car-sharing for occasional activities which can make this mode of transport an ideal alternative for infrequent travel. Such changes in an individual's behavior can lead to more efficient, environmentally friendly, and rational mobility in urban areas. A case study in Lisbon showed that the car-sharing concept may contribute to a 65% reduction in CO_2 emissions and up to 47% in energy consumption (Baptista et al., 2014). Additionally, a shift away from owning cars, can improve congestion problems and free up parking space in central areas of cities.

Shared micro-mobility

Shared micro-mobility is a term used to refer to sharing services for modes with a low speed, such as bicycle, scooter, or other modes. These modes have become one of the fastest-growing innovation in transport in cities around the globe and provide short term access to a mode for users (Shaheen, Cohen, Chan, & Bansal, 2020). They enable both one-way trips, as well as roundtrips based on the service model: (1) station-based shared micro-mobility, (2) dock less micro-mobility. Dock less services work with GPS technology to locate the vehicles. Unlike station-based services they do not face challenges related to accessibility, limited places, available parking, or a need for public subsidies. They are also more popular among individual travelers because they eliminate the need for "last-mile transport": there is no need to park the vehicle at the designated station and walk the last mile (Chen, van Lierop, & Ettema, 2020). Shared micro-mobility users are mostly used for short-distance trips by individuals in the 20-40 age group, with a higher education level. Their main motivation for using these services is their convenience and low cost (Chen et al., 2020; Netherlands Institute for Transport Policy, 2018). A sense of moral obligation to use more sustainable modes, as well as environmental awareness are two important additional behavioral factors that play a role in choosing these modes (Si, Shi, Tang, Wu, & Lan, 2020). Finally, shared micro-mobility services have the potential to alter its user's travel behavior towards a more frequent use of public transport and less private car as a result of tighter integration between forms of shared micro-mobility and modes of public transport. In Beijing, China, 81% of shared bikes of one of the major service providers in the field of shared micro-mobility, is found active within a 300 meter radius of public bus and metro stations (Chen et al., 2020). As a result, it can be concluded that shared-micro mobility services can fill the gap of the often problematic 'first mile' and 'last mile' commute, and as such decrease the share of private cars.

Shared autonomous vehicle

Automated mobility technologies or self-driving vehicles have significantly advanced over the past decades. Although not yet commercially available, this technology is expected to create the biggest shift in how mobility is perceived since the advent of combust engine vehicles (Lamotte, de Palma, & Geroliminis, 2017; Narayanan, Chaniotakis, & Antoniou, 2020). Shared autonomous vehicle (SAV) would be a shared mobility service working with autonomous technology. SAV has the potential to enhance the growth of shared mobility services. This growth can in turn pave the way for better implementation of autonomous technology and thereby contribute to a more sustainable future (Lang & Mohnen, 2019; Narayanan et al., 2020). The potential impact of this technology covers a broad range of topics, from the economy to travel behavior, from governance to land use. It is a research field that is rapidly expanding, with many questions still left unanswered. Regarding travel behavior, research shows that the length of trips can increase when SAVs become operational (Childress, S., Nichols, B., Charlton, B., & Coe, 2015; Narayanan et al., 2020). An increase in satisfaction level and free time during travel can help individuals use their travel time more productively and contribute to an increase in vehicle kilometer traveled (VKT) (Lang & Mohnen, 2019; McKinsey, 2017). Although this effect could result in higher congestion levels, other research shows that automated mobility can reduce vehicle ownership drastically when combined with sound policies and thus reduce the number of vehicles on the road. (Milakis, Van Arem, & Van Wee, 2017; Narayanan et al., 2020). It is estimated that senior individuals (over 65 years old), non-drivers, and individuals with medical conditions will experience the biggest shift in their VKT after adoption of automated mobility technologies (Harper, Hendrickson, Mangones, & Samaras, 2016).

Demand-responsive transport

Demand-responsive transport (DRT) provides "on-demand" transport for users to pick up and drop off by their need and can be interpreted as a cross over service between conventional "taxi" and "bus service" (Mageean & Nelson, 2003). DRT services are mostly used in rural areas where there is a lack of public transport system and investments are limited (Netherlands Institute for Transport Policy, 2018). This type of DRT is also referred to as coverage-oriented DRT service and targets younger (under 24 years of age) and older (over 55 years of age) people with lower income, who live far from mobility hubs and do not possess a driving license and/or private vehicle (Netherlands Institute for Transport Policy, 2018). However, another study by Frei et al. (2017) shows that this mode of transport may also appeal to current car users who dislike driving.

DRT can be beneficial also in urban areas as a complementary travel mode for public transport, where there is a high demand for specific destinations. For this type of DRT, higher income older individuals and millennials are the most likely users (Frei, Hyland, & Mahmassani, 2017). A possible reason for this is that older higher-income individuals and millennials have a more flexible agenda which allows them to take advantage of DRT. (Frei et al., 2017). The research on the effects of DRT on travel behavior is still limited. Existing literature suggest that the effect of DRT on travel behavior is highly dependent on the design of DRT and might reduce car use and active modes of transport such as walking and biking (Frei et al., 2017; Mageean & Nelson, 2003; Netherlands Institute for Transport Policy, 2018).

Table 2.1 summarizes the main effects of the novel sustainable mobility services on travel behavior and the demographic of early adopter's target group. It can be concluded that EV's societal and environmental benefits may be overrated, as EV's effects on travel behavior such as an increase in car travels is often neglected. SAV is a promising technology and has the potential to be a big leap in modern transportation. However, this technology is still very much in its infancy and will not be commercially available within the coming years. This is different for the three other mobility concepts that were discussed. Car sharing shared micro-mobility, and demand-responsive transport are commercially available and their effects on travel behavior adoption have shown positive results. Therefore, these concepts can be promoted as currently available sustainable modes of transport in urban areas. It should be noted that the travel behavior adoption research on these mobility concepts is mainly or completely based on frequent travel of individuals. Incidental travel behavior adoption of individuals with sustainable transport is largely neglected by this line of research. Ultimately, new mobility concepts will benefit from the use of information and communication technology (ICT) for better integration and more efficient allocation of transport resources (Khan, Habib, & Jamal, 2020; Schikofsky, Dannewald, & Kowald, 2020). Mobility-as-a-service (MaaS) is a new concept, which combines new mobility modes with ICT technologies and thereby has the potential to change the concept of mobility. The following will elaborate on this topic and discuss in more depth the ICT technologies can influence the travel behavior of individuals.

Mobility Concept	Effects on travel behavior	Who is more inclined to use?	Authors
Electric Vehicles	➢ No change in travel behavior or an increase in the number of travels because of a rebound effect, ➢ Decrease in the number of active modes of travel such as walking and biking.	➢ Individuals with higher income and higher education, ➢ Individuals with more than one vehicle in their household, ➢ Individuals in the late 40s and mostly male.	*J.D. Kim & Rahimi, 2014* *Langbroek, Franklin, & Susilo, 2018* *Haustein & Jensen, 2018*
Car sharing services	➢ Reduction in the use of private vehicles, ➢ Increase in share of public transport, ➢ Reduction in car ownership.	➢ Young individuals with higher education, ➢ Individuals dwelling in urban areas, ➢ Individuals with moderate to high income.	*Baptista et al.,2014* *Suiker et al.,2013* *Netherlands institute for transport policy, 2018*
Shared micro-mobility	➢ Increase in share of public transport, ➢ Decrease in use of private vehicle, ➢ Improve the integration level of public transport modes by filling the gap in the first and last mile.	➢ Individuals in 20s, 30s, and 40s with higher education, ➢ Individuals with higher moral obligations and environmental concern.	*Chet et al.,2020* *Chen, Van Lierop, & Ettema,2020* *Si, Shi, Tang, Wu, Lan, 2020*
Shared autonomous vehicles (SAV)	➢ Increase in travel satisfaction and free time during the trip, ➢ Increase in number of travels and distances, ➢ Decrease in private vehicle ownership.	➢ Senior individuals (over 65), ➢ Non-driver individuals, ➢ Individuals with medical conditions.	*Lang & Mohnen, 2019* *Narayanan et al.,2020* *Harper, Hendrickson, Mangones, & Samaras, 2016*
Demand responsive transport	➢ Complementing public transport system, ➢ Reduction in use of private vehicle, ➢ Reduction in use of active mode transport such as biking, walking.	➢ Higher-income older individuals, ➢ Millennials and individuals with flexible agenda.	*Frei et al.,2017* *Netherlands Institute for Transport Policy, 2018*

Tab.2. 1 Mobility concepts travel behavior adaptation and early adopters

2.2.2.1 Emergence of Mobility-as-a-service

Advancement in mobile ICT technologies and the development of new mobility concepts as mentioned in previous sections have paved the way for a new mobility ecosystem that has the potential to provide a multi-modal door-to-door solution called Mobility-as-a-Service (MaaS) (Goodall, Dovey Fishman, Bornstein, & Bonthron, 2017). This new concept can be defined as a combination of shared mobility modes, new ICT technology (mobile applications), and integration of mobility providers as can be seen in figure 2.9 (Netherlands Institute for Transport Policy, 2018).

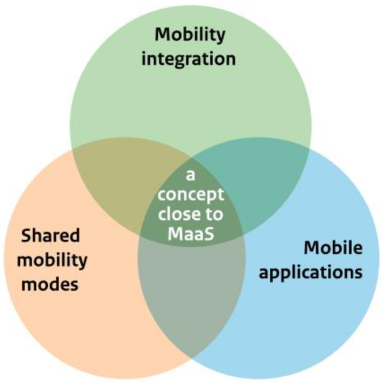


Fig.2. 9 Main themes in MaaS, adapted from Netherlands Institute for Transport Policy (2018)

MaaS is a relatively new concept in smart mobility, which was first coined in Finland in 2014 by Heitanen, who defined MaaS as “a mobility concept that provides the user’s transport demands through one integrated interface”(Hietanen, 2014). This integrated interface includes tailored access to different modes of transport like a monthly mobile phone contract. These tailored packages are referred to as mobility bundles and are the key factor in the implementation of MaaS. Figure 2.10 illustrates four three mobility options available in Whim, a MaaS operator in Helsinki, Finland (Whim,2019).

TIER:	WHIM TO GO	WHIM URBAN	WHIM UNLIMITED
Subscription Fee:	0 €	49 € per month (99 € for extended Helsinki Region)	499 € per month
Includes:	• No monthly free • Pay as you go • Public Transport tickets, taxi rides, and rental cars can be all bought from Whim App	• Unlimited number of public transport tickets • All taxi trips within 5 km radius for max 10 € • Fixed 49 € daily rental car fee • Unlimited city bike trips up to 30 minutes at a time	• Unlimited number of public transport tickets • Unlimited number of taxi rides within 5 km radius • Unlimited rental car use • Free to use city bikes for 30 minutes at a time

Fig.2. 10 Mobility packages in MaaS ecosystem, adapted from Whim (2019)

This MaaS operator has started work in Helsinki, at the end of 2016 and surpassed 70,000 registrations by late 2018. Whim offers three different services: a pay-as-you-go option (whim to go) and two fixed monthly mobility packages (Whim, 2019).

MaaS is based on the idea that users, in general, are more interested in grouped items than a set of individual items and this can also increase market revenue by lowering per-unit costs (Mulley, Nelson, & Wright, 2018). As a result, the concept is customer-centric and users can enjoy a single payment channel instead of integrated ticketing payment for different operations (MaaS Alliance 2019). MaaS can also provide pay-as-you-go for single trips as demonstrated in Figure 2.11. This figure shows an imaginary illustration of a MaaS app interface (Schikofsky et al., 2020). As can be seen, the MaaS app provides a multimodal door-to-door mobility solution based on users' preference, based on a single payment via an application. A monthly subscription offers a cheaper price and is user-centric. The pay-as-you-go option can fill the need for incidental travel such as visiting places during a holiday trip or commuting to the airport.

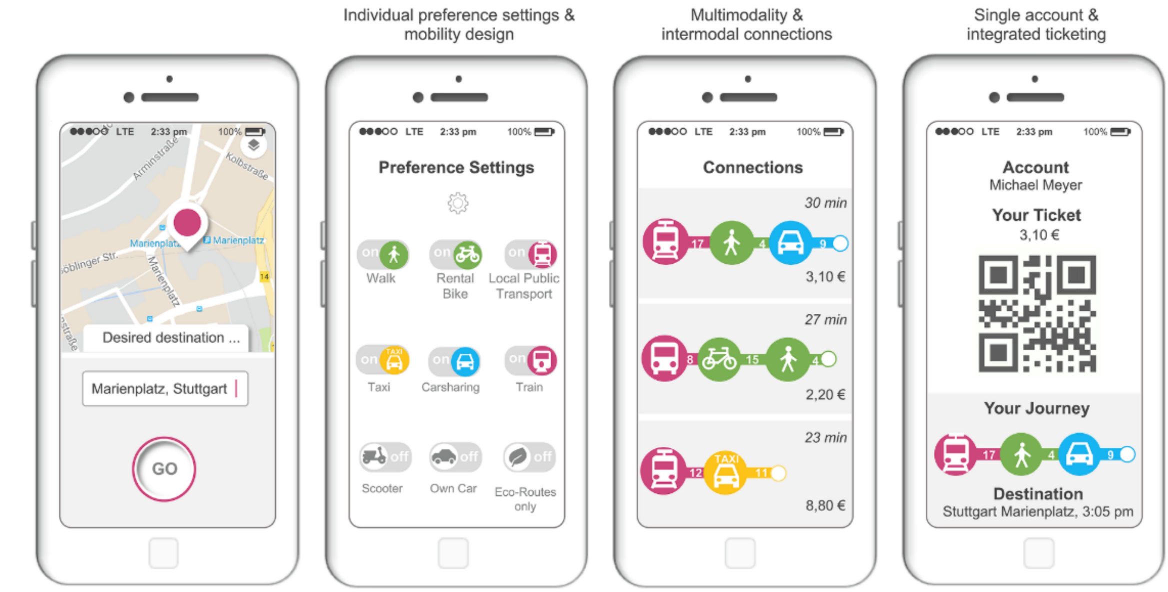


Fig.2. 11 MaaS app conceptual illustration, adapted from Schikofsky et al. (2020)

2.2.2.2 MaaS adaptation

Most recent research has studied the preference of users towards mobility packages offered by MaaS and how travel behavior adapts within MaaS implementation. Ho, C.Q et al. (2020) conducted a stated choice experiment in Sydney, Australia, and Tyneside, United Kingdom, to see the similarities and differences for demand in MaaS packages and pay-as-you-go options. The result showed that people who use both car and public transport are most likely to adopt MaaS. Offering pay-as-you-go was expected to increase the interest in using the service, but the result showed that pay-as-you-go adopters planned to maintain their travel patterns, while subscribers used more public transport and active modes. Figure 2.12 shows that the pay-as-you-go option is more attractive to infrequent car users of all ages, with the exception of the age group of over 65 years old. Monthly plans (mobility packages) are more attractive for more frequent and younger car users (Ho, Mulley, & Hensher, 2020).

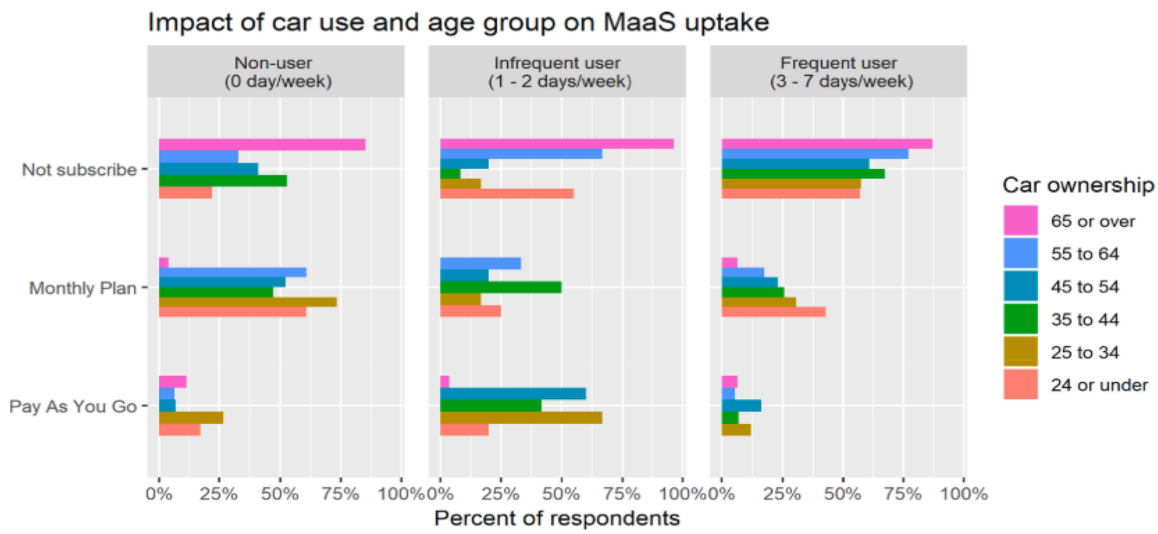


Fig.2. 12 Impact of age on MaaS subscription, segmented by frequency of car use, adapted from C.Ho et al. (2020)

What is more, the study revealed that the public appears to value the use of MaaS, but is not prepared to pay for it. In another study by T.Ahtela et al. (2017), respondents mentioned that they are favorable towards MaaS, but only 15-25% could imagine using 'new sustainable modes' of commuting such as car sharing, demand-responsive transport or bike service. The result therefore suggests that the MaaS platforms need to be accompanied by some form of discount or incentive to guarantee a wide adaptation of MaaS (Ho et al., 2020). Other studies suggest that mobility packages should be based on users' travel habits to provide the push towards MaaS adoption (Ho, Hensher, Mulley, & Wong, 2018; Matyas & Kamargianni, 2018). In the Netherlands, a recent study on MaaS by Caiati et al. (2020) showed that Dutch society is not yet inclined to adopt MaaS services. The study evaluated the preference for mobility package configuration employing the stated choice experiment. The result of the Random Parameters model showed that most socio-demographic variables have a significant effect on the subscription.

Most recent research on MaaS user adaptation have concentrated on designing monthly mobility packages and estimating users' preference towards them. However, the literature sheds very little light on the pay-as-you-go option. This often-underestimated part of MaaS can provide users with a chance to experience how MaaS works without a subscription. As a result, users can try MaaS for an incidental trip or for their infrequent travel and adapt at a later point to a MaaS subscription. Previous studies also confirm that trialability and overt experience of a mobility service/mode are important factors in decision making and change towards a sustainable mobility behavior (Hensher & Ho, 2016; Strömberg, Rexfelt, Karlsson, & Sochor, 2016).

All in all, MaaS and new mobility concepts seem to be promising technologies to achieve more sustainable travel behavior. Given the novelty of these concepts, the ultimate effect of them on travel behavior and specifically private vehicle use is still not fully understood. Next section elaborates on the possible effect of MaaS on the private vehicle use.

2.2.2.3 MaaS and private vehicle use

Given that MaaS is such a recent technology, there are limited studies about the actual impact of MaaS on travel behavior. However, a handful of publications discuss the potential influence of MaaS on individuals' mobility behavior based on trials and surveys. The changes in travel behavior brought about by MaaS can be compared to those resulting from the novel mobility concepts discussed above. However, the one-platform, single payment nature of MaaS can facilitate the use of these new mobility modes and thereby have an even greater effect on the travel behavior of users.

The most often mentioned effects of MaaS on travel behavior are the reduction in private car dependency and the increase in modal share of shared and public mobility options (Ahtela & Viitamo, 2018; Goodall et al., 2017; Jittrapirom, Marchau, van der Heijden, & Meurs, 2018; Netherlands Institute for Transport Policy, 2018). The results from UbiGo, a MaaS trial in Sweden show a 44% decrease in the use of private vehicle during the MaaS trial period

(Karlsson, Sochor, & Strömberg, 2016). Another pilot study in Vienna, Austria, shows a 21% reduction in the use of private vehicle during the trial period (Netherlands Institute for Transport Policy, 2018). However, in a recent MaaS pilot study in Ghent, Belgium, did not show a the reduction in private car use in a real-life setting was not as significant as previous studies had suggested (Storme, De Vos, De Paepe, & Witlox, 2020). The study points out that MaaS requires more planning and organization compared to a private vehicle. For people who are involved in activities in different locations at different times, possible delays or a lack of vehicles can cause significant stress. As a result, individuals may use MaaS only as a supplement for their current travel plans.

Another possible effect of MaaS is the effect it may have on the rate of private car ownership. In a survey undertaken in London, the United Kingdom, 26% of car-owning respondents showed an interest in selling their car in case of a fully operational MaaS system. Yet another 36% of current non-car owning respondents stated that they would delay buying their car if MaaS were to become commercially available (Kamargianni, Maria. Matyas, 2018). This may make MaaS especially interesting for the "millennial generation". According to L.Lang et al. (2019) this generation "has a different understanding of mobility and it is not any more important to own something as long as it can be used". This suggests that the younger generations are potentially early adopters of MaaS in the years to come (Lang & Mohnen, 2019).

2.2.3. Incentives and triggering travel behavior adaptation

Over the past decade the use of incentives to influence commuting behavior and promote sustainable mobility has been an increasingly used policy tool. It has also become the topic of much academic research In general, an incentive can be defined referred to as an award-allocating policy to provoke certain actions in an individual's behavior and can include positive and negative incentives. (Poslad et al., 2015). Positive incentives aim to promote the use of a mode such as shared car services by allocating monetary rewards (e.g tax reduction, bonuses, gamification). By contrast, negative incentives aim to change specific behavior by connecting negative consequences to such behavior, making it disadvantageous not to adapt for (e.g levies or fines, such as congestion charges). Non-monetary incentives are considered to have a significant effect on behavior, especially when combined with travel convenience. As an example one can mention the access to fast lanes for electric cars, which was introduced in Norway back in the 1990s (Santos, 2018). Incentives are costly and mostly implemented and supported by mobility brokers/agencies or authorities such as municipalities (Santos, 2018). Hence, it is important to establish whether their influence is positive enough to justify introducing them.

In transport and mobility studies, there is a handful of empirical academic research on incentives and adaptation of travel behavior. In an experiment in The Netherlands, in 2006, travelers were offered a bonus of either 3 or 7 euro to avoid traveling during peak hours. The result showed an astonishing 50% reduction in car trips at these times. However, travelers mainly changed the timing of their travel rather than their travel mode. What is more, the research showed that the travelers returned to pre-experiment travel hours once the incentives were stopped (Ettema, Knockaert, & Verhoef, 2010; Knockaerta, Tsenga, Verhoef, & Rouwendal, 2012). The results suggest that the effect of incentives only lasts as long as they are in place and do not modify travel behavior more permanently. However, the Dutch study did not engage with the question of trialability (Strömberg et al., 2016). Another study in Beijing, China, the impact of a variety of incentives on subway commuters' travel behavior has been researched based on a stated preference experiment. The study shows that parameters for incentives of "free WIFI" and "discount on the ticket fare" are statistically significant and have a positive impact on avoiding the morning rush hour (Zhang et al., 2014). Although incentives have shown promising results in triggering travel behavior change, it is crucial to introduce an effective incentive that can motivate commuters to change their travel behavior. S. Poslad et al. (2015) designed an experiment using mobile sensors to record mobility behavior and gamification method that offered incentives to users based on their mobility patterns. Incentives that were offered to users were context-based and varied depending on time and place. The result showed that incentives have the potential to change car drivers to change their driving time but inducing drivers to change to public transport when the incentives are individualized. In a travel survey done for Cal Poly campus California in 2019, alternative incentives were designed and tested to induce respondents to give up driving. Options varied from monetary incentives, gift cards, social requests to change their previous behavior, or a combination of monetary incentives and social requests. The result showed that gift card incentives are slightly more effective compared to monetary incentives (31% acceptance rate to 30%). Surprisingly, the social request showed the most effective with a 38% acceptance rate, while incentives with a combination of monetary and social requests showed the smallest acceptance rate (15.2%) (Riggs, 2019). The overall result of these studies suggests that understanding which incentives are effective requires an investigation of the case by case.

2.2.4. Conclusion

This section introduced recent developments and technologies in sustainable mobility, including new modes of mobility, as well as the development, including the recent COVID-19 pandemic, that may influence their adoption by by travelers. The availability new mobility alternatives such as car-sharing services, demand responsive, and micro-mobility have shown positive results in travel behavior adaptation in frequent commutes. In addition, MaaS has introduced a new concept that can offer integrated mobility services using ICT technologies, which can reduce car ownership and incline the public transport modal share. As was explained MaaS is built around ar subscribed mobility packages to maximize the benefit of providers and users. However, incidental trips without subscription or pay-as-you-go trips can play a role as a trial for users to experience traveling with MaaS and sustainable modes. Furthermore, as discussed in section 2.2.3, although the development of Covid-19 has resulted in the sharp decline in the number of trips and negative attitude towards public transport, there are new opportunities for sustainable mobility and MaaS. For instance, owning a private vehicle can become expensive and unnecessary and hence favor the adaptation of MaaS and some train users will adopt toward car-sharing services. Incentives are mentioned as a strategy to promote sustainable mobility concepts. Research has shown a positive result in travel behavior adaptation when incentives are used as a supplement in the service. However, the effectiveness of incentives needs a case-by-case analysis. Section 2.3 provides insight into the developments of the study area of this research: Eindhoven Airport, situated in the city of Eindhoven, The Netherlands.

2.3. AIRPORT ACCESS MODE CHOICE BEHAVIOR

Air travel has become one of the main modes of long-distance travel transportation in the last few decades (Pasha & Hickman, 2017). According to the International Air Transport Association (IATA), The Netherlands has the 9th highest level of air connectivity in Europe, which grew by 36% between 2013 and 2018 (IATA, 2019). A total number of 79.6 million passengers arrived and departed from the airports in The Netherlands in 2018, in which regional airports processed over 8.6 million of this total number (CBS, 2019). Figure 2.13 shows the total passengers in regional airports in The Netherlands, which has grown nearly 11 percent in 2018 (CBS, 2019).

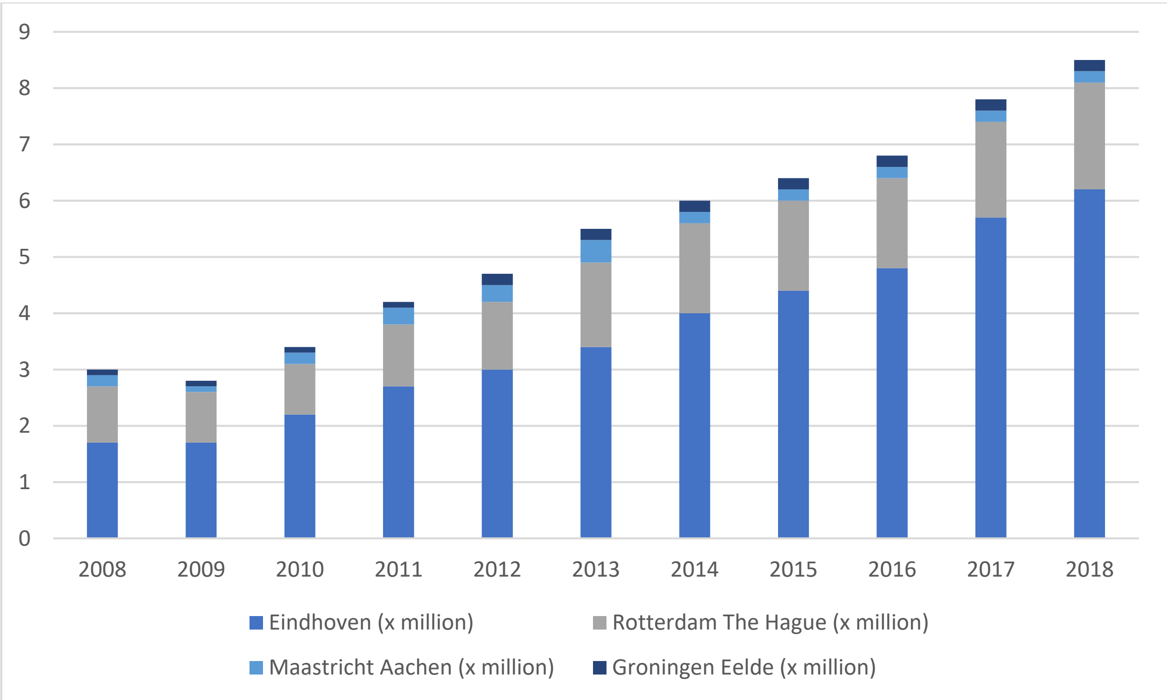


Fig.2. 13 Number of passengers in regional airports, CBS. (2019)

As a result of this national and international air-passenger growth, the access modes of airports have become more important given the competition among airports. Providing modern transport modes to access airports is a key factor in sustaining growth for airports and brings an advantage over neighboring airports (Birolini, Malighetti, Redondi, & Deforza, 2019).

A private vehicle can offer a door-to-door journey with a short travel distance, high comfort (space for luggage, no need to transfer), safe, and flexible. Therefore, a private vehicle is often responsible for the highest modal share for airport access in most airports (Wadud, 2020). For instance, private vehicles and taxis had a modal share of 85% in UK airports in 2003 (Humphreys, Ison, Francis, & Aldridge, 2005). A similar pattern is observed in The Netherlands as well (Donners & Van Genugten, 2018). Wadud (2020) studied the emerging effects of ride-hailing services on parking facilities at three airports serving New York City. The result of time-series econometric models on available parking data showed that introducing ride-hailing service resulted in a reduction in car parking at the airport and therefore, a reduction in using a private vehicle to access the NYC airports. Another study based on a survey of travelers at Manchester Airport in the UK, suggests that apart from implementing new travel modes, traveler's attitudinal characteristics are also determinant in the behavior change toward using lesser private vehicle (Budd, Ryley, & Ison, 2014). Hence, an analysis was sought to define segments of passengers with the greatest potential in reducing their private vehicle use and two groups were identified: 1. travelers using mostly public transport, drop-off, and taxi with a more positive view on drop-off and taxi than the bus and 2. Travelers with high environmental concerns and a very positive attitude towards using public transport. Consequently, the study states that the other segments (devoted drivers, ardent taxi-users) show strong resistance towards behavior change.

Regarding the choice of alternatives, there are a handful of studies that have tried to understand the determinant factors that influence airport mode choice. Harvey (1986) conducted one of the first studies on the factors influencing the mode choice behavior for travelers living in the San Francisco Bay Area. He included traditional modes of driving, drop-off, taxi, and train into his research and concluded that travel time and travel cost are the most important determinants in mode choice of airport travels (Harvey, 1986). Chebli & Mahmassani. (2002) conducted similar research in three major airports in Texas. The results from model estimation showed that the mode choice of travelers is significantly influenced by gender, income, and the number of times the individual travels per year (Chebli & Mahmassani, 2002). However, mode choice of the behavior of travelers to airports might be also depended on the airport factors. Hess & Polak. (2006) argue that traveler's choice of airport, choice of airline, and choice of access mode are closely related, and they have studied the nature of this interaction in research in the San Francisco Bay Area. The estimations from the Multinomial model and nested logit models showed that travel time to the airport, the frequency of flights are the most significant factors for the travelers (Hess & Polak, 2006). What is more, factors such as airline and aircraft size showed to have an impact for some of the population subgroups (Hess & Polak,2006). In another research, the influence of low-cost airlines and transport mode for travel to airports in Spain are investigated and the results estimated that travelers flying with low-cost airlines are 6% less likely to take a taxi to the airport and are 4% more likely to drive or rent a car (Castillo-Manzano, 2010).

In research by Bezerra & Gomes., (2015) satisfaction of travelers is proven to be positively correlated with airport choice. The regression model showed that 'ambience', 'basic facilities', and 'prices' are the most significant airport factors (Bezerra & Gomes, 2015).

Regarding the different alternative transport modes, Jou, Hensher, & Hsu., (2011) investigated air travelers' mode choice at Taoyuan International Airport (TIA), Taiwan. The research included five existing modes of private vehicle, taxi, drop-off, public bus, high-speed train, and one future mode of Mass Rapid Transit System (MRT). The result from the Likert scale questionnaire showed that "time-saving" and "no-transferring" are the most important alternative factors for the respondents. Furthermore, the Mixed Logit model estimation showed that alternative private vehicle is preferred by male respondents and travelers with luggage. Additionally, parking fees and travel costs by private vehicle showed a significant negative impact on travelers who drove a private vehicle to the airport (Jou, Hensher, & Hsu, 2011). The lower-income travelers and students showed a preference for drop-off alternatives by a family member or friends. In another survey analysis from a Taiwanese sample, characteristics of mode alternatives and their importance are studied and the result showed that "safety", "convenience for storing luggage" and "user friendly" are the most influential determinants in the choice of transport alternative (Chang, 2013). Additionally, the model estimation suggested that elderly passengers prefer to get a ride to the airport from their family and other travelers prefer the alternative taxi the most (Chang, 2013).

Satisfaction level towards the mode alternatives is another important factor of the mode choice behavior of departing passengers. Tam, Lam, & Lo. (2010) implemented "satisfaction" as a latent variable in the discrete mode choice model of travelers to Hong Kong International Airport (HKIA). The model estimation from four alternatives of airport-express, bus, taxi, and private vehicle showed that the mode utility increases with passenger's satisfaction level (Tam, Lam, & Lo, 2010). It was further found that travel cost is the most important factor for departing travelers.

In recent research, Birolini, Malighetti, & Redondi et al. (2019) investigated the impact of the introduction of new direct rail service on the mode choice of travelers to Milan-Bergamo airport. The mixed logit model estimations revealed that although travel cost is a very significant factor, passengers place considerable value on access time savings and are willing to pay more for mode alternatives that have less travel time. Hence, airport access policymakers should consider time-cost trade-offs and not simply provide a transport alternative with the lowest possible cost (Birolini et al., 2019). Further, the analysis showed that business passengers are willing to pay more for a shorter travel time than other travel purposes. What is more, contrary to previous research, Birolini et al. (2019) also included "out of vehicle travel time" as an alternative attribute for the waiting time and first/last mile travel duration and the model estimation showed negative and significant parameters for this attribute (Birolini et al., 2019).

Table 2.2 summarizes the literature on the airport access mode choice behavior. It can be concluded that the existing research is limited to mostly traditional alternative modes to access airports. Sustainable mobility concepts such as car-sharing services, MaaS, and ride-hailing are not yet investigated. Furthermore, no research has been found to comprehend air passenger mode choice in a Dutch context. As a result, this research aims to provide insight into this area. The next section elaborates on the focused airport of this study in the Eindhoven region.

Author	Airport/area	Investigated alternatives	Determinants	Models
Harvey (1986)	San Francisco International (SFO), Oakland International (OAK), San Jose Municipal (SJC)	Private vehicle, drop-off, taxi, train	Travel time, cost, distance to the airport, trip purpose, income	MNL
Chebli & Mahmassani (2002)	Dallas-Fort Worth International (DFW), Austin Bergstrom International Airport (ABIA), George Bush International Airport (IAH)	Train, transit, off-airport terminal	Gender, age, income, number of annual flights, education	Ordered probit model
Hess & Polak (2006)	SFO, OAK, SJC	Private vehicle, Taxi, public transport, limousine	Travel time, flight frequency, airline, aircraft size	MNL, NL
Tam, Lam, & Lo (2010)	Hong Kong International Airport (HKIA)	Private vehicle, bus, taxi, airport-express	Satisfaction, travel cost, travel time, walking time, waiting time, purpose, gender, education	Structural equation modeling, multiple indicator multiple cause models
Jou, Hensher, & Hsu (2011)	Taoyuan International Airport (TIA)	Private vehicle, drop-off, taxi, bus, train, high-speed transit	Time-saving, no-transfers, luggage storage, parking fee, travel cost, convenient, gender, income	Mixed logit model
Chang (2013)	Taiwan Airports	Privat vehicle, bus, MRT, taxi, drop-off	Safety, luggage storing, user friendly	Logistic regression model
Budd, Ryley, & Ison (2014)	Manchester Airport	Private vehicle, drop-off, taxi, public transport	Attitudinal profile	Likert scale analysis, cluster analysis
Birolini, Malighetti, & Redondi et al. (2019)	Milano-Bergamo Airport	Private vehicle, bus, drop-off, taxi, train	Time-cost trade-off, travel purpose, outside vehicle travel time	Mixed logit model
Wadud 2020	New York City Airports	Ride-hailing	Travel cost	Econometric models

Tab.2. 2 Airport access mode literature review

2.3.1. Eindhoven Airport

Eindhoven Airport is a compact airport located 7 kilometers west of the city of Eindhoven in the province of North Brabant, The Netherlands. It is the fastest-growing airport in The Netherlands after Schiphol Airport in Amsterdam (Brabant.nl, 2019). Serving 89 destinations, Eindhoven Airport is an important hub for air connectivity of The Netherlands. It reached 6.7 million passengers by the end of 2019 compared to 6.2 million in 2018 (Eindhoven Airport, 2019a). Eindhoven Airport contributes to the economy of 'Brainport Eindhoven'by providing an accessible environment for companies and employees, connecting Eindhoven directly with over 20 capitals and economic regions within Europe (Figure 2.18).

Fig.2. 14 Eindhoven Airport flight destinations, adapted from Eindhoven Airport (2019)

In April 2019, Eindhoven Airport started a trial ('Proefcasus') together with the province of North Brabant, the municipality of Eindhoven, surrounding municipalities, in collaboration with the Dutch Ministry of Infrastructure and Water Management, aimed at developing a smart, sustainable airport in the period 2020-2030. The starting point of the trial is noise pollution. In the short term, Eindhoven Airport will curb its growth, freezing the number of flights at 41,500. Moreover, from winter season 2020, there will be no more flights taking off and landing after 23:00 to prevent late-night noise nuisance (Eindhoven Airport, 2019a).

The airport has a direct impact on the surrounding living environment through CO2 emissions and air pollution. At the annual European conference of the Airport Council International (ACI) in Cyprus in June 2019 (Figure 2.19), Eindhoven Airport joined the Net-Zero 2050 agreement. Under this agreement, a total of 194 airports from 24 European countries have committed themselves to reduce their CO2 emissions to zero by 2050 latest (Eindhoven Airport, 2019b).

Fig.2. 15 Net-Zero2050 agreement, Eindhoven Airport (2019)

Eindhoven Airport is already taking action towards an emission-free airport. It has, for instance, replaced the operational cars the airport owns by electric vehicles, it has substituted diesel emergency power generators with battery powers, and has installed solar panels (Figure 2.20). Since 2013, Eindhoven airport has reduced it CO2 emissions with more than 2160 tons. Its goal is to emit 40% less CO2 per passenger in 2020 compared to 2013. For this, Eindhoven Airport has adopted a 'smart and sustainable' action plan to achieve the goals in the framework of national Climate Agreement ('Klimaatakkoord'), which has the following main themes:

- Optimizing flight routes and procedures,
- Stimulating cleaner aircraft,
- Use of sustainable transport to and from the airport,
- Fleet renewal,
- Use sustainable fuel,
- Emissions free terminals,
- Fast and efficient transport to and from the airport(Eindhoven Airport, 2019a).

Fig.2. 16 Innovative solar panel placement in Eindhoven Airport, adopted by Eindhoven Airport (2020)

Two of the mentioned themes of the airport's action plan to reach the Net-Zero 2050 goal fall within the topic of this study. Improving public transport and implementing new sustainable mobility alternatives can contribute to making the transport to and from Eindhoven Airport more sustainable and efficient. Next section elaborates on current accessibility of the airport and available transport modes.

2.3.2. Airport Accessibility

As mentioned, Eindhoven Airport is located 7 kilometers west of the center of the city of Eindhoven. Currently, two bus lines run from Eindhoven Central to Eindhoven Airport. Bus line 400 is the Airport Shuttle and serves as the fastest way to reach the Airport by public transport. It leaves every 10 minutes from Eindhoven Central Station and only stops once at the Woensel XL bus station (a bus station in north of Eindhoven). Travel time between the Eindhoven Airport and Eindhoven Central Station is approximately 21 minutes and 2 minutes of walk to the airport. Bus Line 401 (HOV1) is the regular bus connection between Eindhoven Central Station and Eindhoven Airport which runs at 10-minute intervals. Hence, each hour 12 buses leave from Eindhoven Central Station to Eindhoven Airport. The routes of the two bus lines have been indicated the map in Figure 2.21.

Fig.2. 17 Current bus lines to and from Eindhoven Airport, adapted from Donners et al. (2018)

There are of course other ways to reach Eindhoven Airport. In addition to Uber and other taxi services, the airport has its own taxi service, based on an agreement with a taxi company. However, the most frequent and the base mode of access to Eindhoven Airport is a private vehicle. Based on the data collected from 600,000 OV Chip cardholder (OV is the public transport card in the Netherlands) in 2016 and 740,000 card holders in 2017, it can be concluded that private vehicle has a modal share of around 85% in morning peaks and around 80% for the total day (Figure 2.22) (Donners & Van Genugten, 2018).

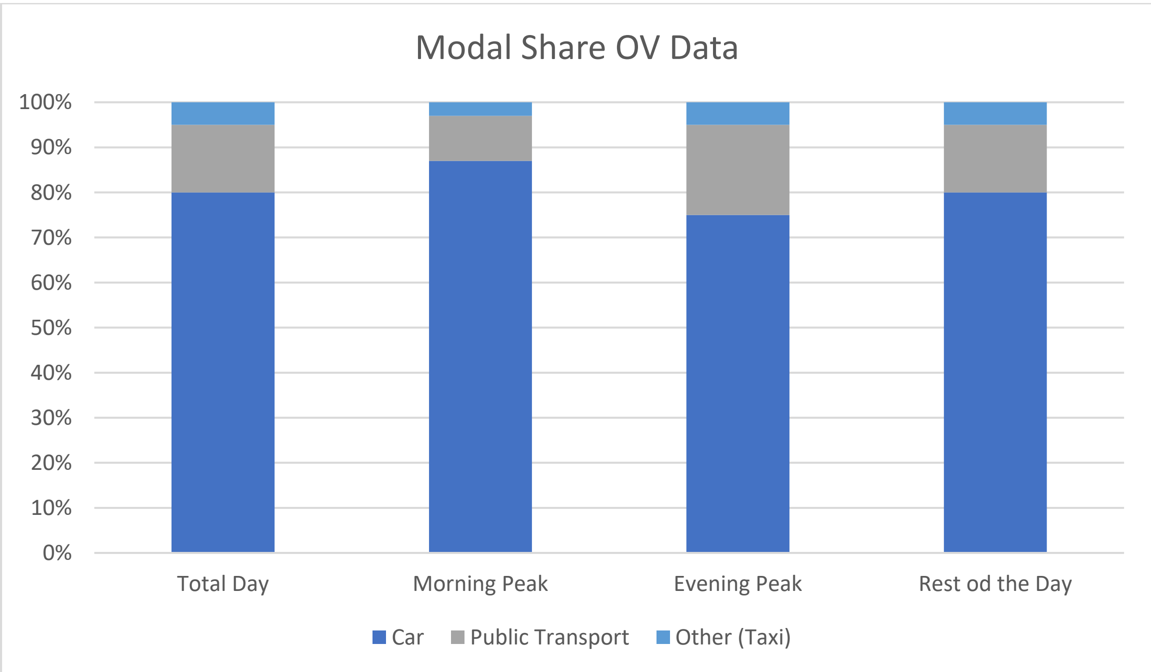


Fig.2. 18 Transport modes modal share of travelers to Eindhoven Airport, segmented by the time, adapted by Donner et al. (2018)

Furthermore, the high modal share of private vehicle demands extensive parking facilities, which Eindhoven Airport constantly tries to improve and provide new spaces in the airport area. The official parking facilities can be booked online through the airport website and can be used for both short term and long-term use. They are all within walking distance to the airport and their facilities. P1 parking is the most recent rebuilt multifunctional building finished in October 2019 (Eindhoven Airport, 2019a). The P1 parking provides a 780 parking spaces and a Kiss & Ride zone, charging points for electric cars, 110 bicycle sheds (Figure 2.23). What is more, the building also includes a public transport terminal for busses, where the shuttle bus stops and has other facilities such as restaurants. Table 2.3 shows an overview of the official parking facilities of Eindhoven Airport.

Parking Name	Accessibility	Cost per Week	Capacity	Transfer time (minutes)
Gold Parking (P1)	Walking distance	170 Euro	780	2
Silver Parking (P3)	Walking distance	96 Euro	700	5
Bronze Parking (P4)	Walking distance	76 Euro	1745	7
Budget Parking (P5)	Walking distance	68 Euro	1394	7

Tab.2. 3 Overview of official parking facilities in Eindhoven Airport

Table 2.4 shows the share of different transport modes to Eindhoven Airport and trip legs (number of trips) generated by each transport mode. It can be seen that the kiss & ride option is the only transport mode that needs a two-leg trip with a share of 34% (Donners & Van Genugten, 2018).

Transport mode to Eindhoven Airport	Share of use	Number of trip legs
Car: kiss & ride	34%	2.0
Car: parked in an official parking	23%	1.0
Car: Parked in unofficial parking	10%	1.0
Public transport: train + bus	23%	1.0
Public transport: bus	5%	0.0
Public transport: train + taxi	1%	1.5
Public transport: car rental	1%	1.0
Other	3%	0.0

Tab.2. 4 Modal share transport mode

Accessibility is an important factor in passengers'' choice for the airport (Eindhoven Airport, 2019a). Therefore, Eindhoven Airport aims to improve its accessibility and promote multi-modality of commuting to and from the airport. Moreover, Eindhoven Airport needs to invest in new sustainable mobility options to reach the environmental goals of Net-Zero 2050.

Fig.2. 19 P1 parking building in Eindhoven Airport, adapted by Eindhoven Airport (2019)

2.3.2.1 Accessibility improvement

A public transport feasibility study by B. Donners et al.2018 has studied different transport modes (bus, light rail, slow ("sprinter") train station, and fast ("intercity") train station) to improve the accessibility of Eindhoven Airport. The results show that in the short term (2020-2030), realizing a new bus line (HOV3) connecting Eindhoven Central Station and Eindhoven Airport can accommodate the increase in demand for transportation and improve the accessibility of Eindhoven Airport (Donners & Bos, 2018). However, the added value of the new bus line is highly dependent on the route and the travel duration. Figure 2.24 shows the suggested route for the bus line HOV3 and the existing airport shuttle and bus line 401 (HOV1).

Fig.2. 20 Suggested route for the new HOV3 bus line, adapted from Donner et al. (2018)

Other options include constructing a light rail line between Eindhoven Central Station and Eindhoven Airport and building a new train station in Acht, close to the airport. However, the results of the study indicate that the speed and capacity of the light rail do not score significantly higher than the HOV bus line and Airport shuttle. On the other hand, the construction of a station for light rail or train require large investments and are only financially viable in case of a high frequency of passengers. Given the current growth scenarios and limitation of flights to and from Eindhoven Airport, light rail does not yield added value and is only beneficial in the long run (2040) (Donners & Bos, 2018). Another study concluded that at a maximum growth of flights (to 100,000 yearly), with the public transport modal share remaining at its current 15%, the capacity of public transport would be exceeded. There would also be the need for parking spaces, on top of the existing extension plans (Donners & Van Genugten, 2018).

It can be concluded that the accessibility of Eindhoven Airport depends highly on the use of private vehicles. Public transport options between Eindhoven city and Eindhoven Airport are limited to bus and taxi. Multimodal public transport using sustainable modes such as car-sharing services and demand-responsive transport may offer solutions that can help to reduce the modal share of private vehicles and complement the current bus network. The next section elaborates on the status of these concepts in Eindhoven.

2.3.3. Insight into local MaaS and sustainable mobility agendas of Eindhoven

"By shared mobility, we mean all the mobility options that are accessible to everyone and that you can use together. This can be the bus, train, but also a car-sharing and bike-sharing. Riding with someone or traveling with a demand responsive mode (Flex) is also a part of share mobility" (Provincie Noord Brabant, 2018).

The Dutch province of Noord-Brabant uses the above definition of shared mobility. This includes public transport such as buses (HOV) and trains, which are essential for implementing MaaS. Demand responsive modes (Flex) such as Bravo Flex and car-sharing and bike-sharing services also contribute to the shared mobility concept (Provincie Noord Brabant, 2018).

The municipality of Eindhoven has embraced this definition as it tries to use shared mobility to keep the city livable, accessible and yet reach the sustainability goals to reduce CO2 emissions by 55% in 2030 and 95% in 2050 (Gemeente Eindhoven, 2019; Ministerie van Economische Zaken en Klimaat, 2019).

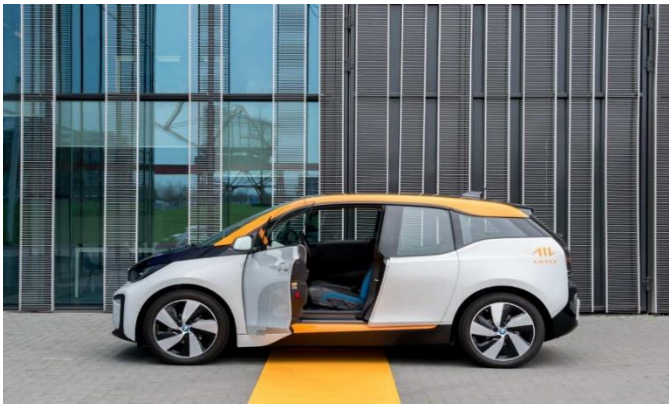


Fig.2. 21 Car-sharing service in Eindhoven, adapted from Gemeente Eindhoven (2019)

In 2019 the municipality of Eindhoven laid the foundation for the development of sustainable mobility concepts in Eindhoven. Local tech company ASML and the municipality are currently working on a MaaS pilot, which will be realized in 2022 (Gemeente Eindhoven, 2019). To make the pilot successful and attractive for locals and visitors of Eindhoven, the municipality is working on expanding the shared mobility network within the ring, at hubs (park and ride) and in interchanges such as train stations and bus stops (Gemeente Eindhoven, 2019). For this reason, it is of utmost importance for the municipality and sustainable mobility providers to have insight into locations where supply may be placed, under what conditions, and in what number.

2.3.4. Conclusion

Eindhoven Airport is key to the development of the Brain Port Region Eindhoven, as well as the air connectivity of The Netherlands as a whole. Eindhoven Airport has recently joined the Net-Zero 2050 agreement to be C02 neutral by the year 2050. Developing fast and efficient sustainable transport from and to the airport is one of the themes in which the airport is going to invest. Currently, there is a a high dependency on private vehicle use. Adding a new HOV3 bus line will contribute to the sustainable transport but will not reduce the private vehicle share. The use of new sustainable mobility concepts such as MaaS and car-sharing and demand-responsive services may be able to contribute to Eindhoven Airport's goals.

Moreover, the municipality of Eindhoven is also working on improved car and bike-sharing services in the city of Eindhoven and plans to start a MaaS trial in 2022. The implementation of these plans and the use of transport sharing services may also contribute to a reduction of the use of private vehicle for travel to and from the airport.

2.4. CONCLUSION

This literature review mapped decision-making theories, and more specifically travel decision theories in Section 2.1. Travel behavior can be a building block of travel demand and transport planning. Understanding travel behavior is crucial to enable a shift to modern mobility paradigms. Three main categories of psychological, economical and geographical travel decision theories were introduced. These theories identified the parameters that influence travel decision making, with habits, attitudes, socio-demographics, utility, and quality as main factors for infrequent travel decision making. However, the precise effect and effectiveness of these parameters on incidental travel decision making is not yet clear.

Section 2.2 discussed the idea of sustainability in the mobility sector and new sustainable mobility concepts. As discussed in the section, new mobility concepts such as car-sharing and demand-responsive transport can reduce private vehicle dependency and help to reach climate goals. Additionally, MaaS has introduced a new ICT based technology with the ability to integrate new mobility concepts and existing public transport modes, using a single platform that provides subscribed mobility packages. The option of pay-as-you-go was also introduced in MaaS for visitors or users who are not yet willing to subscribe. Finally, the idea of incentives was introduced as a tool to promote sustainable mobility concepts. Although proven effective in behavior adaptation, their effectiveness requires a case-by-case assessment.

Section 2.3 look in detail at the airport access mode choice behavior. Aviation industry is growing nationally and internationally. Consequently, accessibility and transportation to airports are gaining momentum as competitive factors among airports. Hence, previous research is reviewed to find the determinant factors influencing traveler's choice regarding transport modes. Travel time and travel cost are shown to be the most mentioned factors in the literature following by socio-demographics, travel contexts and attitudinal parameters. However, the existing literature to date are focused on conventional transport modes (private vehicle, taxi, bus, train) and the preference of travelers towards new sustainable mobility modes in airport travel is neglected and missing in this research area. Furthermore, no to very little research in airport access mode choice in a Dutch context has motivated the research area of this study to be focused on Eindhoven Airport, which has recently joined the Net-Zero 2050 agreement that obliges the airport to bring down CO2 emissions to zero by 2050. Therefore, the airport aims to invest in sustainable transport to and from Eindhoven Airport, which is both fast and efficient. As discussed in this section, the current modal share of travel to Eindhoven Airport consists of more than 80% private vehicles. As a result, it is vital to move towards solutions such as MaaS and car-sharing services that can reduce car dependency and provide convenient transport to the airport. What is more, the municipality of Eindhoven is currently planning to expand the network of car-sharing services within the ring and a MaaS pilot will link mobility services in 2022. Eindhoven Airport can benefit from this initiative to reach its own mobility and environmental goals. However, no quantitative research has been done on the preference regarding sustainable transport modes to travel to airports. Consequently, it is vital to find out what are the decisive determinants influencing the sustainable mode choice of commuters to Eindhoven Airport?

In order to answer these questions, it is important to gain an understanding of the preferences regarding sustainable mobility modes for commuting to Eindhoven Airport in combination with incentives as stimulating policy. This will be done through a Stated Choice (SC) experiment, explained in more detail in the Chapter 3 on methodology.

3 METHODOLOGY

As follows from the literature review, insights in the implementation of sustainable mobility modes in relation to the reduction of private vehicle use for travel to Eindhoven airport are vital to define the strategy that will allow for a reduction in the use of private vehicles and contribute to Eindhoven Airport's goal of eliminating CO2 emissions by 2050. Incentives can play a role as a stimulus to initiate the behavior adaptation towards new sustainable modes such as car-sharing and demand responsive transport. This research will provide knowledge on the choices of travelers to Eindhoven Airport as regards sustainable transport modes

The scientific method that will be applied in this study is the Stated Choice (SC) experiment and discrete choice models. This method has been used across disciplines, from marketing to environmental economics, and has become popular in the transportation community as well (choiceMetrics, 2018). In SC experiments, sets of imaginary alternatives with different attributes and levels are presented to respondents, who have to choose the alternative they think suits them best. The goal of this process is to find the isolated effect of each attribute and alternative on the choice behavior of the respondents.

This study researches the travel behavior of people from and to Eindhoven Airport, to find out what factors trigger people to use more sustainable modes of transport. Bonuses such as "fast track line" and "coffee discount" are introduced to encourage people to use sustainable modalities for their trip, as well as other sustainable forms of transport, such as car-sharing and bus hailing. The process of including this method is detailed in section 3.1. and 3.2. Section 3.3 provides an introduction into the choice modeling method, which is used to model and predict the behavior of individuals. Finally, section 3.4 concludes the chapter.

3.1. INTRODUCTION TO STATED CHOICE EXPERIMENT

This study focuses on the travel behavior of passengers of Eindhoven Airport. As elaborated in the previous chapter, numerous factors can influence travel behavior, such as economic, attitudinal and socio-demographic attributes.

Individuals can only make a choice when they are confronted with more than one alternative. This set of different alternatives is often referred to as a *choice set.* These alternatives can have names which are called as *labeled* and otherwise as *unlabeled.* If the research has alternatives with alternative-specific parameters, then alternatives need to be *labeled* (e.g., car, taxi, bus). If alternatives have generic parameters, they are considered *unlabeled* (intersection A, intersection B). This research has alternatives that are *labeled* (choiceMetrics, 2018). Each alternative can have different attributes that vary among alternatives and, each attribute is assigned to a parameter. Respondents can compare and trade among alternatives and their attributes and levels to make a choice. Modeling the choice behavior of respondents can shed light on factors that influence their behavior which can be beneficial for policymakers or developing new strategies in the future (Hensher et al., 2015).

According to Kemperman (2000), there are two main methods to measure the choice data: Revealed and Stated. Figure 3.1 demonstrates an overview of these two main methods. The difference between the aforementioned methods lies within the type of data used in the experiment. The revealed approach is based on observations of the actual behavior of respondents. Hence, the model parameters and utility function are determined based on this data. On the other hand, stated choice models are based on responses in hypothetical controlled situations and are divided into two categories of preference and choice (Kemperman, 2000). Consequently, stated preference has also two subdivisions of compositional and decomposition. Compositional preference is used when respondents have to evaluate the attractiveness of the levels of the attributes within an alternative. For the decompositional preference approach, respondents have to rate alternatives. In contrast, the decompositional choice approach asks respondents to choose among two or more alternatives and this is repeated for a number of times. Respondents have to do trade-offs among alternatives and their attribute and hence, it is very close to the real-life choice situation. (Kemperman, 2000). The latter method is used in this study and is further discussed in the following section.

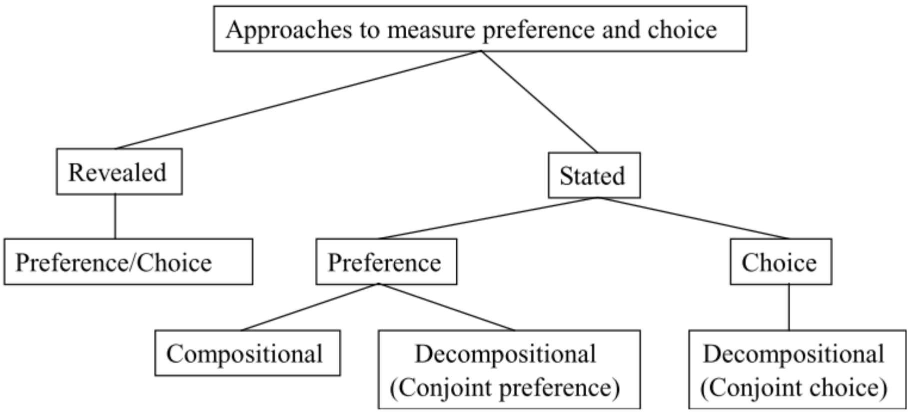


Fig.3. 1 Approaches to measuring preference and choice; adapted from Kemperman (2000)

3.2. STATED CHOICE EXPERIMENT DESIGN

The core of the Stated choice experiment is called the *experiment design.* A process that determines the variables and the levels of the variables (Hensher et al., 2015). The manipulation occurs with changes through attributes and their levels and follows the statistical rule of the utility function which is discussed in section 3.3.

For the design of the experiment, this study will use the procedure developed by by Hensher et al. (2015). The process starts with the analyst's understanding of the problem that needs to be solved. When the problem is understood, the next step is to determine available alternatives, attributes, and levels to use in the SC experiment. The third stage addresses the decisions regarding the statistical properties of the final design. Consequently, the fourth stage executes the experimental design by standard statistical packages. It has to be mentioned that, these 4 stages have iterations which means that analysts might go back to one of the previous stages and refine the experiment further. In stage 5 the analyst allocates attributes to columns to produce the response stimuli. The next step is to generate the choice sets to be used in the survey, followed by randomizing it to avoid errors such as correlation among alternatives or attributes. The last step, stage 7, is to construct the survey which is often executed in standard survey systems. Sections 3.2.1 – 3.2.4 will elaborate on these stages.

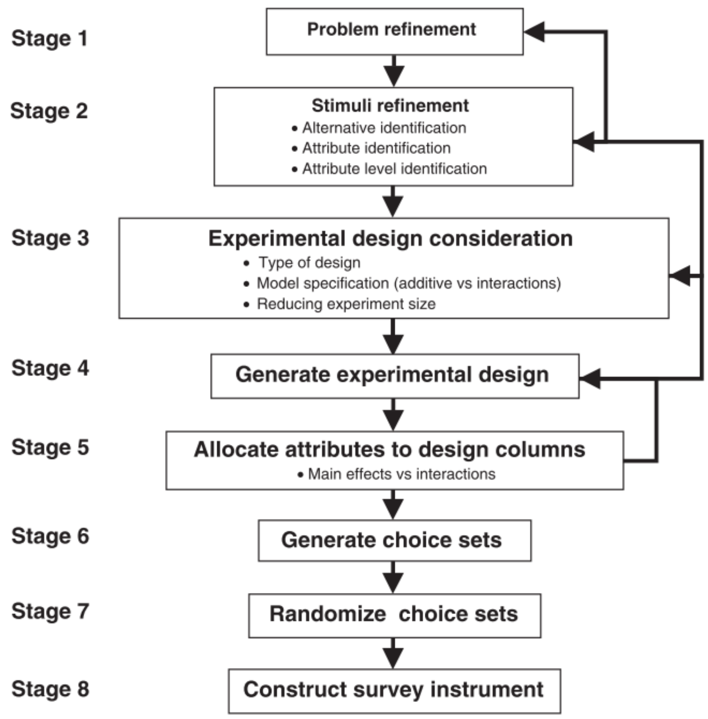


Fig.3. 2 Experimental design process of stated choice experiments adapted from Hensher et al. (2015)

3.2.1. Stage 1: Problem Refinement

As discussed in chapter 2, in order to reach the climate goals of Eindhoven Airport and to improve its accessibility, there is a need for a shift in the travel behavior of airport users towards more sustainable modes of transport and a reduced use of private vehicles. It is hypothesized that the use of (dis)incentives such as adding bonusses and increasing parking tariffs, combined with the creation of car sharing and bus hailing hubs, may trigger the desired behavorial change.. However, as these measures have not yet materialized, this study opts for a stated choice experiment. In this hypothetical experiment, respondents make a trip to Eindhoven Airport. The distance of this trip in combination with the purpose, number of items of luggage and accompany level, act as the context for a respondent. Traveling by car is assumed to be the base alternative. In the experiment, respondents are offered a number of alternatives, depending on the distance of their trip

3.2.2. Stage 2: Stimuli Refinement

The second stage of experiment design determines the identification of alternatives, attributes, and attribute levels. Attributes can either be *general*, the same within all the alternatives, or they can be *specific,* belonging to a certain set of alternatives. It is important to note that in selecting alternatives, attributes and levels are important since they affect the required number of respondents and hence the predictive power of the model (choiceMetrics, 2018). This stage is divided into two parts: the refining alternatives and selection of attributes and their levels.

3.2.2.1 Alternative Refinement

For identifying suitable alternatives, a two-stage process is used following Hensher et al. (2015). First, all existing and non-existing but potential transportation modes to Eindhoven Airport are defined, after which the ones applicable to this study are shortlisted. Currently, there are 7 transport options in use for commuting to Eindhoven Airport (Donners & Van Genugten, 2018):

- **Car**: get a ride from family members or friends.
- **Car**: driving to the airport and park in the official parking facilities of Eindhoven Airport.
- **Public Transport**: train+bus combination for passengers who come from other cities.
- **Car**: driving to the airport and park in unofficial parking around Eindhoven Airport.
- **Public Transport**: bus for shorter distances located mainly within the Eindhoven area.
- **Public Transport**: train+taxi for passengers who come from long distances by train and get a taxi from Eindhoven Central Station to the airport.
- **Car Rental**: using rental car services and driving to Eindhoven Airport.

The second type of alternatives is sustainable MaaS options that are non-existing at the moment (e.g Autonomous vehicle, e-taxi) or existing sustainable alternatives that are currently not being used as transport options to Eindhoven Airport (e-car sharing, bus hailing, e-bike sharing). An optimal combination of the aforementioned, non-existing modes may be realized via a MaaS application in the near future. However, considering that the multimodalities would result in a wide range of alternatives, is not possible to evaluate them all in one stated choice experiment. This option is therefore not considered in this study.

The scope of the study is limited to a set of sustainable and non-sustainable existing options accompanied by potential transport modes that exist in the Eindhoven area but that are not being used for transport to the airport.

The base alternative is defined as a direct trip to Eindhoven airport with the car. This alternative is used when people drive to the airport and park in one of the parking facilities of Eindhoven Airport. There are both official and unofficial parking facilities in close radius of Eindhoven airport. This study considers only the official parking facilities since they are a part of Eindhoven Airport and adjust their tariffs and policies according to decisions of Eindhoven

Airport. Unofficial parking, however, is an independent organization and does not follow Eindhoven airport goals and policies and hence is dismissed from this study.

Another popular means for transport to Eindhoven Airport is the kiss & ride option for passengers who are brought or picked at the airport by someone else with modal share of 34% (Table 2.4). Furthermore, conventional public transport counts for 30% of the trips to Eindhoven airport (Table 2.4). Hence, these two modes are included in alternative selection of this study Among new sustainable MaaS transports, shared-(e)bicycle services are removed from the alternative selection of this study. Although this service exists and operates in the Eindhoven area (e.g Gobikesharing), they are not yet implemented for longer distances and drop off near the airport area is not possible. What is more, the limitation of using bikes to carry luggage is another main reason that they are eliminated from this study. On the other hand, shared e-car is included as an alternative in this study, Table. 2.4 shows that the car is currently the most popular mode of transportation to Eindhoven airport with a modal share of almost 70%. Hence, it is assumed that in a future scenario where shared e-car hubs exist in all Eindhoven's neighborhoods and surrounding villages, people will use this service instead of using a private car.

Bus hailing (Flex bus) is another nonexistent public transport mode that is included in this study. Unlike traditional bus service, bus hailing is a demand-responsive transport service that only works where there is a demand. This can be especially an alternative for transport from Eindhoven and surroundings to the airport. The relatively cheap costs and ability to carry luggage make them interesting for people who live near in the Eindhoven area.

Autonomous vehicle (AV) is another futuristic transport mode in which passengers can benefit from cars that are completely self-driving and are electrical. However, the implementation of AVs in the near future is highly unlikely given that the technological knowledge and infrastructure requirement for AVs to be fully operational is not yet available. Additionally, adding AVs to the choice task, may create unnecessary confusion among respondents, as they may not be familiar with the concept and may have trouble in imagining this scenario. Respondents' perception toward AVs and its influence on people's travel behavior is an independent topic of research and as such removed from the scope of this study. This study limits itself to the reduction of car use as the main transport mode to commute to Eindhoven Airport with stimulation of public transport and using new sustainable transport modes to Eindhoven Airport

This results in six alternatives to be included in the choice task:

1. **Car:** drive car and park in official parking of the airport and walk from parking location to the airport's terminal or being brought to the airport by someone else (kiss & ride).
2. **Taxi:** use taxi services available by the airport or in the Eindhoven area and arrive in front of the airport's terminal.

3. **E-Car sharing:** walk to the nearest e car-sharing hub and drive to the airport. Drop off at designated mobility hubs and walk to the airport's terminal.
4. **Bus:** walk to the nearest bus station. Wait for the bus to arrive and use direct or undirect bus lanes and arrive at the airport's terminal.
5. **Bus Hailing:** request flex bus and walk to the nearest hub. Wait for the bus to arrive Take it to the airport's terminal. This alternative is shown when the distance is within 5km from Eindhoven Airport.
6. **Public Transport:** this alternative is only shown for longer distances to Eindhoven Airport. It is supposed that people use the bus, train or a combination of them to arrive at Eindhoven Airport. People have to wait for public transport to arrive and regarding their trip origin, they might have to transfer up to 2 times during their travel to arrive at the airport's terminal.

3.2.2.2 Attributes Identification

The attributes describing the alternatives in this study are divided into the 'context attributes' and the 'alternative attributes'.

Context attributes describe the initial scenario of the respondent's trip and are provided at the top of the choice task. Table 3.2 demonstrates context attributes and their levels. These attributes are based on literature review and expert meeting with Eindhoven Airport and Royal HaskoningDHV and consist of:

- **Travel purpose** is considered an influential factor in the literature on travel behavior and Mobility-as-a-service (MaaS). It is assumed that the purpose of a trip influences the mode of transport chosen by individuals. For example, the cost of arriving late at mandatory activities such as professional meetings and business trips is higher than for shopping trips, which influences the mode choice (Langbroek et al., 2018).
  Travel purpose is also associated with the frequency of using different modes of transport (Netherlands Institute for Transport Policy, 2018). According to Eindhoven Airport, passengers have three main purposes for using the airport: business trips, holidays and weekend breaks, visits to friends and family (*Jaarverslag*, 2018). The scope of choice task experiment in this study has been limited to the two purposes of "business" and "leisure". This decision is made in order to keep the scenario simple for respondents, to keep the number of levels among context variables coherent and to limit the size of experiment.
- **Distance** in combination with duration is one of the most mentioned attributes in transport studies. Travel behavior studies consider distance as one of the actual limitations attributes in the decision making process. Hence, individuals have to limit their decision options regarding their travel distance and then make a choice (Rojas López & Wong, 2018). For this study, two distances (5 and 30 km) were chosen as the choice tasks of this study. Having a short and long distance in a choice task allows the study to examine the differences in preferences among unimodal and multimodal

public transport options. As such, one can observe the trade-off respondents make between shorter and longer distances (Arentze & Molin, 2013). According to Verboekt et al. (2018), 38% of passengers of Eindhoven Airport come from the province of Noord Brabant where the city of Eindhoven is located. Hence, a 5 km distance is chosen to incorporate the Eindhoven area and its surroundings, whereas 30km is used to cover the whole province of Noord Brabant. In case of longer distances, like 100 km, other attributes such as airport choice (Schiphol airport or Brussels Airport) become an important factor in decision making. As a result, longer distances are excluded from the choice task.

- **Travel company** influences the frequency of trips and the travel mode of individuals. In addition, traveling alone or with others can change the perception of comfort, which is proven to influence the level of satisfaction towards public transport and hence affects the decision-making process (Allen Singleton & Allen, 2013; Fellesson & Friman, 2012). When traveling together, people opt for using a car to share costs and because people value the time spent together in the car, especially during recreative travels (Strategy Development Partners, 2019). Finally, to make the choice tasks comprehensible for respondents, the two levels of "traveling alone" and "with another person" were chosen for this attribute.
- **Luggage** is usually an inseparable part of trips to airports. Carrying luggage needs a physical effort and works as a barrier to traveling (Allen Singleton & Allen, 2013). According to Rojas López et al. (2018), barriers are one of the main determinants in the process of mobility decisions. Therefore, the number of pieces of luggage and their weight can affect the travel mode individuals choose for their travel to Eindhoven Airport. In this study, it is assumed that all individuals have either one or two pieces of luggage when traveling to Eindhoven airport. This decision is made for 2 reasons: 1) to keep the levels of this attribute coherent with other context variables, and 2) because most flights from the Eindhoven Airport are domestic European flights (*Jaarverslag*, 2018), which means traveling with more than 2 luggage is considered rare. Table 3.1 demonstrates the selected context variables and the associated levels for each attribute.

Attributes	**Purpose**	**Travel accompany**	**Luggage**	**Distance**
Levels	Business	Alone	One	5 km
	Leisure	With another	Two	30 km

Tab.3. 1 Context attributes and assigned levels

Alternative attributes are specified the selection of context attributes. The factors selected for this study are travel time, travel cost, incentives, and the number of transfers for public transport.

Travel time seems to have a dominant effect on the choice among car and public transport modes such as trains (Limtanakool, Dijst, & Schwanen, 2006). Travel time is also believed to influence the commuting satisfaction of individuals and hence alter their mode choices (Ahtela & Viitamo, 2018). Furthermore, the travel time to Eindhoven Airport is assumed to consist of two parts:

- **In-vehicle time** is the time spent in the vehicle while commuting and seems to have an influence on the perception of travel satisfaction and is also included in this experiment (Ahtela & Viitamo, 2018).
- **Out-of-vehicle time** is divided into the first mile and last mile time. In the case of using public transport, the first mile refers to walking time to the mobility hub and waiting for the transport mode's arrival. Last-mile travel time refers to the walking time to Eindhoven Airport terminal upon arrival. In order to avoid confusion in the stated choice experiment, walking time to the mobility hub is removed from the first mile travel time in this study and only walking time to the airport's terminal upon arrival is included. The latter decision is made to make the choice task simple for respondents. What is more, examining the last mile walking time to the terminal can inform policy making by Eindhoven Airport itself. Waiting time seems to have a vital role in the perception of satisfaction with public transport and is included in the experiment (Fellesson & Friman, 2012).

Other attributes, apart from travel time, are the travel cost, bonus and the number of transfers. Parking cost is mentioned in numerous studies as a factor influencing mode choice behavior (Arentze & Molin, 2013; Asgari & Jin, 2019; Habibian & Kermanshah, 2013). This factor can be used as a policy implementation from Eindhoven Airport to push passengers to switch from using a car to public transport options. Hence, the factor of parking cost is included for 'car' alternative to investigate the impacts of different parking tariffs on respondent's behavior. Except for parking cost, travel cost for each alternative is also included in the choice task and is believed to influence choices.

Contrary to cost, incentive is also considered effective in influencing choice behavior. According to social cognitive theory, incentives can trigger behavior and act as "carrots" for the desired actions and "sticks" for unwanted actions (Allen Singleton & Allen, 2013). Other studies in travel behavior suggest that incentives can result in behavior change and increase the use of public transport (Murtagh, Gatersleben, & Uzzell, 2012). It has been found that the effects of incentives on behavior change can last even after the incentives have been withdrawn (Fujii & Kitamura, 2003). As such, incentives seem to be an effective strategy for promoting MaaS and sustainable transports (Hensher, 2017). However, all the aforementioned research has concentrated on the effect of incentives on frequent travels and the possible influence of incentives on infrequent travels, amongst which travel to the airport, is not clear. Therefore, this factor is included in this study to shed light on its possible effects on passengers' travel behavior.

The last alternative attribute relates to the number of transfers needed during the trip to Eindhoven Airport and applies to public transport alternatives such as bus and bus + train options. This factor has a proven negative impact on the mode choice of individuals, with some studies going even further, concluding that the number of transfers is more important than factors such as travel cost and travel time (Frei et al., 2017). Therefore, this attribute is also included in the generation of choice tasks for this study.

It has to be mentioned that not all the attributes apply to the full set of alternatives. Table 3.2 demonstrates the allocation of attributes to alternatives (for both the 5 and 30 km experiment).

Attributes	Car	Taxi	E-Carsharing	Bus	Bus hailing	Public transport (multimodal)
Travel Time	x	x	x	x	x	x
Travel Cost	x	x	x	x	x	x
Parking Cost	x					
Waiting Time				x	x	x
Walking Time Last Mile	x		x			
Incentives			x	x	x	x
Transfers				x	x	x

Tab.3. 2 Attribute allocation to alternatives

3.2.2.3 Attribute levels

In this study, the choice task is divided into two separate stated choice experiments based on travel distance to Eindhoven Airport. Alternative specific attributes in these two experiments are the same, however the alternatives and attribute levels differ. Given the attributes discussed in the last section, this section determines the levels of selected attributes are determined based on the two distances that are used in context attributes (5 and 30 kilometers). These attribute levels are discussed in the two following sections.

3.2.2.4 5-kilometers Experiment

This section elaborates on the attribute levels regarding the 5-km experiment. Values for the levels are calculated or extracted to be close to the values of a trip to Eindhoven Airport within 5 kilometers radius. Consequently, a similar approach is used to determine the 30 kilometers experiment.

Travel Time

The first attribute level concerns the in-vehicle commuting time. The levels for alternatives 'car', 'taxi' and 'e-carsharing' are considered generic and are 10, 15 and 20 minutes. These values are based on measurements on Google Maps for the radius of a 5-kilometer distance from the airport (Google, 2019)**.** The duration for alternative 'bus' is also derived from Google Maps and is 25, 30 and 35 minutes (Google, 2019). Lastly, travel time levels for alternative 'bus hailing' are extracted from the OV Flex application and are 10, 15 and 20 minutes (Bravo Flex, 2019).

Travel Cost:

The levels for the travel cost to Eindhoven Airport are specific for each alternative and are explained below:

- **Car**: the cost for this alternative has been limited to fuel costs. This decision is made to make the measurement straight forward. Hence, maintenance, depreciation, insurance and tax costs are deliberately excluded. To calculate the cost, the 10 most sold car models in The Netherlands are extracted and represented in Appendix A (Statistica, 2019). Thereafter, the average fuel consumption per 100-kilometers of the 10 models in a highway and a city environment are used as a reference fuel economy for this study (Table 3.3).

Models	Consumption Combined (Highway and City)
Volkswagen polo	4.5liter/100km
Renault clio	5.6 liter/100km
Kia Picanto	6.8 liter/100km
Ford Fiesta	5.2 liter/100km
Opel Karl	6.1liter/100km
Volkswagen UP!	4.5liter/100km
Volkswagen Golf	8.5liter/100km
Peugeot 108	4.9liter/100km
Renault Captur	5.8liter/100km
Toyota Aygo	4.1liter/100km
Total Average Consumption	5.6liter/100km

Tab.3. 3 Average fuel consumption, most sold car models 2018, adopted from Statistica (2019)

Finally, the fuel price for a 5-kilometer distance is calculated:

$$Fuel\ Price\ 5km = \left(\frac{Average\ feul\ consumption\ in\ liter}{100\ km}\right) \times 1.5 \times 5 = 0.42\ Euros$$

Three-level of 0.25, 0.5 and 1 euro are selected as levels for car travel cost to include both lower and higher ranges of the calculated average price.

- **Taxi:** has a start rate of 7.50 euro, which includes the first two kilometers for a maximum of four persons. The fare consists of the start rate plus the distance and duration of the trip. The rate may vary from 0 euro to 2.20 euro per additional kilometer (Holland.com, 2019). Hence, three levels of 7.5, 10 and 12 euro are selected to consider a lower and higher range.

- **E-Carsharing:** travel cost levels for this alternative are adopted from the existing car-sharing service in Eindhoven, Amber. Hence, the price of 0.25 euro per minute is selected to measure the travel cost (Amber, 2019). Therefore, three levels of 2,3 and 5 euro are selected.
- **Bus:** It is assumed that passengers own an OV chip card. The levels for this attribute are 2, 3 and 4 Euros and are based on tariffs of Bravo (OV9292, 2019).
- **Bus hailing:** Levels for this attribute are considered based on measurements of the price for 5-kilometers trips with BravoFlex and are 2.5, 5 and 7.5 euro.

Parking Cost:

The third attribute represents the costs for parking at official parking's of Eindhoven Airport and applies to the 'car' alternative. Relative location of the parking facilities to the A2 highway and the airport's terminal are shown in Figure 3.3. Tariffs of these parking locations are based on their facilities and relative distances to the airport terminal. The levels are considered based on the official prices of Gold parking (P1), Silver Parking (P3), Bronze Parking (P4 & P5) and Kiss & Ride lane (Eindhoven Airport, 2019). Hence, the levels are 0, 20 and 30 euro per day.

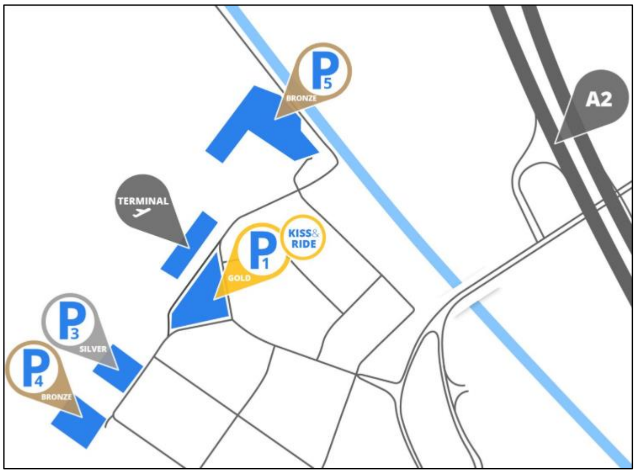


Fig.3. 3 Relative location of parking facilities

Waiting Time:

The fourth attribute is the waiting time for the transport mode's arrival, which applies to 'bus' and 'bus hailing' in the 5-kilometers experiment. For the alternative 'bus', these times are extracted based on the current and future frequencies of bus lines that stop at Eindhoven Airport. At the moment, the HOV1 (line 401) and Shuttle go to the airport from central station 6 times per hour which makes a total of 12 busses per hour to Eindhoven Airport (OV9292, 2019). This makes two levels of 5 and 10 minutes to the attribute. However, another level is added for the frequency of 3.5 minutes, with reference to the future plan of the municipality of Eindhoven to realize HOV3 to the airport (Fig.3.4). The frequency of this line would be 4 times per hour based on the first flight growth scenarios of Eindhoven Airport (Verboket et al., 2018).

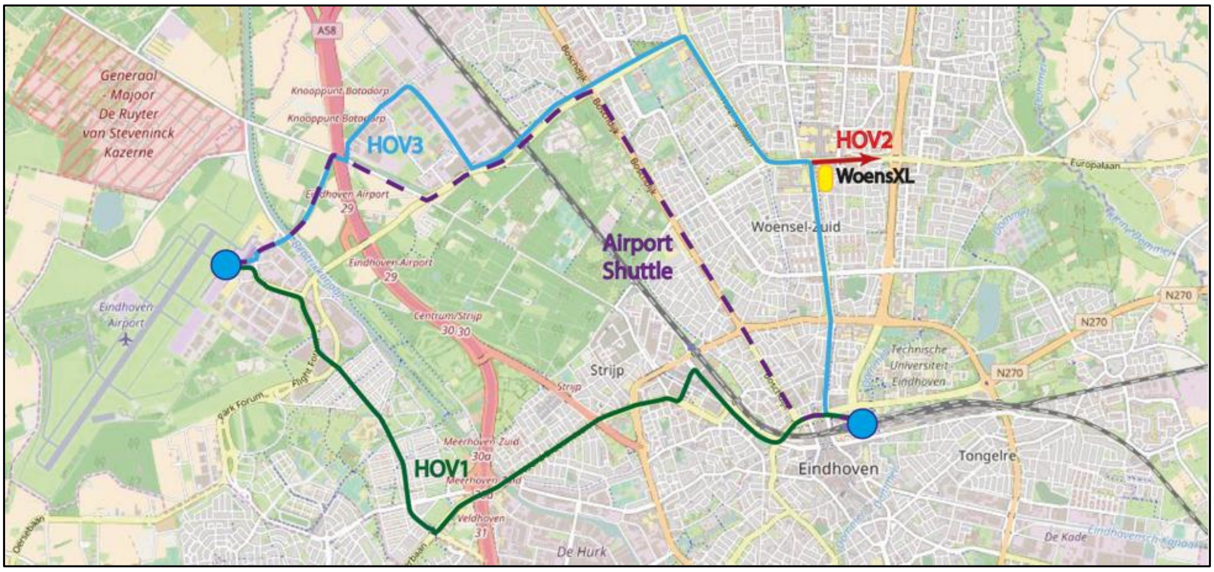


Fig.3. 4 Current and future bus lanes to Eindhoven Airport, adopted from Verboeket et al. (2018)

Waiting times for alternative 'bus hailing' are estimated on the basis of arrival times in the OV Flex application: 10, 15 and 20 minutes.

Walking Time Last mile:

The fifth attribute is the walking time to the terminal upon arriving at Eindhoven Airport. It is assumed that 'bus' and 'bus' hailing can use the public transport hub in front of the terminal and hence walking time for these alternatives is considered to be zero. Similarly, walking time for the alternative 'taxi' is assumed zero as well. For the alternatives 'car' and 'e-carsharing', the walking time to the terminal is based on the distance of the official parking facilities to the terminal. Hence, three levels of 0, 5 and 10 minutes, respectively, are allocated to these two alternatives

Incentives:

The sixth attribute represents the incentives. The attributes apply to sustainable alternatives and levels of this attribute are identified based on expert meetings with Eindhoven Airport, three levels for incentives are identified: 'No Bonus', 'Coffee Discount' and 'Fast Track line'.

Number of Transfers:

The last attribute takes into account the amount of transfers needed during the travel to Eindhoven Airport and applies to 'Bus' and 'Public Transport' alternatives. 3 levels are determined: 'Direct Trip' meaning no transfer, 'One Transfer' for travels that require one change of travel mode and, finally, 'Two Transfers' for travels that require two mode changes. An overview of attribute and levels for the 5-kilometers experiment is given in Table 3.4.

Attribute	Unit	Car			Taxi			E-carsharing			Bus			Bus Hailing		
Travel time	min	10	15	20	10	15	20	10	15	20	25	30	35	10	15	20
Travel cost	€	0.25	0.5	1	7.5	10	12	2	3	5	2	3	4	2.5	5	7.5
Parking cost	€ per day	0	20	30	-	-	-	-	-	-	-	-	-			
Waiting time	min	-	-	-	-	-	-	-	-	-	3.5	5	10	10	15	20
Walking time last mile	min	0	5	10	-	-	-	0	5	10	-	-	-			
Bonus	-	-	-	-	-	-	-	No Bonus	Coffee Discount	Fast Track	No Bonus	Coffee Discount	Fast Track	No Bonus	Coffee Discount	Fast Track
Number of transfers	-	-	-	-	-	-	-	-	-	-	Direct	1 Transfer	2 Transfers	-	-	-

Tab.3. 4 Attribute levels and units for the 5-kilometers experiment

3.2.2.5 30-kilometer Experiment

The second group of attributes is designated for the 30-kilometer experiment. Attributes for this experiment are the same as 5-kilometers experiment and levels are determined on the same basis of the previous experiment and are mentioned below.

Travel Time:

The first attribute level concerns the in-vehicle commuting time. The levels for alternatives 'car', 'taxi' and 'e-carsharing' are considered the same and are 40, 60 and 80 minutes. These values are based on measurements on Google Maps for the radius of 30-kilometer distance from the airport (Google, 2019)**.** The duration for the alternative 'Public Transport' is also derived from Google Maps and is 50, 60 and 75 minutes (Google, 2019).

Travel Cost:

The second attribute demonstrates the travel cost. The levels are allocated with the same method as a 5-kilometers experiment (Table 3.5) and will not be repeated here. Reference is made to the 5-kilometers experiment for the allocation description.

Alternative	Travel Cost in Euros		
Car	4	5	6
Taxi	45	60	72
E-Carsharing	7.5	15	30
Public Transport	7	9	11

Tab.3. 5 Travel Cost levels for the 30-kilometers experiment

Parking Cost:

The third attribute is parking costs for parking in one of the official parking facilities at Eindhoven Airport. The levels are considered based on the official prices of Gold parking (P1), Silver Parking (P3), Bronze Parking (P4 & P5) and Kiss & Ride lane (Eindhoven Airport, 2019). Hence, the levels are 0, 20 and 30 euros per day.

Waiting Time:

The fourth attribute describes the waiting time for the 'Public Transport' alternative. The 3 levels are determined in such a way as to include both 'direct' and 'indirect' travel. Hence, waiting times for a multimodal trip from cities that are within a 30-kilometers range (e.g Den Bosch and Uden) are extracted from Google Maps and 9292.nl. The levels are considered to be 15, 20 and 30 minutes.

Walking Time Last mile:

Levels for this attribute are the same as a 5-kilometers experiment and apply to alternatives 'Car' and 'E-carsharing'. Hence, the last mile walking time to the Airport terminal is set at 0, 5 and 10 minutes.

Incentives:

The sixth attribute demonstrates the incentive for choosing sustainable alternatives for transport to the airport as in the 30-kilometers experiment. This attribute applies to 'E-carsharing' and 'Public Transport' and has the same level as the previous experiment: 'No Bonus', 'Coffee Discount' and 'Fast Track Line'.

Number of Transfers:

This attribute applies only to alternative 'Public Transport' and has the same as a 5-kilometer experiment: 0, 1 and 2 transfers. An overview of 7 attributes and levels for the 30-kilometers experiment is shown in Table 3.6.

Attribute	Unit	Car			Taxi			E-carsharing			Public transport		
Travel time	min	10	15	20	10	15	20	10	15	20	50	60	75
Travel cost	€	4	5	6	45	60	72	7.5	15	30	7	9	11
Parking cost	€ per day	0	20	30	-	-	-	-	-	-	-	-	-
Waiting time	min	-	-	-	-	-	-	-	-	-	15	20	30
Walking time last mile	min	0	5	10	-	-	-	0	5	10	-	-	-
Bonus	-	-	-	-	-	-	-	No Bonus	Coffee Discount	Fast Track	No Bonus	Coffee Discount	Fast Track
Number of transfers	-	-	-	-	-	-	-	-	-	-	Direct	1 Transfer	2 Transfers

Tab.3. 6 Attribute unit and levels for the 30-kilometers experiment

3.2.3. Stage 3,4 and 5: Considerations, design, and allocation

After identifying the alternatives, attributes, and their levels, it is time to determine the appropriate experiment design (Hensher et al., 2015). In this research, the alternatives are specific transport modes and hence a *labeled* experiment has been used. Thereafter, the utility model has to be specified taking into consideration generic and specific parameters. Following that, the experimental design can be done in standard software packages and the survey can be conducted (Figure 3. 5). For this study, the software package Ngene by Choice Metrics is used to generate the experiment design. Unlike other software packages like SPSS, Ngene considers the utility models in order to conduct experimental design. For that reason, the models need to be specified in advance.

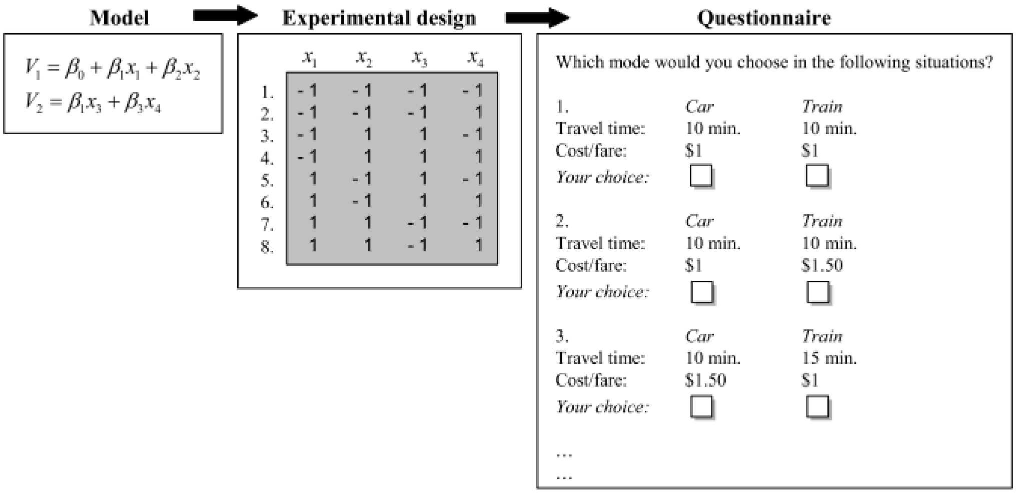


Fig.3. 5 Sated choice design from Model to Survey, Adopted from Choice Metrics (2018)

3.2.3.1 Utility model identification 5-kilometers experiment

An important decision to be made in generating the utility model is to decide whether the parameters are *generic* or *specific.* Unlike specific parameters, generic parameters (Beta values), stay the same across alternatives. This study contains both generic and specific parameters.

Table 3. 7 shows the parameters for the 5-kilometers experiment. Repeated β parameters in each row determine that they are generic among all or a group of alternatives. For instance, β 1 is the parameter for travel time and is the same across alternatives 'Car', 'Taxi' and 'E-carsharing'.

Attributes	Car	Taxi	E-Carsharing	Bus	Bus hailing
Travel Time	β 1	β 1	β 1	β 8	β 12
Travel Cost	β 2	β 5	β 6	β 9	β 13
Parking Cost	β 4	-	-	-	-
Waiting Time	-	-	-	β 10	β 10
Walking Time Last Mile	β 3	-	β 3	-	-
Bonus			β 7	β 7	β 7
Transfers	-	-	-	β 11	-

Tab.3. 7 Parameter specification 5-kilometers

Consequently, the utility functions for the 5-kilometers experiment are generated as an input for coding in Ngene:

$V_{Car} = \beta_{0Car} + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4$

$V_{Taxi} = \beta_1 X_1 + \beta_5 X_5$

$V_{E-carsharing} = \beta_1 X_1 + \beta_3 X_3 + \beta_6 X_6 + \beta_7 X_7$

$V_{Bus} = \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11}$

$V_{Bus\ Hailing} = \beta_7 X_7 + \beta_{10} X_{10} + \beta_{12} X_{12} + \beta_{13} X_{13}$

The 'X' variables refer to alternative attributes. Table 3.8 shows the meaning of each 'X' value and abbreviates that are used to code in Ngene. See Appendix I for the Ngene code used for designing the experiment.

Variable	Type of variable	Name in Ngene
X1	Travel time for car	TTc
X2	Travel cost for car	TCc
X3	Walking time last mile	TWalk
X4	Parking cost for car	ParkingCar
X5	Travel cost for the taxi	TCt
X6	Travel cost E-carsharing	TCsh
X7	Bonus	Bonus
X8	Travel time for bus	TTb
X9	Travel cost	TCb
X10	Waiting time for mode arrival	TWAIT
X11	Number of transfers	Transf
X12	Travel time for bus hailing	TTbh
X13	Travel cost for bus hailing	TCbh

Tab.3. 8 Variable types and abbreviates

Interaction effects are eliminated in this study in order to limit the choice situations and based on the assumption that attributes are independent of each other. This means that the orthogonal full factorial design contains 3^{13} choice situations because each parameter has 3 levels. This amount of choice tasks is not manageable and therefor a fractional factorial design with 72 profile is selected for the 5-kilometers experiment, see Appendix II. A design is *Orthogonal* if there is no correlation among attribute levels and parameters are estimable independently (choiceMetrics, 2018). Ngene can generate either a sequential orthogonal design or a simultaneous orthogonal design. In sequential orthogonal design, orthogonality holds within each alternative attribute whereas in simultaneous design, orthogonality holds across alternatives. Sequential orthogonal design is used in this study because it leads to smaller designs (choiceMetrics, 2018). It is too much to show all 72 selected profiles to a single respondent. Therefore, *block* property in Ngene is used to create 12 blocks of 6 profiles. Each block is not orthogonal by itself and it is only the full combination of 72 profiles that holds the orthogonality property.

3.2.3.2 Utility model identification 30-kilometers experiment

The process of designing the 30-kilometers experiment is identical to the 5-kilometers experiment. see Appendix III for parameter specification and variable type tables and Ngene code that is used to generate the experiment design. Consequently, 72 sequential orthogonal profiles are conducted in Ngene like previous experiments and are divided into 12 blocks. (Appendix IV & V).

3.2.3.3 Travel Scenario

Context attributes are introduced in section 3.2.2. Respondents see these variables as their imaginary initial travel scenario. There are 4 context attributes with 2 levels each, resulting in 2^4 choice situations for full factorial design. Thereafter, orthogonal tables are used to make the fractional factorial design which resulted in 4 scenarios. See Table 3.9 for selected scenarios for the 5-kilometers experiment. Scenarios for the 30-kilometer experiment is similar with only distance changing to 30-kilometers

Travel Scenario	Purpose	Travel accompany	Luggage	Distance
1	Business	Alone	1	5km
2	Business	With another person	2	5km
3	Leisure	Alone	2	5km
4	leisure	With another person	2	5km

Tab.3. 9 Travel Scenarios

Matching the scenarios to choice profiles are based on the blocks. Table 3.10 shows an example of a block with 6 choice profiles in it and the column next to it shows how scenarios are allocated sequentially. This process repeats for all blocks of both experiments and allows the whole design to stay orthogonal.

Choice profiles in one block	Scenario allocation
1	1
2	2
3	3
4	4
5	1
6	2

Tab. 3. 10 Example of scenario allocation in one block

3.2.4. Stage 6,7,8: Randomization, choice sets, and survey Instrument

The last three stages have been performed in LimeSurvey Professional software package, used for SC experiments by the Department of the Built Environment of the Eindhoven University of Technology.

Randomization:

LimeSurvey does not have an in-built choice system. However, it is possible to code the system with the JSON coding language. Hence, two conjoint software for 5- and 30-kilometers experiments are coded into the survey system. Each software has two parts in it, the first part contains the experiment code and data code and the second part randomly calls 6 questions out of 72 choice situations for each of 5 and 30-kilometer experiment. Therefore, there are 12 choice task questions called in total out of 144 possible choices which are time-consuming for respondents to answer. Hence, a randomization code is added to the system to select 6 out of the 12 selected choice tasks. Finally, respondents have to answer 3 questions for a 5-kilometers experiment and 3 questions for the 30-kilometer experiment.

Questionnaire design:

The questionnaire is conducted in both English and Dutch and consists of four parts (See Appendix VI for the complete questionnaire). The first part starts with a target group selection to determine if the respondents fall within the target group of this research. The respondents meet the target group when:

- They have been in Eindhoven Airport in the past 12 months.
- They have no disability that constraints their public transport use, as alternatives offered in SC experiment contain public transport options.

Consequently, respondents have to answer questions regarding the purpose of their trip and transport mode they used the last time they went to the airport.

The second part of the survey asks questions regarding travel behavior and attitude of respondents and contains radio (multiple choice) and likert scale questions. Literature suggests that stress levels for arriving on time influence the mode choice behavior of individuals(Legrain, Eluru, & El-Geneidy, 2015). Hence, respondents have to determine their level of stress and arrival time frame before their flight in a unipolar likert scale question . Next question is a bipolar 5scale likert question that asks respondents opinion about the following statements:

- Previously, I always used a car to go to Eindhoven Airport

Literature suggests that past habits besides intention is the most important predictor in mode choice of travelers (Lanzini & Khan, 2017). However, the influence of previous habits on infrequent travel behavior is not yet clear.

- I enjoy driving to Eindhoven Airport

According to Verboekt et al. (2018), the car is still the most used transport mode for commuting to Eindhoven Airport. What is more, the results of another study shows that using a car is positively correlated with travel satisfaction and suggest that the comfort and driving pleasure influence the mode choice of travelers (Ye & Titheridge, 2017).

- I think Eindhoven Airport is better accessible with a car than public transport

Verboekt et al. (2018) suggest that the frequency of bus lanes to Eindhoven Airport has to increase. What is more, the high modal split of the car suggests that Eindhoven Airport might be better accessible with the car than public transport options.

- I think the ambiance of the Eindhoven Airport is pleasant for me to spent time in, I think security services in Eindhoven Airport are efficient

The last two statements ask the respondent's opinion about the ambiance and security service of the airport. Up to knowledge of this study, no previous research has estimated the influence of airport satisfaction on mode choice of passengers. However, there are studies showing that mobility to airport and ambiance of the airport (security and environment) are positively correlated with the level of satisfaction(Bezerra & Gomes, 2015). Additionally, travel behavior studies suggest that the destination of the trip can play a role in the mode choice of travelers(Langbroek et al., 2018). Hence, it is assumed that the internal factors of the Airport might have an influence on the mode choice of travelers.

Next likert question asks about respondents' opinion about the importance of factors mentioned in literature as a determinant in mode choice:

- **The availability of alternative transport options** can bring added value to travelers. MaaS literature suggests that having the freedom of choice can increase travel convenience and hence initiate the change in travel behavior (Netherlands Institute for Transport Policy, 2018).
- **Environmental concern** is increasing among the population and can influence their travel behavior (Lang & Mohnen, 2019).
- **The safety of transport mode** is shown to have a positive correlation with the perception of satisfaction in public transport (Fellesson & Friman, 2012).
- **Reliability** might significantly affect travel choices by changing route choices and willingness to pay for different alternatives(Moghaddam, Jeihani, Peeta, & Banerjee, 2019). This might be even more important for infrequent travels such as going to the airport where arriving on time plays a vital role.

The next question asks the frequency of use for different modes of transport during a normal week. A research done in a city of Utrecht suggests that there might be a link among the level of multimodality and higher levels of behavior change(Heinen, 2018). However, literature still did not find enough evidence to confirm or disconfirm this hypothesis.

The last question on the third page indicated the distance respondents live from the closest transport hub. This question is asked to make an indication about the first-mile walking distance of respondents and can be used for further researches that want to include the first-mile duration into account.

The next page (Appendix VI: introduction to concepts) provides the respondents with an introduction to the concepts of ‘E-Carsharing’ and ‘Bus hailing’. E-carsharing is introduced as an electric car that you do not own personally but can be picked and drop from different locations. Bus hailing is introduced as an on-demand bus service. BravoFlex is the provider of this kind of service in the Eindhoven region.

The next part of the questionnaire is the SC experiment (Appendix VI: choice task), which has been discussed previously. The first 3 questions of the SC experiment ask respondents about scenarios based on a 5-kilometer experiment and the last 3 questions ask about the 30-kilometers experiment.

The final part of the questionnaire (Appendix VI: socio-demographics) asks the socio-demographic characteristics of gender, age, education level, yearly net income, household size and employment status.

3.2.5. Conclusion

This section elaborated on the design process of the SC experiment based on the theory of Hensher et al. (2015). Two different SC experiments are designed for distances of 5 and 30 kilometers. Hence, alternative and attribute levels are varied across two SC experiments. Sequential fractional factorial design of 72 choice profiles (144 in total) are generated using a standard software package of Ngene, and each respondent is given 6 choice task to evaluate. Section 3.3 describes the modeling part of stated choice experiment and explains the statistical theory of it briefly.

3.3. CHOICE MODELING

Current discrete choice models are the results from developments in the fields of economy and psychology(Kemperman, 2000). These models try to describe the choices made by individuals between number of alternatives. In general, it is assumed that an individual will choose the alternative from a choice set that provides the individual with the highest level of profitability. Hensher et al. (2015), refers to this behavioral rule as "utility- maximizing", which describes that individuals try to amplify their overall utility when choosing an alternative.

Discreet choice models aim to find the level of contribution of each attribute to the overall utility of each alternative in a choice set based on two main components: structural utility (observed) and random utility (unobserved) (Hensher et al., 2015; Kemperman, 2000). The equation for describing the utility can be calculated by the following expression:

$$U_{iq} = V_{iq} + \varepsilon_{iq} \quad (3.1)$$

U_{iq} represents the utility of alternative *i* for individual *q*. V_{iq} represents the structural utility, which captures the observed utility of the alternative, and ε_{iq} is the random utility (unobserved), which is assumed to be independent and identically distributed across all individuals. Consequently, the structural utility V_{iq} is explained by the following expression:

$$V_{iq} = \sum_n \beta_{in} X_{inq} \quad (3.2)$$

Where β_{in} represents the weight of attribute *n* for alternative *i* and, X_{inq} is the score of alternative *i* on attribute *n* for individual *q*. β_{i0} is the alternative specific constant, which represents the role of unobserved utility on average and is not associated to the observed and measured attributes.

According to Hensher et al. (2015), the probability that an individual choose the alternative *i* is equal to the probability that the utility of alternative *i* is greater than the utility of alternative j after evaluating all alternatives J in the choice set. This can be explained by the following expression:

$$P_i = P\left(U_i \geq U_j\right) \forall j = 1, \dots i, \dots J \quad (3.3)$$

3.3.1. Multinomial Logit (MNL) model

The multinomial logit model is the most common form in discreet choice analysis and is based on the assumption that error components distributions are independent and distributed identically (IID) according to a Gumbel distribution (Hensher et al., 2015; Kemperman, 2000). The probability that individual *q* choose alternative *i* from set of *J* alternatives, is equal to:

$$P_{iq} = \frac{\exp\,(V_{iq})}{\sum_{j=1}^{J} \exp\,(V_{iq})}; j = 1, \dots, i, \dots, J \quad (3.4)$$

This equation states that the probabilities of all alternatives sum up to value of one, which indicates that an increase in probability of one alternative results in decreasing in probability for choosing the other alternatives (Train, 2009). However, the ratio of choice probabilities for an individual is assumed to be unaffected. This is known as the Independence from Irrelevant Attributes; the IIA-property.(Train, 2009).

In the MNL model, the most likely value of the parameters is estimated through a maximum loglikelihood estimation:

$$LL(\beta) = \sum_q \sum_i y_{iq} Ln(p_{iq}) \quad (3.5)$$

Where y_{iq} is 1 when the alternative is chosen by individual q and 0 otherwise. Hence, an average estimation of parameters is resulted for each attribute level. What is more, within MNL model, taste variation is only attributed to observed variables and variation for unobserved variables is not possible (Train, 2009).

The goodness-of-fit of the model can be determined by McFadden's Rho-Square:

$$\rho^2 = 1.0 - \frac{LL(\beta)}{LL(0)} \quad (3.6)$$

Where LL(β) is the log-likelihood function using the estimated parameters and LL(0) is the loglikelihood assuming equal choice probabilities for all alternatives in the choice set. According to Hensher et al. (2015), ρ^2 between 0.2 and 0.4 is considered a decent model fit.

3.3.2. Mixed Logit (ML) model

Mixed Logit (ML) models allow individuals to have different β', unlike MNL models where only one β is estimated representing the entire sample population. The equation below provides the ML model (Hensher et al., 2015):

$$P\left(choice_{qt} = i \middle| x_{qt,i}, z_q, v_q\right) = \frac{\exp\left(V_{qt,i}\right)}{\sum_{j=1}^{J_{qt}} \exp\left(V_{qt,j}\right)}; \;\; j = 1, \dots, i, \dots, J_{qt} \quad (3.7)$$

Where, $V_{qt,j} = \beta'_q \, x_{qt,j}$ and $\beta_q = \beta + \Delta z_q + \tau v_q$

$x_{qt,j}$ = the *K* attributes of alternative *j* in choice set *t* for individual *q*;

J_{qt} = The J alternatives in choice set *t* for individual *q*;

z_q = set of *M* characteristics of individual *q* that influence the mean of taste variation parameters;

v_q = a vector of *K* random variables with zero means and known variances and zero covariances.

ML model is more elaborate than MNL models and allow similarities to exist between choice alternatives in the unobserved part of utility (Error Components Model). Additionally, ML model can include panel effects into consideration and is suitable for panel data and repeated choice models. Finally, ML model can measure taste differences in the parameters of an attribute across the sample data (Random Parameters Model) (Hensher et al., 2015; Louviere & Hensher, 2000).

3.3.3. Conclusion

A stated choice experiment is performed in this research in order to understand the mode choice behavior of travelers to Eindhoven Airport. There are different approaches in analyzing the data and measuring the probability of an individual choosing a certain alternative. The MNL model is used which the most common applied model in this type of research. MNL model is used in this research to analyze overall preference of choice alternatives. However, MNL model does not satisfy the IIA property. Hence, ML logit model was introduced to investigate the similarities between alternatives and include the IIA property . This model includes the effect of repeating choices and allows for heterogeneity in the parameters across the sample. Finally, LC model was represented, which allows classes of individuals based on their choice behavior. As a result, classes might be an interesting estimation or policy making.

3.4. CONCLUSION

This chapter represented an introduction to choice behavior and elaborated on the experiment design. The Stated Choice is selected as experiment method for this research, which has the possibility to investigate individual's decision-making process. Design stages followed the process suggested by Hensher et al. (2015) and resulted in two independent SC experiments for shorter and longer travel distances to Eindhoven Airport. As a result, six repeated choice questions were shown to respondents accompanied with questions regarding their socio-demographic characteristics and attitudinal Likers scale questions.

The fundamentals of the MNL model, the ML model and LC model have been introduced as modelling approach to analyze the SC data and investigate the choice behavior of respondents. Chapter 4 elaborates on data collection and analysis.

4 RESULTS

As explained in the methodology chapter, an SC experiment is done to have insights into the travel choice behavior of individuals traveling to Eindhoven Airport with a focus on more sustainable modes. This chapter provides an analysis of the data collected for this SC experiment. Section 1.1 provides information about the data. Section 1.2 presents the descriptive analysis of the sample and section 1.3 elaborates on estimations of the discrete choice models: Multinomial Logit model and Mixed Logit model. Lastly, Section 1.4 concludes this chapter by summarizing the findings.

4.1. DATA COLLECTION

An online questionnaire is designed and executed to collect the data for this research. The online survey consisted of three parts. First part of questionnaire consisted of Likert scale questions about respondent's environmental attitudes and opinions regarding Eindhoven Airport. Second part of the survey represented two SC experiments to travel to Eindhoven Airport with different alternatives and respondents had to choose preferred transport mode. The alternative selection and their general and specific attributes and levels are discussed in detail in section 3.2. Third and last part of survey included socio-demographic questions.

People that have visited Eindhoven Airport in the past 12 months and do not have a physical disability are the target group of this study. This group was recruited as respondents between the 20th of December and 27th of January by the following channels:

- Installing 4 banners with QR codes at the Eindhoven Airport. The banners were put after the security check and around the sitting areas. Figure 4.1.1 and 4.1.2 show one of the banners at the Eindhoven Airport. The banners were permitted by the Eindhoven Airport during holiday breaks and were removed on January 9th.
- 151 members of the Infrastructure and Transport group of Royal HaskoningDHV received an invitation to complete the questionnaire by Email.
- Emailing by the secretary of CME to CME students.
- LinkedIn, which the post was shared 5 times by friends and colleagues.
- Own network of friends and their networks.
- Facebook, at which the post was shared in TU/e International students' group and Eindhoven Expats group.

2 Bol.com vouchers worth 50 Euros each were raffled among respondents who finished the questionnaire completely in order to stimulate the response rate.

Fig. 4.1. 2 photo of a data collection banner in Eindhoven Airport

Fig. 4.1.1 Banner design and text for data collection in Eindhoven Airport

A total number of 372 respondents started the questionnaire. Table 4.1.1 shows the number of respondents recruited from each channel.

Channel	Frequency	Percent %
Banner at the Airport	146	39.2
Email	58	15.6
Social media	91	24.5
Other	51	13.7
Not specified	28	7.5
Total	372	100

Tab.4.1. 1 Description of respondents based on channel

The questionnaire has been made in the English and Dutch version. Table 4.1.2 shows the starting, finishing, and within target group number of respondents.

Questionnaire	Started	Finished	In target group
English	246	122	99
Dutch	126	51	38
Total	372	173	137

Tab.4.1. 2 Description of completion

A total of 137 respondents finished and are within-group respondents. The average answering time of the questionnaire is 13 minutes and 36 seconds and counts for all 372 respondents.

4.2. SAMPLE DESCRIPTIVE

The analysis of the socio-demographic characteristics of respondents is shown in Table 4.2.1. The variables are adjusted to new categories with fewer levels in order to increase the observations at each level.

Regarding gender, the sample has more male respondents (54%) than female respondents (43.8%). This is due to the higher male/female ratio in respondents who have been recruited through Email in Royal HaskoningDHV and CME students. The age groups show a dominant peak in the group between 21 to 30 years (60.6%) and the group between 31 to 40 comes in second (23.4%). This can be attributed to the data collection method with QR code in the airport, which might have attracted younger people and discouraged older population to take part in the survey. Another explanation might be the researcher's network of fellow academics and colleagues in Royal HaskoningDHV, which mainly consist of higher education individuals.

For further analysis, age levels are categorized into three groups (≤ 30 years, 31- 40 years, and ≥ 41 years). The education levels show high peaks at the master's degree (40.9%) and bachelor's WO (21.9%). This attribute is also categorized into three levels to make groups bigger. Hence, primary and secondary school education are merged into lower education levels, MBO and HBO are merged as professional education and WO educations and Ph.D. are categorized as scientific education.

The yearly net income of the sample shows peaks in lower- and middle-income categories. This variable is categorized into four levels. The lower-income level is the levels ‘≤10k’ and ‘10k-19k’. Levels ‘20k-30k’ and ‘30k-40k’ are categorized as middle-income levels. ‘40k-99k’ and ‘≥100k’ are categorized as higher income levels. 19 respondents chose not to share their income, which is reflected in the ‘Not provided ‘category.

Regarding household size, most respondents have a household between one to four persons with a peak at one and two persons. This variable is categorized into four categories as can be seen in the table.

Regarding employment status, most of the respondents have a full-time job (49.6%) or are students/interns (33.6%). This variable is categorized into three levels to have a more evenly spread. Appendix VII shows the graphs for the descriptive analysis.

In order to compare the sample data with the distribution of the Dutch population, the Chi-square test is performed for the adjusted categories. The data regarding the Dutch socio-demographic characteristics are mainly retrieved from Statistics Netherlands (CBS). In this test, if the chi-square test is significant ($p \leq 0.05$), then the sample is not representative (lower chi-square values suggest a better fit). Table 4.2.2 shows Chi-Square test results and the detailed analysis is presented in Appendix VIII.

It can be seen from the chi-square values that characteristics household size, and employment are representative to the Dutch population. However, characteristics of age, gender, education, and income are not representative of the Dutch population.

Variable	Category	Freq.	Percent %	Adjusted category	Freq.	Percent%
Gender	Female	60	43.8	Female	60	43.8
	Male	74	54	Male	74	54
	Other	3	2.2	Other	3	2.2
Age	≤20	3	2.2	≤30	86	62.8
	21-30	83	60.6	31-40	32	23.4
	31-40	32	23.4	≤≥41	19	13.8
	41-50	18	13.1			
	≥51	1	0.7			
Education	Primary School	1	0.7	Lower education	8	5.8
	Secondary School	7	5.1			
	Vocational (MBO)	10	7.3	Professional education	39	28.5
	Bachelors (HBO)	29	21.2			
	Bachelors (WO)	30	21.9	Scientific education	90	65.7
	Masters (WO)	56	40.9			
	PhD and higher	4	2.9			
Income	≤10k	38	27.7	Lower income	45	32.8
	10k-19k	7	5.7			
	20k-29k	8	5.8	Middle income	38	27.7
	30k-39k	30	21.9			
	40k-49k	18	13.1	Higher income	35	25.5
	50k-99k	14	10.2			
	≥100k	3	2.2			
	Prefer not to share	19	13.9	Not provided	19	13.9
Household size	1	55	40.1	1	55	40.1
	2	43	31.4	2	43	31.4
	3	15	10.9	3	15	10.9
	4	18	13.1	4 and more	24	17.5
	5	2	1.5			
	6 and more	4	2.9			
Employment	Full time	68	49.6	Full time	68	49.6
	Part time	16	11.7	Part time	62	45.3
	Student/Intern	46	33.6			
	Looking for a job	2	1.5	Other	7	5.1
	Prefer not to Share	5	3.6			

Tab. 4.2. 1 Frequencies

Variable	Adjusted category	Freq.	Percent%	Expected	Residual	Chi-square
Gender (CBS,2018)	Female	60	43.8	69	-9	9.782 Sig=0.008
	Male	74	54	67	7	
	Other	3	2.2	1	2	
Age (Statista,2019)	≤30	86	62.8	54	32	66.395 Sig=0.00
	31-40	32	23.4	19	13	
	≤≥41	19	13.8	63	-44	
Education (Ministry of education, culture and science, 2017)	Lower Education	8	5.8	91	83	389.06 Sig=0.00
	Professional Education	39	28.5	29	10	
	Scientific Education	90	65.7	17	73	
Income (CBS,2018)	Lower income	45	32.8	35	10	32.256 Sig=0.00
	Middle income	38	27.7	67	-29	
	Higher income	35	25.5	21	14	
	Not provided	19	13.9	-	-	
Household size (CBS,2017)	1	55	40.1	52	3	0.332 Sig=0.954
	2	43	31.4	45	-2	
	3	15	10.9	16	-1	
	4 and more	24	17.5	24	0	
Employment (CBS,2018)	Full time	68	49.6	66	2	0.668 Sig=0.919
	Part time	62	45.3	64	-2	
	Other	7	5.1	7	0	

Tab. 4.2. 2 Chi-square representativeness

4.2.1. Trip Purpose

Regarding travel to Eindhoven Airport, the frequency of the purpose of trips (See Appendix I: Descriptive analysis) show that most of the respondents use the Eindhoven Airport for a holiday trip (65.4%) whereas, the business trips are the least popular purpose for trips (6.3%). Figure 4.2.1. This can be attributed to the low-fare airlines working with Eindhoven Airport. According to Hess & Polak (2006), traveler’s choice of airport is related to their trip purpose and the transport mode they choose to commute. As a result, Eindhoven Airport might be more popular for vocational trips and visiting family and friends.

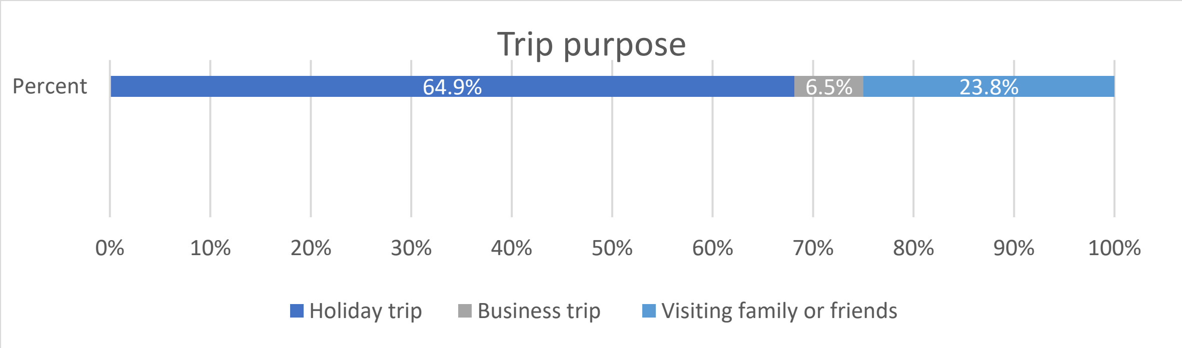


Fig. 4.2. 1 Trip purpose for the flight

Figure 4.2.2 shows the purpose of travel in comparison to how respondents have traveled to Eindhoven Airport. I general, public transport has the most share of all three travel purposes. However, public transport seems to be the most used when the purpose of travel is visiting family and friends (61%). It seems that using private commute modes of driving private auto (18.8%) and taxi (18.8%) are the most popular when the purpose of the trip is business. Furthermore, getting a ride from family or friends seems to be most popular when the purpose of the trip is a holiday (22.4%). On the other hand, getting a ride from friends and family is the least when the purpose of travel is business (6.3%). These results are in line with findings of Tam et al. (2010), Catillo-Manzano (2010) and Birolini et al. (2019), which stated that trip purpose influence the mode choice and business travelers are more likely to use private vehicle and taxi services than other purposes.

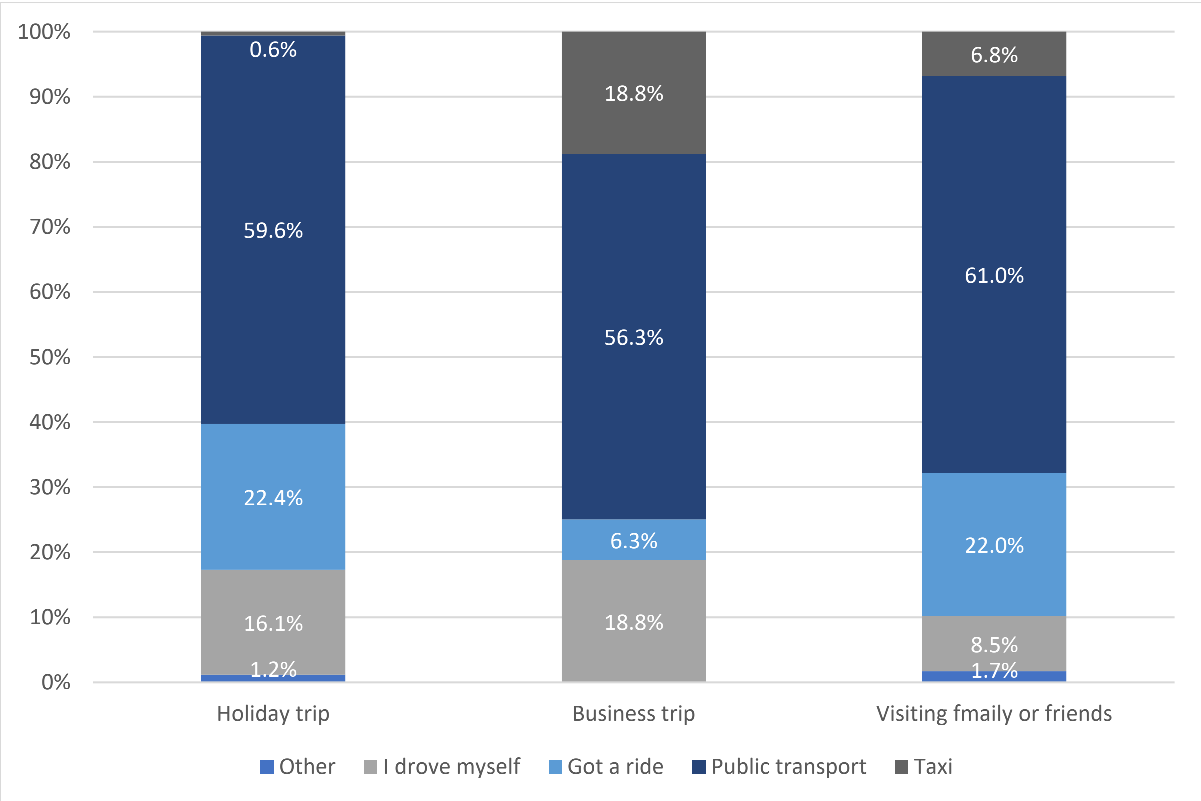


Fig. 4.2. 2 Trip purpose and the transport mode used

4.2.2. Distance to the nearest hub

Another determinant for the use of cars or public transport to go to the airport might be the distance from home to the nearest hub. Figure 4.2.3 shows that in total, 52% of the respondents live in a distance less than 500 meters from a transport hub. 27.8% of the respondents live in a distance between 500 meters to 1 kilometer. However, 21.2% of the respondents live in distances longer than 1 kilometer to the transport hub, which might influence people's choice. All in all, the majority of respondents live in a close distance to transport hub.

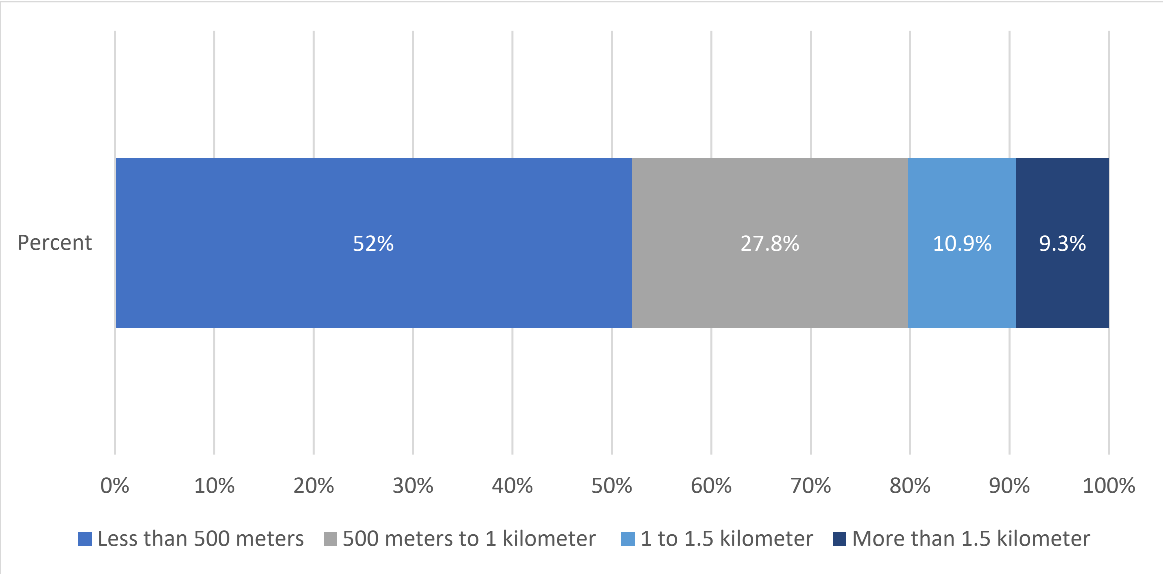


Fig. 4.2. 3 Distance to the nearest transport hub

Figure 4.2.4 shows that public transport has been most used (63.6%) when the distance to the nearest hub is less than 500 meters. It can be seen that the share of public transport decreases with an increase in distance to transport hubs. For distances more than 1.5 kilometers, the modal share of public transport is almost half of what it is for distances less than 500 meters (30.4%). On the contrary, the use of a car and getting a ride to go to the airport increased from 10.9% and 20.9% for less than 500 meters to 30.4% for distances longer than 1.5 kilometers. These results suggest that first mile accessibility might be a determinant factor for airport traveler's mode choice, which is neglected in the older researches. However, these findings are in line with the results from Birolini et al. (2019), which is discussed in section 2.3 and Table 2.2 and showed that "out of vehicle travel time" has negative impact of the probably of alternatives.

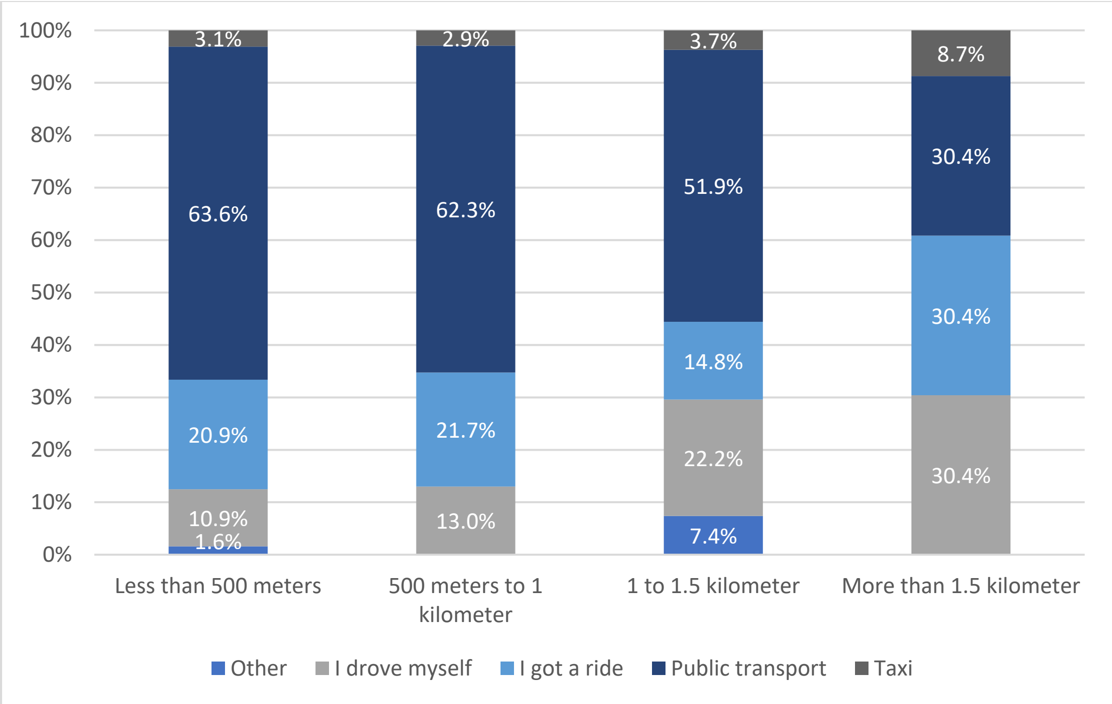


Fig. 4.2. 4 Distance to the nearest hub and the transport mode used

Regarding the average weekly modal share of transport modes, it can be seen from Figure 4.2.5 that active modes of the private car, train and bus are used mostly between 1 to 3 days a week. This might be related to incidental travel purposes such as shopping and visiting family and friends. It seems that the alternative bike is a popular transport mode for everyday use among the respondents with a modal share of 41.9%. On the other hand, alternative 'Electric bike' is the least used mean of transport with a modal share of 94.8% of no use in a normal week. It can be concluded that the majority of sample are not private vehicle-dependent individuals.

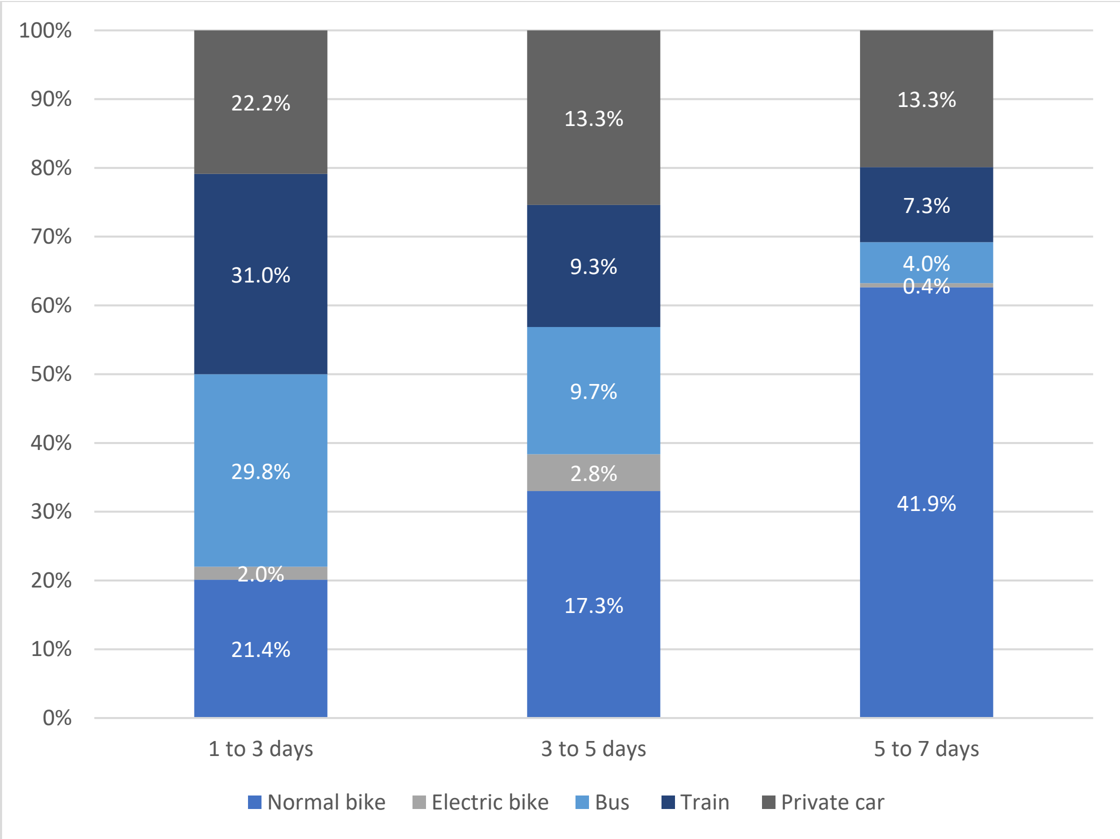


Fig. 4.2. 5 weekly frequency of use for different modes

4.2.3. Transportation factors

Regarding the importance of the factors, it can be seen from Figure 4.2.6 'reliability of transport mode' is the most important factor for the respondents with 74.6% find it very important. This is in line with findings from Tam, Lam, & Lo. (2010), which stated that 'travel time reliability' is the most important transportation factor for travelers to Hong Kong International Airport.

Further, despite the overrepresentation of young highly educated people in the sample, 'environmental concern' is the least important factor for respondents and only 23.4% of them determined it as very important. Chebli & Mahmassani (2002) has previously investigated the environmental attitude of airport travelers to help explain the mode choice and could not find significant result. The lack of 'environmental concern' in choosing transport mode to airport might be attributed to the perception of passengers towards air-travel as an unstainable travel alternative. Hence, travelers might think that their travel is already not environmental friendly and as a result, loose concern about the environmental impact of their travel to the airport.

The factors 'safety' and 'availability of transport mode' show a similar level of importance among respondents and the majority of them find relatively important. This finding is in line with the research from Chang (2013), which found 'safety' as one of the most important factors in the airport mode choice.

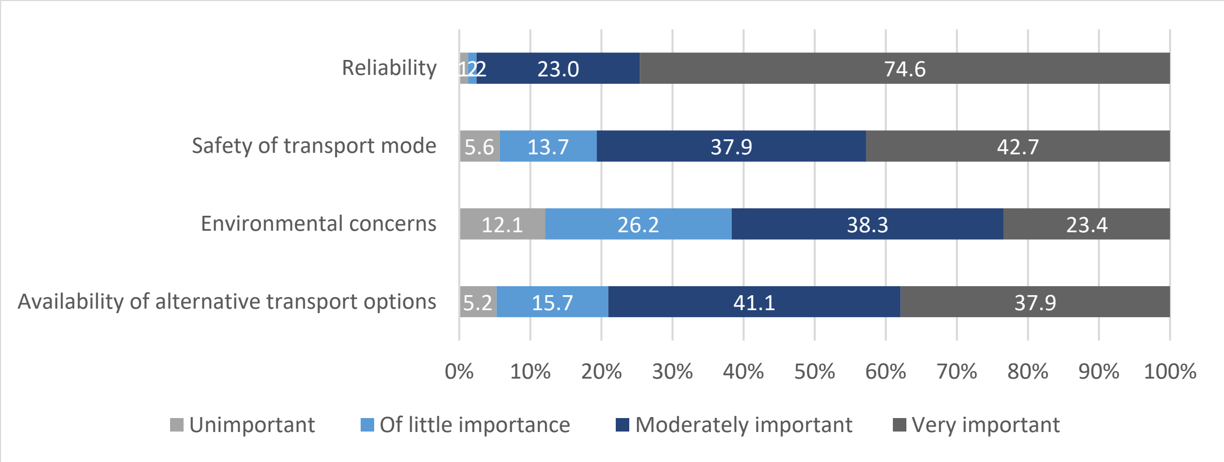


Fig. 4.2. 6 Transport factors

4.2.4. Stress level and arrival time

In the survey respondents were asked to determine how early they wish to be in the airport before their flight. Figure 4.2.7 shows that the majority of respondents (46%) prefer to arrive between 1.5 to 2 hours before their flight. 37.2% of respondents chose for 1 to 1.5 hours before the flight and 16.8% prefer to be in the airport more than 2 hours before their flight. Tam. Lam, & Lo.(2010) has mentioned that the arrival time (safety time margin) might be a determinant factor in mode choice of travelers. Hence, the average time of arrival in the Eindhoven Airport can be use as a latent variable for the MNL model in future research.

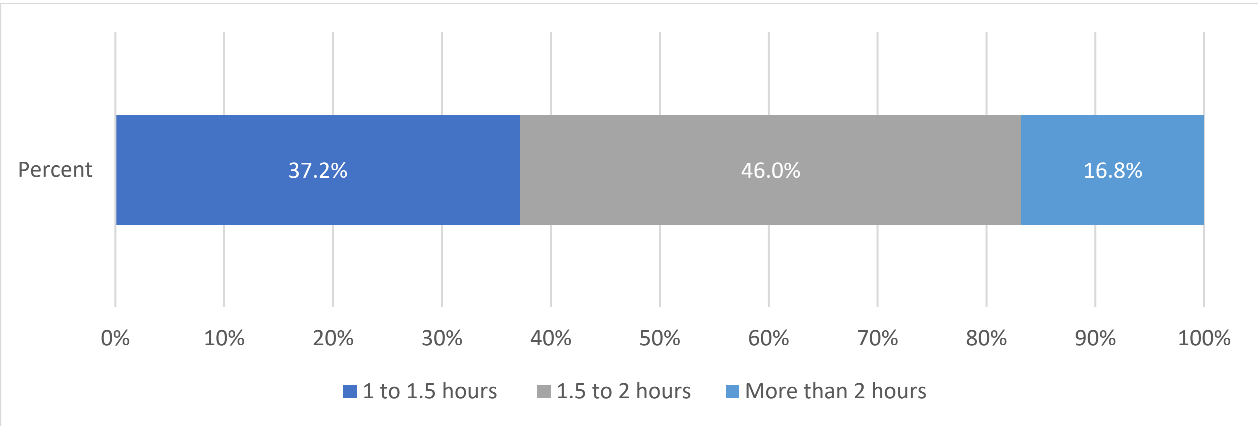


Fig. 4.2. 7 Arriving time

Regarding the stress level, 40.1% of respondents mentioned that they are not stressed to arrive on time at the airport. On the other hand, 51.1% of the respondents mentioned that they are stressed to arrive on time for their flights and 8.8% mentioned that they are very stressed for their arrival (Figure 4.2.8). The Chi-square value of cross tab analysis for stress level and socio-demographic characteristics of the sample does not show any signs and hence is not mentioned in this report. However, it can be concluded that the majority of respondents are stressed to arrive on time to Eindhoven Airport. Future research should investigate the effect of stress in the mode choice of travelers to Eindhoven Airport and find out if the stress is the result of difference from actual and perceived travel time (the unexpected travel time with different mode alternatives) or is it an internal factor of Eindhoven Airport (stress from check-in and boarding).

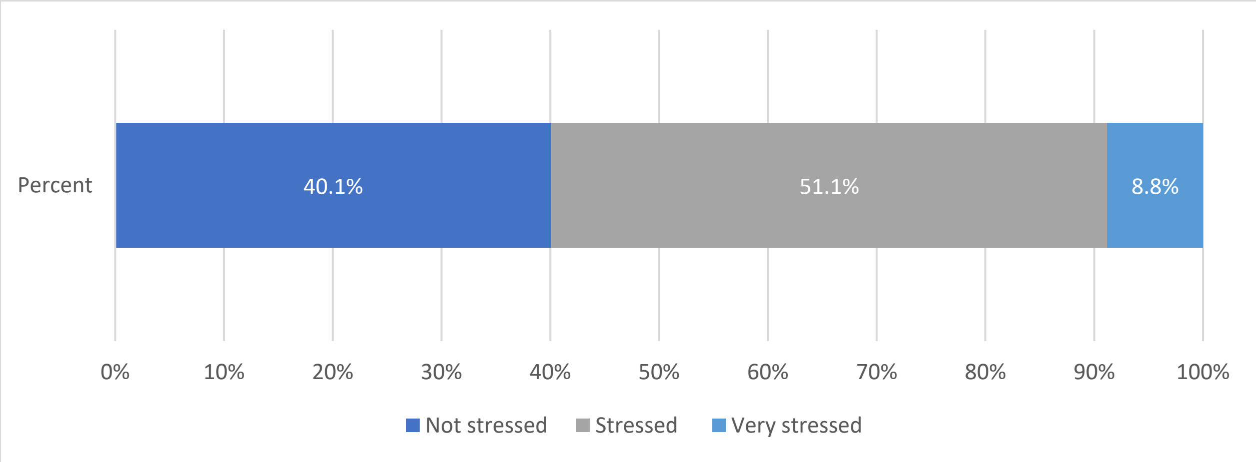


Fig. 4.2. 8 Stress level

4.2.5. Analysis of attitudinal questions

In this section, the result of behavioral questions is reflected in combination with the socio-demographic characteristics of the respondents. The socio-demographic used for analysis are gender, age, education, income, household size, and employment. Furthermore, the 5-point Likert scale questions are reduced to a 3-point Likert scale. This decision has been made because the frequency of 'Strongly Agree' and 'Strongly Disagree' options are low. The significance of the results is based on the Pearson Chi-square test from the cross tabs analysis. Test results and the cross tabs can be found in Appendix

- I am worried about global warming

In the first statement, respondents are asked if they are worried about global warming. On average, 75.2% of the respondents agreed, 16.1% had a neutral opinion and 8.8% disagreed. According to chi-square results (Appendix IX), only education level shows significant results. Figure 4.2.9 demonstrates the overall and education level. As can be seen from the figure, respondents with scientific education agreed more with the statement than the overall average (82.2%). On the contrary, respondents with lower education disagreed the most with the statement (25%). Based on the overall result, it can be concluded that the respondents are worried about global warming.

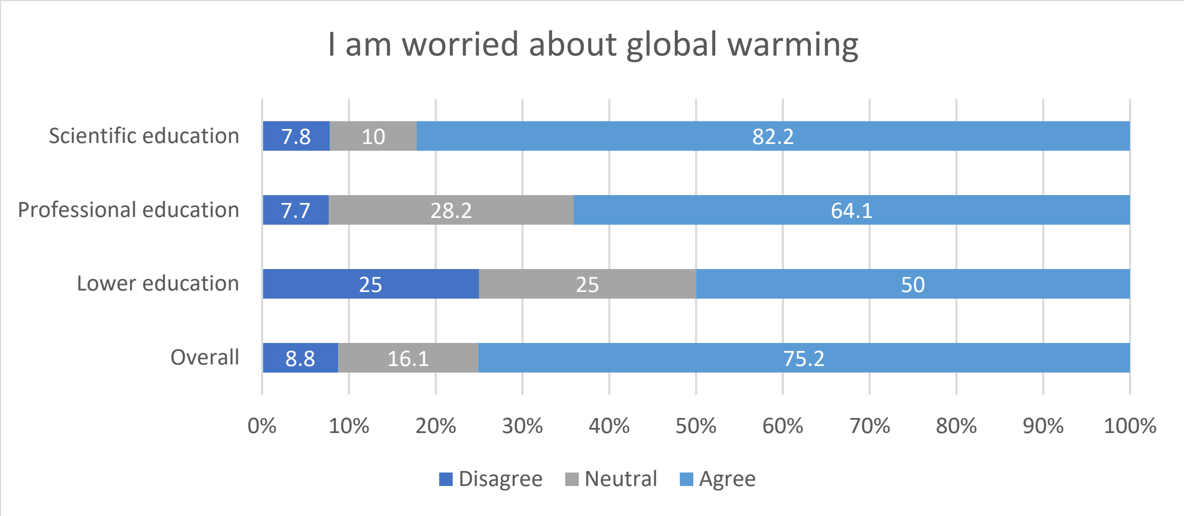


Fig. 4.2. 9 Statement: I am worried about global warming

- The majority of the population is not acting environmentally conscious

According to the chi-square results (Appendix IX), there is no significant differences were found among socio-demographic characteristics. As can be seen in figure 4.2.10 76.6% of the respondents agreed with the statement which means that all in all, respondents agree that majority of people are not acting environmentally conscious.

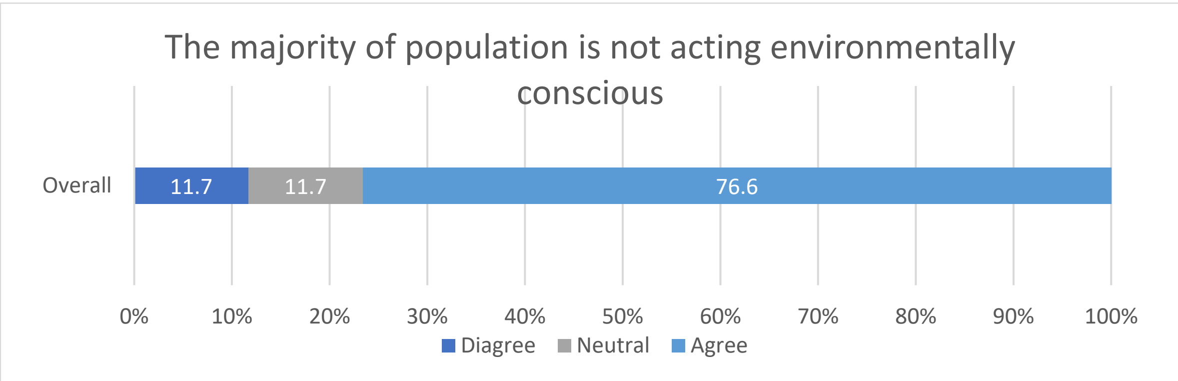


Fig. 4.2. 10 Statement: The majority of the population is not acting environmentally conscious

- I am willing to adopt a more environmentally friendly lifestyle

The third statement asked respondents to determine if they are willing to adopt a more environmentally friendly lifestyle. In total, 82.5% of the respondents agreed on this statement, 10.2% were neutral and only 7.3% disagreed (Figure 4.2.11). This means that the sample is very willing to adopt a more environmentally friendly lifestyle. According to the chi-square test results (Appendix IX), there is a significant difference in the characteristics of age and education. It can be seen that respondents with lower and professional education and age group of 31 years and above are less willing to adopt a more environmentally friendly lifestyle compare to the overall response.

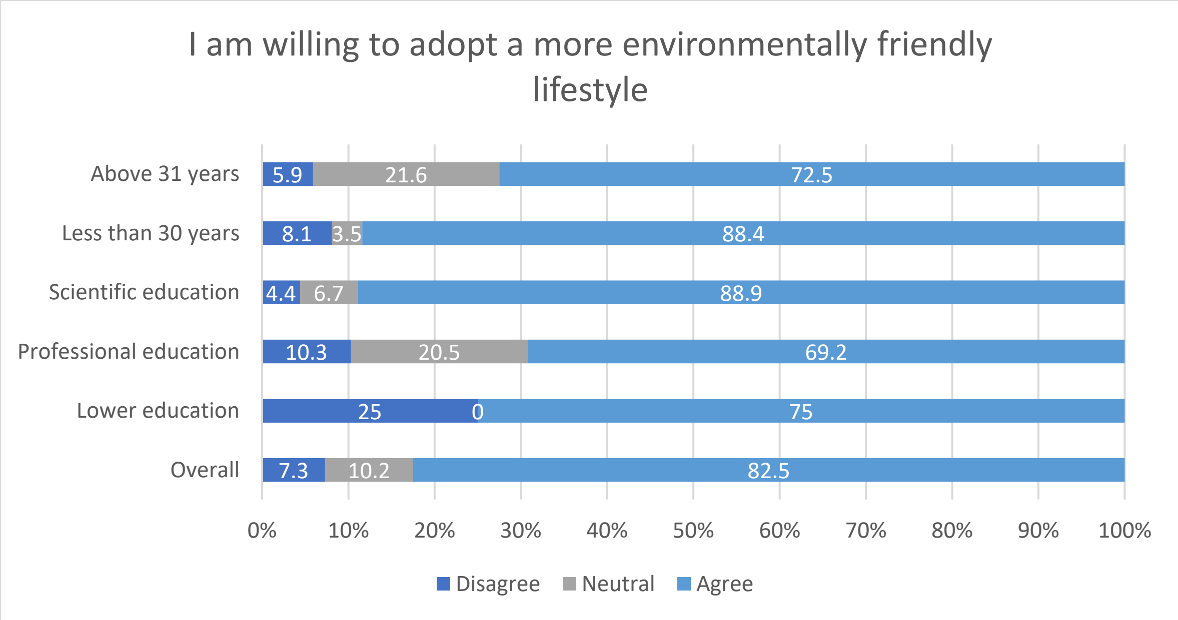


Fig. 4.2. 11 Statement: I am willing to adopt a more environmentally friendly lifestyle

- I am prepared to pay more for environmentally friendly transport

The objective of the last statement is to find out to what extend respondents think they are prepared to pay more for a mode of cleaner transport. According to the results, 51.8% of the respondents agreed on this statement, 22.6% are neutral and 25.5% disagreed. The result from the chi-square test shows no significant differences in the characteristics (Figure 4.2.12).

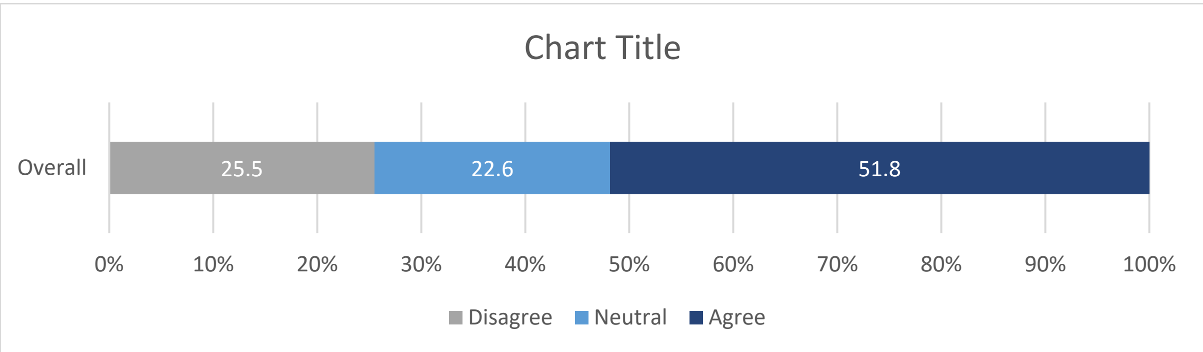


Fig. 4.2. 12 Statement: I am prepared to pay more for environmentally friendly transport

4.2.6. Analysis of airport statements

This section reflects the result of the Likert scale questions regarding Eindhoven Airport. The results are compared with socio-demographic characteristics using the Chi-square test in cross tab analysis. Test results and the cross tabs can be found in the appendix.

- I think the security services at Eindhoven Airport are efficient

In the first statement, respondents are questioned if they think the security services in Eindhoven Airport sufficient. The results from cross tab analysis (Appendix X) show that 29.9% of respondents agree with the statement, 49.6% are neutral and 20.4% disagree with it (Figure 4.2.13). According to Chi-square values, age and income show a significant difference in their responses. As can be seen in figure 4.2.13, respondents with higher income and above 31 years old agree more with the statement than the overall distribution. People below 30 years old disagree the most with the statement with 22.1%. It can be concluded that people with higher income and older age are more satisfied with the security services in the Airport.

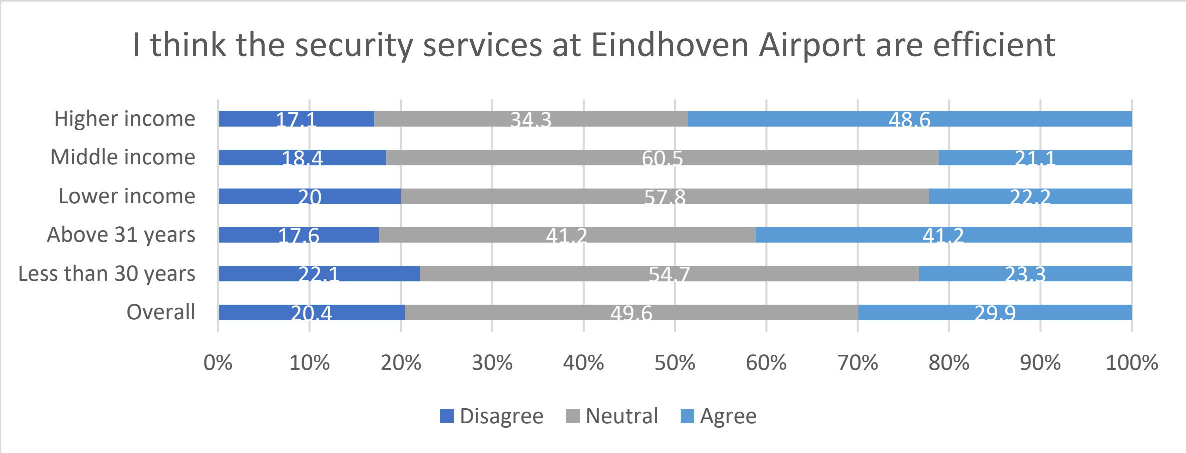


Fig. 4.2. 13 Statement: I think the security services at Eindhoven Airport are efficient

- I think the ambiance of Eindhoven Airport is pleasant

The second statement asks the respondent's opinion about the overall ambiance of the Airport. As can be seen in Figure 4.2.14, 48.9% of the respondents agree on this statement, 40.1% are neutral and 10.9% disagree. According to the Chi-square test from cross tab analysis (Appendix X), age, household size, employment status, and income level show significant differences in responses. Respondents with a part-time job agree more with the statement (62.9%). Whereas only 33.8% of people with fulltime jobs agreed with the statement. Respondents with a household size of 1 person agree the most with the statement (61.8%) and respondents with a household size of 2 persons agree the least with the statement (30.2%). Additionally, respondents with a household size of 3 persons disagree the most to this statement (20%). Regarding the income groups, the lower-income respondents agree the most with the statement (68.9%) whereas only 40% of the higher income respondents agree with the statement and 11.4% of them disagree. Regarding the age groups of respondents, it can be seen that 52.3% of respondents below 30 years old agree with the statement which is more than the average answer of respondents above 31 years old with 43.2% agree with responses.

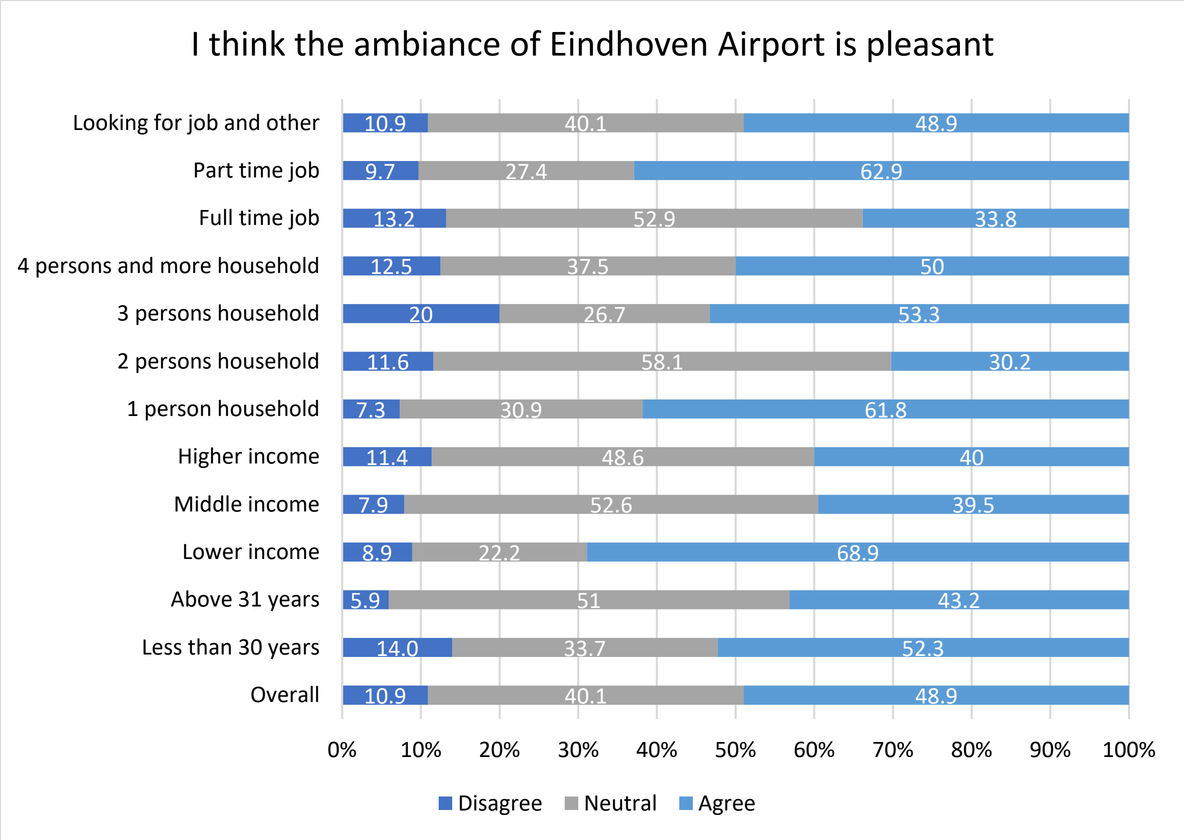


Fig. 4.2. 14 Statement: I think the ambiance of Eindhoven Airport is pleasant

- I think Eindhoven Airport is better accessible with car

The third statement asked the respondent's opinion about the accessibility of Eindhoven Airport by car. According to the results, in total 51.1% agree, 21.9% are neutral and 27% disagree with the statement (Appendix X). The Chi-square test from the crosstab analysis of socio-demographics shows a significant difference in age, gender, and income levels. The result of these socio-demographic characteristics is demonstrated in Figure 4.2.15. There is a significant difference between female and male respondents. According to the results, female respondents think that Eindhoven Airport is more accessible with the a car (66.7%) compare to male respondents (39.2%). Additionally, the result from income groups shows that 60% of lower-income groups agree that Eindhoven Airport is better accessible with a car whereas only 22.9% of higher-income agree to the statement. What is more, the higher income respondents are the biggest group that disagrees with the statement (48.6%). The result from age groups shows that younger age groups think Eindhoven Airport is better accessible with a car (59.3%) than the older age group of above 31 years old (37.3%). Based on the overall results, it can be concluded that half of the respondents (51.1%) think that accessing the Airport is easier with a car than other transport modes (Figure 4.2.15).

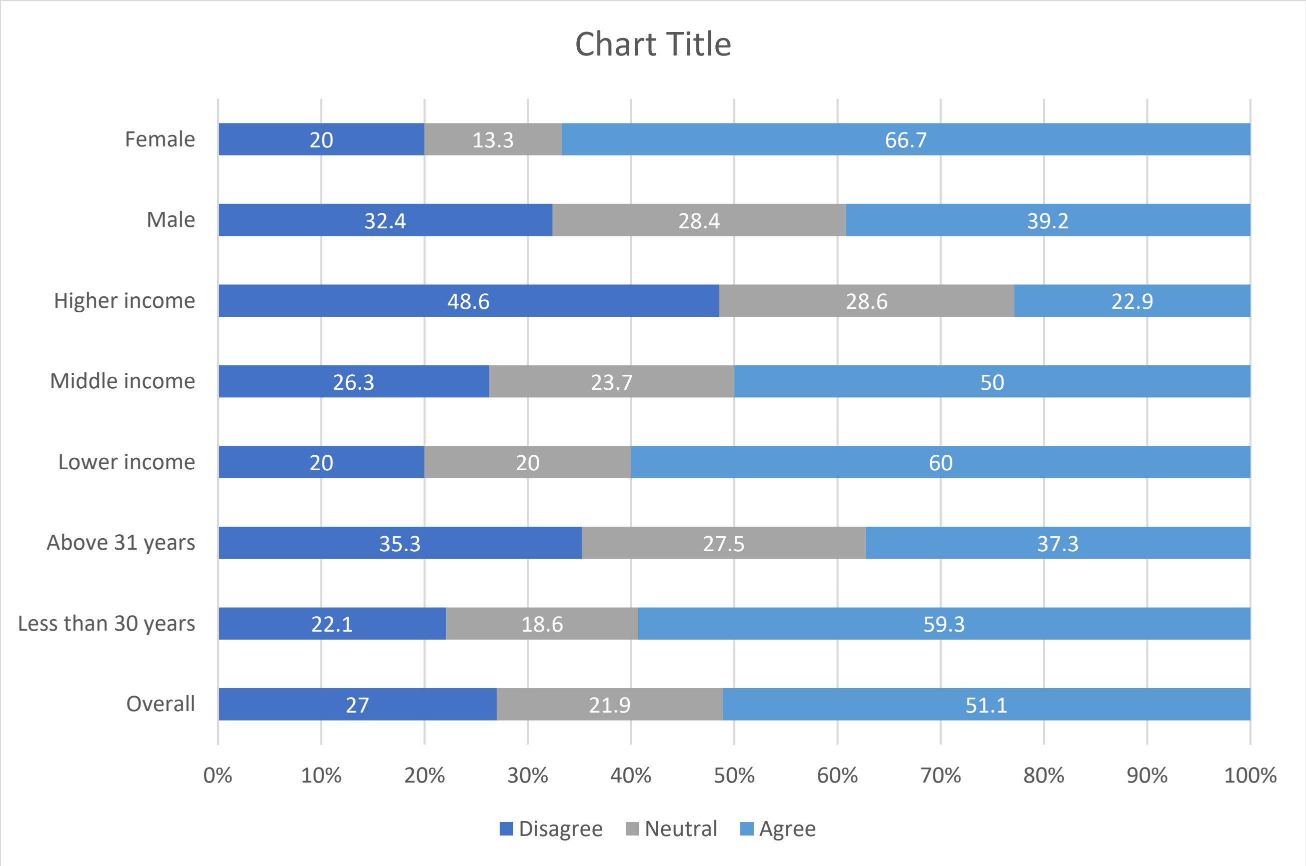


Fig. 4.2. 15 Statement: I think Eindhoven Airport is better accessible with car

- I enjoy driving to Eindhoven Airport

The last statement asks respondents if they think driving to Eindhoven Airport is a pleasurable activity. In total, 65.7% agree with this statement, 18.2% are neutral and only 16.1% disagree. According to the Chi-square test (Appendix X), only education levels show a significant difference. As can be seen in figure 4.2.16, the lower education group has the highest percentage of agreeing with the statement (87.5%).

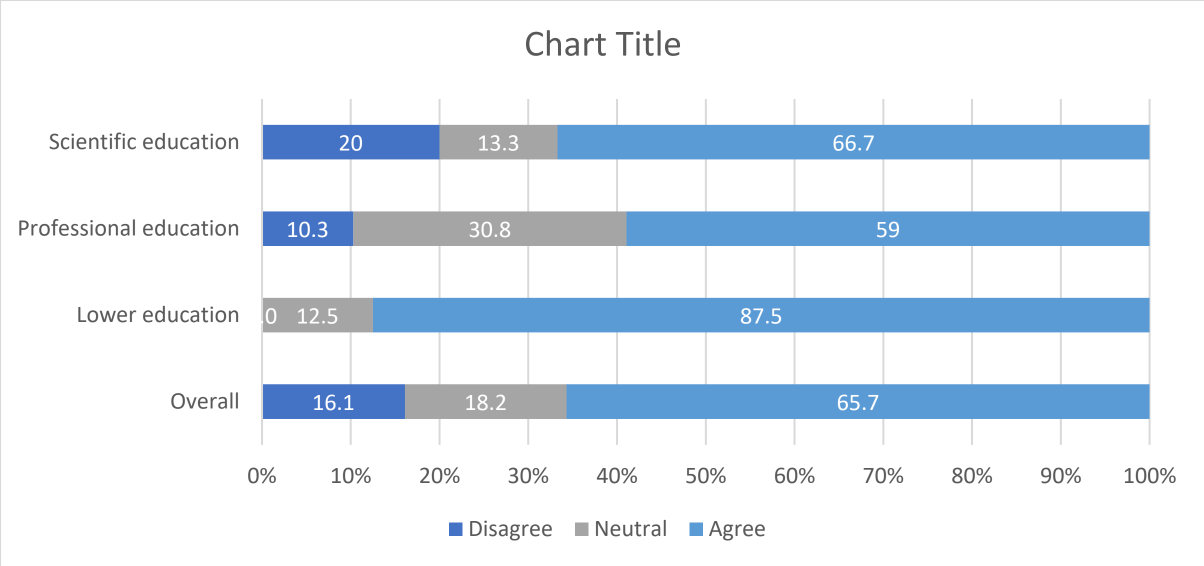


Fig. 4.2. 16 Statement: I enjoy driving to Eindhoven Airport

4.2.6.1 Cronbach Alpha Coefficient for internal consistency

It is imperative to calculate the Cronbach Alpha Coefficient for internal consistency reliability when using Likert-type scale questions. This coefficient ranges 0 to 1 and values of >0.8 indicate high reliability (Woollins, 1992). Values of higher than 0.7 suggest good reliability and values of less than 0.5 suggest poor reliability. Table 4.2.3 represents the output of the Cronbach Alpha coefficient for behavioral questions. As can be seen, the coefficient value of 0.82 determines high reliability. This provides the possibility to combine environmental factors or airport factors into single item and use it as a latent variable in future Eindhoven Airport studies.

Reliability Statistics

Cronbach's Alpha	N of Items
.822	4

Tab. 4.2. 3 Cronbach's Alpha coefficient

4.3. MODEL ESTIMATIONS

This section describes the estimations of the Multinomial Logit and Mixed Logit (MNL) model on the sample data. Analysis of the data has been performed using Nlogit; a standard software package from Economics Software Inc. (ESI). Section 1.3.1. discusses the estimations of the Multinomial Logit model. Section 1.3.2. explains the estimation of the Mixed Logit model.

4.3.1. MNL model

The MNL model is estimated first and the complete results of estimations are presented in the Appendix XI. The McFadden's rho-square value(ρ^2) of the model is 0.17 and performs moderately in the goodness of fit (Hensher et al., 2015). The results of coefficient estimations for alternatives are discussed below.

Car

An alternative car is the base alternative in the model estimation. Hence, context and socio-demographic coefficients are not estimated for this alternative. Table 4.3.1 shows the attribute coefficients for the car. It can be seen that travel time, travel cost, and walking time to the terminal is not significant in this alternative.

Attribute	Coefficient	Significance
Travel time 10	0.144	NA
Travel time 15	0.030	
Travel time 20	-0.174	
Travel cost 0.25	-0.084	NA
Travel cost 0.5	0.028	
Travel cost 1	0.056	
Kiss & ride	0.920	NA
Parking cost 20	0.060	
Parking cost 30	-0.980	***
Walking time 0	0.421	-
Walking time 5	-0.343	
Walking time 10	-0.078	

Tab. 4.3. 1 MNL results alternative car

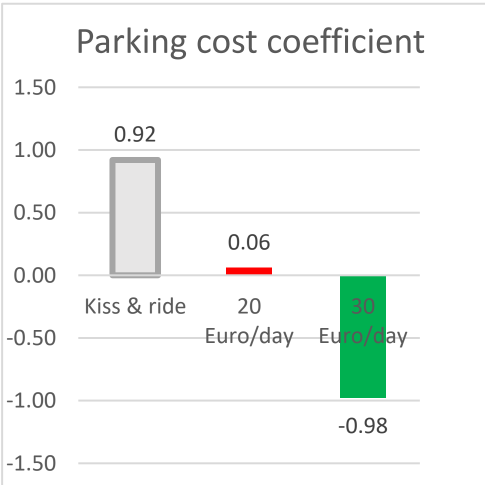


Fig. 4.3. 1 Parking cost coefficients

1% significance level 5% significant 10% significant Not significant

Unknown (base level)

For the attribute parking costs, the base level of kiss & ride has a positive value of 0.920, which the significance is not known (base level). It shows that there might be a strong preference towards kiss & ride (drop off) alternative. This finding is in line with the MNL model estimations from Birolini et al. (2019) for kiss & ride alternative. However, Kiss & ride is regarded as the most environmentally intense mode of transport (2-leg trip), which also brings no revenue for airports. Bud (2014) found that kiss & ride travelers are often not aware of how unsustainable their transport is. Hence, educational campaigns regarding the problem and the impact of this mode of transport might help reducing the preference towards kiss & ride (Bud, 2014). Another possible policy is to allocate entry charge for each drop-off and pick-up or a combination at Eindhoven Airport.

Further, the daily parking cost of 20 Euros does not show any significance in parameter estimation (Figure 4.3.1). On the other hand, the third level of 30 Euros per day has a negative coefficient value of -0.980, which is significant at 1% level and supports the finding by Jou et al. (2011), which mentioned parking prices as significant determinants on travelers who drive a car to the airport. As a result, increasing parking price seems to be an effective policy to incline travelers to choose other alternatives. On the one hand, increasing parking prices can decline the parking patronage and decrease the venue of Eindhoven Airport. On the other hand, reduction in demand for parking will increase a long-term revenue without need to construct new parking lots. What is more, the available parking spaces can be used to implement new mobility services such as car-sharing or used for other purposes.

Taxi

The second alternative in the choice task is taxi, which provides door-to-door transport and has zero first and last mile commute time. Figure 4.3.2 demonstrates the significant coefficients of the alternative taxi and Table 4.3.2 shows the complete coefficient estimations. The constant-coefficient for this alternative has a negative sign and is not significant, suggesting that there is no specific positive or negative preference for this alternative comparing to the base alternative of car.

Regarding the alternative attributes, Figure 4.3.2 represents the travel time estimations for this alternative. The base level of 10 minutes has a positive parameter value of 0.531 (base level). The second level coefficient for travel time 15 minutes is not significant and has a value close to zero. Moreover, third level coefficient for travel time of 20 minutes is significant at 1% level and has a negative value of -0.624. Attribute coefficients suggest that travel time is probably a determinant factor for choosing the alternative taxi for travelling to Eindhoven Airport. This finding is in line with the findings of the literature mentioned in section 3.2, which almost all stressed on the effect of travel time on the utility of transport mode to the airport.

Fig. 4.3. 2 Travel time coefficient alternative Taxi

1% significance level 5% significant 10% significant Not significant

Unknown (base level)

Figure 4.3.3 shows the coefficient values for context attributes. The business travel purpose has a positive coefficient of 0.410, which is significant at 10% level, which is in line with findings from Birolini et al. (2019), suggesting that business-purpose travelers have a preference towards the alternative taxi. This can be attributed to the willingness of business travelers to pay more for their transfer, which is often compensated by their employer (Birolini et al., 2019).

Furthermore, carrying two luggage also has a positive value of 0.335 at 10% significance level, which determines a preference towards the alternative taxi as a result of convenience for storing luggage.

Contrary to previous context attributes, travel accompany does not show any significance and might be not determinant factor in choosing this alternative. This finding is in contrast with the result from Chang (2013), which found that travel company can increase the utility of alternative taxi significantly explained by the fact that travelers can share the cost of taxi.

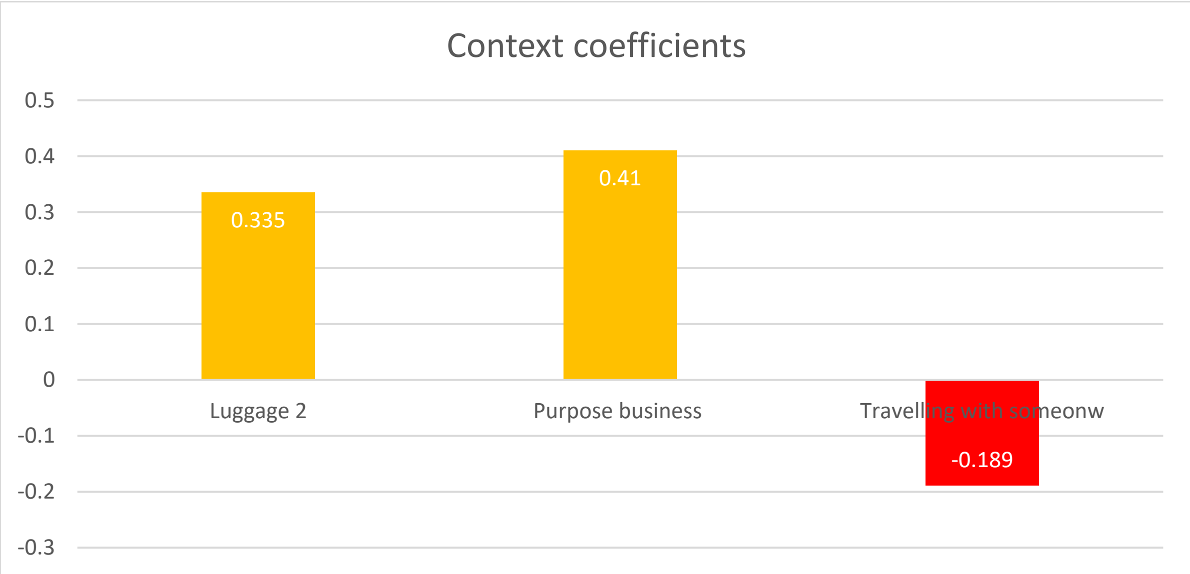


Fig. 4.3. 3 Context coefficients alternative Taxi

Regarding the socio-demographic attributes, as it can be seen in Figure 4.3.4, only the lower-income coefficient has a significant coefficient estimation. This attribute has a negative coefficient value of -0.892, which is significant at 5% level and suggest that lower-income respondents have negative preference towards alternative taxi that has higher travel costs compare to the other alternatives in this research. Middle- and higher-income group coefficient values does not show significant values. Higher income group, however, is the only income group that has a positive coefficient value (0.251).

Fig. 4.3. 4 Income groups coefficients for alternative Taxi

Figure 4.3.5 shows the overall significant coefficients of the alternative Taxi. It can be concluded that people prefer to use this alternative when having more luggage's and the travel purpose of work/business. What is more, people with lower income are probably less inclined to use this alternative due to higher tariffs.

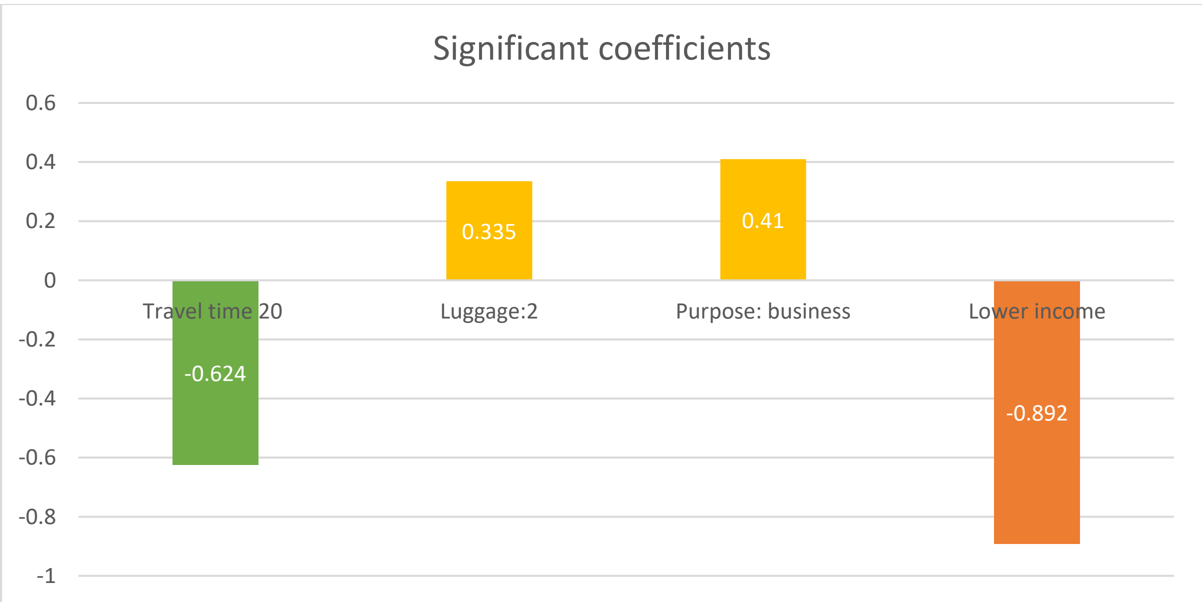


Fig. 4.3. 5 Significant coefficients alternative Taxi

Attribute	Coefficient	Significance
Constant Taxi	-0.137	
Travel time 10	0.531	NA
Travel time 15	0.093	
Travel time 20	-0.624	***
Travel cost 7.5	0.318	NA
Travel cost 10	-0.133	
Travel cost 12	-0.185	
Luggage: 1	-0.335	NA
Luggage: 2	0.335	*
Purpose: leisure	-0.410	NA
Purpose: business	0.410	*
Travelling alone	0.189	NA
Travelling with someone	-0.189	
Male	-0.019	
Female	0.019	NA
Less than 30 years old	-0.169	
31 to 40 years old	0.170	
Above 41 years old	-0.001	NA
Scientific education	-0.136	
Other education	0.136	NA
Lower income	-0.892	**
Middle income	-0.179	
Higher income	0.251	
Not provided income	0.820	NA
Household:1 person	0.144	
Household: 2 persons	0.286	
Household: 3 persons	-0.039	
Household: ≥4 persons	-0.391	NA
Full time job	0.040	
Other job	-0.040	NA

Tab. 4.3. 2 MNL results alternative Taxi

E-Carsharing

The third alternative in the choice task is E-carsharing service, which is a non-existing transport mode for travelling to Eindhoven Airport at the moment and is considered as a future sustainable mobility scenario for this research. This service provides door-to-door service (first mile commute is neglected from the study), and does not have waiting time and there is no transfer during the trip. MNL coefficient estimations of the third alternative E-carsharing are presented in Table 4.3.3 and Figure 4.3.3 demonstrates the significant coefficients.

Unlike the alternative taxi, the constant coefficient of E-carsharing is significant at 1% level and has a positive value of 0.702. This suggests that there is a strong preference towards E-carsharing in comparison with the base alternative of car among the respondents. The finding implies that realizing E-carsharing service hubs in Eindhoven Area can a be successful policy for reducing the modal share of private vehicles.

Regarding the alternative specific attributes, coefficient estimation of the attribute travel time is demonstrated in figure 4.3.6. The first two levels of travel time (10 & 15 minutes) do not show significant results but have positive coefficient values. The travel time of 20 minutes, the third level, has a negative value of -0.402 and is significant at 5% level. It can be concluded that travel time with the alternative E-carsharing is an important determinant for respondents, which is also supported by the findings of literature in section 2.3.

Fig. 4.3. 6 Travel time coefficients alternative E-carsharing

1% significance level 5% significant 10% significant Not significant

Unknown (base level)

Furthermore, as can be seen in Figure 4.3.7, travel cost coefficient values have a similar trend as travel times. The base level and second level have positive values; However, conclusions cannot be drawn since the first level is the base. Furthermore, the third level of this attribute (travel time 20 minutes) is significant at 5% level and has a negative value of -0.438, suggesting that higher travel time negatively influence the preference towards the alternative E-carsharing.

Fig. 4.3. 7 Travel cost coefficients alternative E-carsharing

Regarding the incentive attributes, it can be seen that a coffee discount contributes positively to the overall utility. This coefficient has a value of 0.441 and is significant at 1% level suggesting it can play a role in respondents choosing E-carsharing. Surprisingly, the incentive level of the fast track line is significant with a negative sign. This coefficient has a value of -0.293, which is significant at 10%. It is possible that some respondents did not clearly understand this incentive or did not take it into account due to extended attribute list.

Fig. 4.3. 8 Incentives coefficients alternative E-carsharing

Context and socio-demographic attributes did not show significant results for this alternative. However, as discussed in the section 2.2.2, findings from Baptista et al. (2014) showed that young and higher educated individuals are more likely to use carsharing services. Hence, the lack of significance might be attributed to the limited sample size of the research. Additionally, the over representativeness of young educated individuals in the sample and the highly significant value of the E-carsharing constant might confirm that there is a preference for this alternative among young and educated respondents.

Finally, Figure 4.3.9 reflects all the significant coefficients for the alternative E-carsharing. Estimations suggested that context and socio-demographic attributes does not have significant influence on the overall utility of this alternative. It can be observed that travel time and travel cost can play a role in individual's choice for E-carsharing to travel to airport and the constant suggested that individual's prefer this alternative over the alternative car. What is more, offering incentives such as coffee discount, can have positive contribution to the utility and incline individuals to choose the E-carsharing.

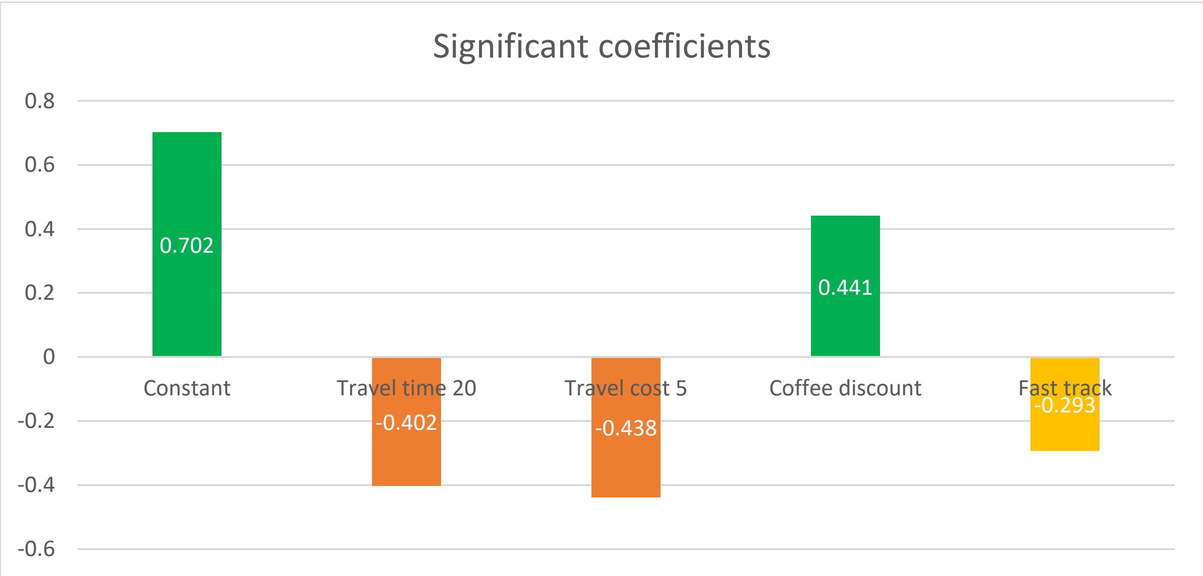


Fig. 4.3. 9 Significant coefficients alternative E-carsharing

Attribute	Coefficient	Significance
Constant E-carsharing	0.702	***
Travel time 10	0.235	NA
Travel time 15	0.167	
Travel time 20	-0.402	**
Travel cost 2	0.271	NA
Travel cost 3	0.167	
Travel cost 5	-0.438	**
No bonus	-0.148	NA
Bonus: coffee discount	0.441	***
Bonus: fast track line	-0.293	*
Walking time: 0 min	0.110	NA
Walking time: 5mins	0.117	
Walking time: 10 mins	-0.227	
Luggage: 1	-0.035	NA
Luggage: 2	0.035	
Purpose: leisure	-0.227	NA
Purpose: business	0.227	
Travelling alone	-0.225	NA
Travelling with someone	0.225	
Male	-0.111	
Female	0.111	NA
Less than 30 years old	-0.047	
31 to 40 years old	0.053	
Above 41 years old	-0.006	NA
Scientific education	0.107	
Other education	-0.107	NA
Lower income	0.084	
Middle income	-0.257	
Higher income	-0.224	
Not provided income	0.397	NA
Household:1 person	0.079	
Household: 2 persons	-0.119	
Household: 3 persons	-0.046	
Household: ≥4 persons	0.086	NA
Full time job	-0.089	
Other job	0.089	NA

Tab. 4.3. 3 MNL results alternative E-carsharing

Bus

The fourth transport mode in the choice task is the alternative bus. This alternative is an already existing transport mode with two bus lines departing from Eindhoven Station to Eindhoven Airport and near future a new bus line (HOV3) will also be available. Model estimations for the alternative bus are represented in Table 4.3.4 and Figure 4.3.4 demonstrates the significant coefficients. The constant value of the alternative bus has a negative value of -0.854, which is significant at 5% level. Therefore, there is a negative preference towards the alternative bus even though (as it could be seen from Figure 4.2.2) most of the respondents have used the alternative bus the last time they visited Eindhoven Airport. A possible explanation for this negative preference could be the possibility to choose from not existing alternatives such as E-carsharing and bus-haling in the choice task. However, negative preference toward the alternative bus is also observed in previous research and is associated with inconvenience for storing luggage, transfer during trip and waiting times (Chang, 2013; Tam et al., 2010).

Furthermore, as can be seen in Figure 4.3.10, increase in travel time contributes negatively to the overall utility of the alternative. Travel time of 25 minutes is the base level with positive value of 0.51. Second level of 30 minutes does not show a significant result. Travel time of 35 minutes, however, is significant at 5% level and has a negative value of -0.495. This finding is in line with previous research mentioned in section 2.3 stressing travel time as a determinant attribute in trips to the airports.

Fig. 4.3. 11 Travel time coefficients alternative Bus

Fig. 4.3. 10 Travel cost coefficients alternative Bus

1% significance level 5% significant 10% significant Not significant

- ☐ Unknown (base level)

Regarding travel costs, the base level of this attribute (2 Euros), has a positive value of 0.4 and is probably significant (Figure 4.3.10). The second level, travel cost of 3 Euros, shows a negative coefficient value of -0.411, which is significant at 10% level. Surprisingly, the third level of travel cost 4 Euros, has a value of 0.01, which is higher than the previous level. However, this coefficient is not significant, and this contradictory result is probably due to limited amount of observations for this specific attribute.

Alternative specific attributes of waiting time for bus arrival and transfers in trip does not show any significance. However, it can be observed that an increase in waiting time and transfers in the trip to the airport contribute negatively to the overall utility of the alternative bus (Table 4.3.4). The negative effect of transfers is also supported by the findings of Tam et al. (2010), which mentioned that departing travelers are sensitive to number of bus transfers required for accessing Hong Kong International Airport.

Regarding context attributes, the coefficients estimates show no significant results, which can be attributed to limited data sample. However, the coefficient signs show that the alternative bus is preferred when respondents are alone (no travel accompany), have only one luggage and the trip purpose is business. The negative effect of travel accompany on the utility of bus is also reported by Tam et al. (2010). It can be argued that departing air passengers in groups of two and more can share the travel cost of a taxi, E-carsharing or private car, while travelers taking bus and bus hailing have to pay per-person. Consequently, Chang (2013) has also stated that carrying luggage decrease the preference towards the alternative bus, which is line with finings of this research.

Surprisingly, the coefficient estimations for the incentives are not significant for the alternative bus, even though they show positive signs. As a result, unlike the alternatives E-carsharing and bus-hailing, incentives are not determinant factors for the alternative bus. This finding and the high modal share of bus (mentioned in section 4.2.1) suggest that the respondent sample has highly positive attitude towards bus and might feel it easy to use or might have a degree of social pressure to use it.

Regarding socio-demographic attributes, it appears that age is an important factor in the utility of the alternative bus. Figure 4.3.12 shows that the coefficient value for age group of less than 30 years old has a positive value of 1.023, which is significant at 1% level. Coefficient estimation for age group of 31 to 40 also positively contributes to the overall utility and has a value of 0.68, which is significant at 5% level. On the other hand, for the age group of above 41 years old, coefficient value is negative with a value of -1.712 (used as reference level). This is consistent with Chang (2013)'s research findings that older people did not prefer to use bus to commute to the airport. This might be attributed to the difficulty for older people to get in and out of bus and also limited space for luggage.

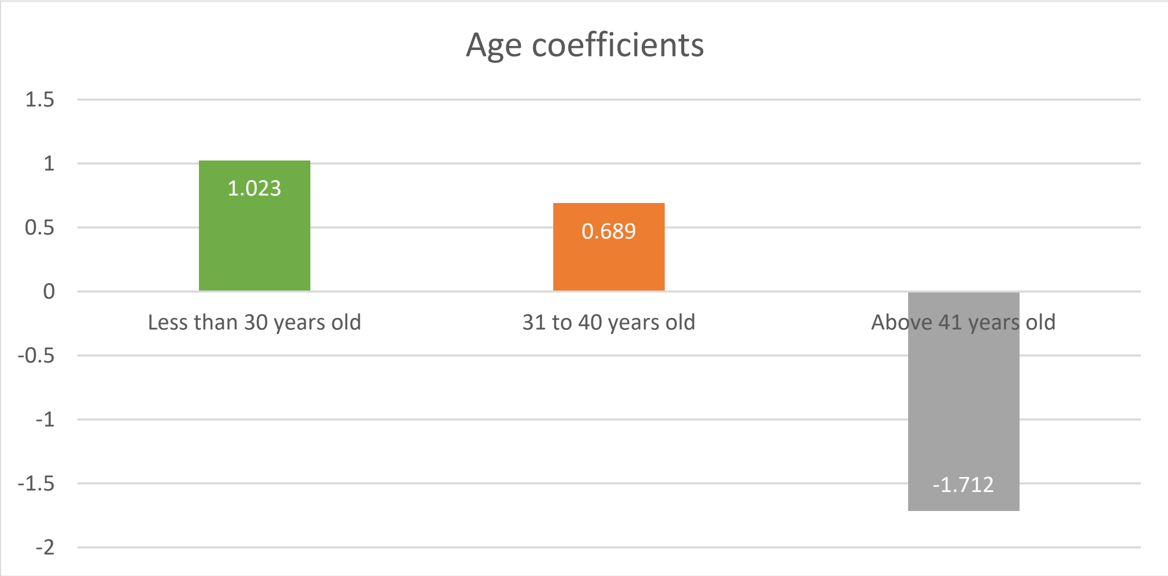
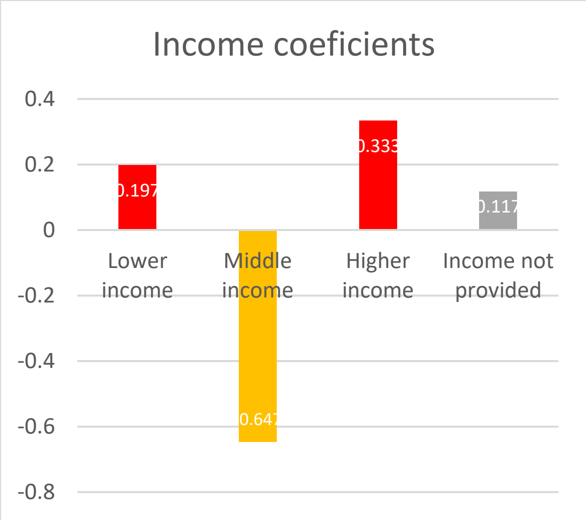


Fig. 4.3. 12 Age coefficients alternative Bus

Regarding the household size, the coefficient for a household size of one person has a positive coefficient value of 0.746, which is significant at 5% level (Figure 4.3.13). Household size of 2 and 3 persons are not significant and have values of -0.413 and 0.581 respectively. Consequently, household size of +4 persons has a negative coefficient of -0.914 (used as reference level). This is in line with Chebli & Mahmassani (2002)'s finding that household size has negative influence on the preference towards bus. This can be explained by two reasons. First, the cost of alternative bus is per-person, while a larger household can share the cost of the taxi, E-carsharing and car. Second, larger households are more likely to own a car and use it to drive or get a ride to the airport. However, the positive coefficient value of 3 persons household is surprising, although, this coefficient is not significant. This can be attributed to the young families without car who have a kid that is young enough to use public transport for free.



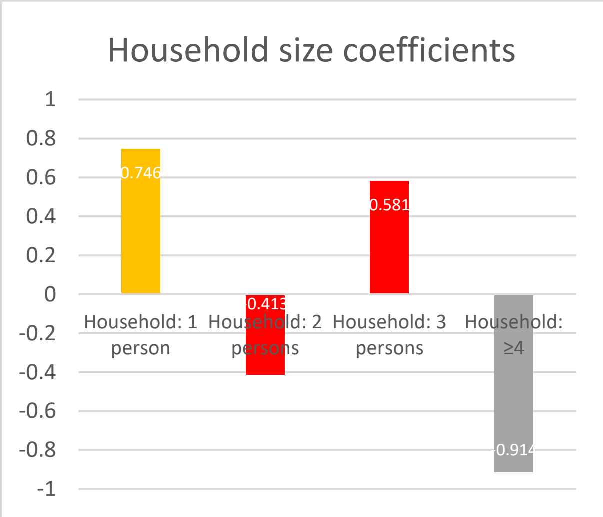


Fig. 4.3. 13 Household size coefficients alternative bus

Fig. 4.3. 14 Income coefficients alternative Bus

Furthermore, the coefficient estimations for income groups are shown in Figure 4.3.14. The lower and higher income groups have coefficients values of 0.197 and 0.33 , which are not significant. The middle-income group has a negative coefficient with a value of – 0.641, which is significant at 10% level suggesting that middle-income respondents have a negative preference towards the alternative bus. The result from lower-income and middle-income groups are consistent with Jou et al. (2011)'s findings that income is inversely proportional to the preference towards the alternative bus. However, the positive coefficient value of higher-income group contradicts that.

Finally, Figure 4.3.15 demonstrates the overall significant coefficients for the alternative bus. Estimations suggested that context attributes and incentives do not show significance result in the overall utility for this alternative. What is more, alternative specific attributes such as waiting time for mode's arrival and number of transfers in the trip are not determinant attributes in individual's choice. Additionally, as seen in other alternatives, travel time and travel cost showed significant results and seem to be important for individual's choice. Finally, socio-demographic characteristics suggested that younger respondents that live alone are more likely to choose alternative bus to travel to Eindhoven Airport.

Fig. 4.3. 15 Significant coefficients alternative Bus

Attribute	Coefficient	Significance
Constant bus	-0.854	**
Travel time 25	0.51	NA
Travel time 30	-0.015	
Travel time 35	-0.495	**
Travel cost 2	0.40	NA
Travel cost 3	-0.411	*
Travel cost 4	0.010	
Waiting time: 3.5	0.097	NA
Waiting time: 5	-0.005	
Waiting time: 10	-0.092	
Direct trip	0.462	NA
One transfer	-0.167	
Two transfers	-0.295	
No bonus	-0.134	NA
Bonus: coffee discount	0.011	
Bonus: fast track line	0.123	
Luggage: 1	0.225	NA
Luggage: 2	-0.225	
Purpose: leisure	-0.076	NA
Purpose: business	0.076	
Travelling alone	0.222	NA
Travelling with someone	-0.222	
Male	-0.138	
Female	0.138	NA
Less than 30 years old	1.023	***
31 to 40 years old	0.689	*
Above 41 years old	-1.712	NA
Scientific education	-0.008	
Other education	0.008	NA
Lower income	0.197	
Middle income	-0.647	*
Higher income	0.333	
Not provided income	0.117	NA
Household:1 person	0.746	**
Household: 2 persons	-0.413	
Household: 3 persons	0.581	
Household: ≥4 persons	-0.914	NA
Full time job	0.354	
Other job	-0.354	NA

Tab. 4.3. 4 MNL results alternative Bus

Bus-hailing:

Fifth and the last transport alternative in the choice task is bus-hailing service, which is a non-existing transport mode for travelling to Eindhoven Airport and is considered a future sustainable mobility scenario for this research. The model estimations of this alternative are represented in Table 4.3.5 and Figure 4.3.5 demonstrates the significant attribute's results. The constant for this alternative is not significant and has a negative value of -0.188. However, bus-hailing performs better regarding the alternative preference comparing the alternative bus.

Regarding the attributes of the alternative bus-hailing, Figures 4.3.16 & 4.3.17 show that the travel time, travel cost, and incentive show significant results in their levels. The travel time of 10 minutes has a coefficient value of 0.156, which is the base level. Surprisingly, the travel time 15 minutes has a positive coefficient value of 0.543 at 5% significant, indicating that this attribute level is preferred more than the base level. A possible explanation might the limited number of data on the base level. Consequently, the third level of travel time has a negative coefficient value of -0.699, which is significant at 1% level. This result is consistent with previous alternatives, which implies that travel time is one of the most important determinants for travelers to the airport.

Travel cost coefficients show similar results (Figure 4.3.16). The base level (travel cost 2.5 Euro) is positive and has a value of 0.637. The second level is not significant and has a value of -0.081. Third level of travel cost (7.5 euros) is significant at 15% level and has a negative value of -0.556.

Fig. 4.3. 17 Travel time coefficients alternative Bus-hailing

Fig. 4.3. 16 Travel cost coefficients alternative Bus-hailing

Furthermore, the coefficients of attribute incentives are presented in Figure 4.3.18. The base level (no bonus) has a negative value of -0.421, which is the highest negative value among the transport alternatives. This suggests that having no bonus reduces the utility of the alternative bus-hailing more in comparison to the other sustainable modes. The second level, the coffee discount, is not significant and has a low value of 0.025. Hence, it can be suggested that this level of incentives does not trigger traveler's mode choice towards bus-hailing. However, the third level, the fast track line incentive, is significant at 5% level and has a positive value of 0.396. It can be concluded that incentives in general, contribute positively to the overall utility of this alternative and lack of incentives can also negatively affect the alternative bus-hailing.

Fig. 4.3. 18 Incentive coefficients alternative Bus-hailing

Regarding the context attributes of travel purpose, travel accompany and luggage, it can be seen from Table 4.3.5 that the estimated coefficients are not significant, and the values are mostly close to zero except the luggage coefficients. Carrying two luggage has a negative value of -0.155, which indicates that the bus-hailing is less preferred among travelers with more than one luggage.

Regarding the socio-demographic attributes, the coefficient estimations do not show any significant result. Figure 4.3.19 demonstrates the overall significant coefficients of the Bus-hailing. Coefficient estimations suggest that alternative specific attribute of waiting time for the bus-hailing is not significant. Additionally, socio-demographics seems to be not determinant attributes in the utility of this alternative. As seen in the previous alternatives, travel times and travel costs seem to be the most important factors in the individual's choice for this alternative. Finally, incentives show to contribute positively to overall utility of this alternative.

Attribute	Coefficient	Sign
Constant bus hailing	-0.188	
Travel time 10	0.156	NA
Travel time 15	0.543	**
Travel time 20	-0.699	***
Travel cost 2.5	0.637	NA
Travel cost 5	-0.081	
Travel cost 7.5	-0.556	**
Waiting time: 10	0.173	NA
Waiting time: 15	-0.086	
Waiting time: 20	-0.087	
No bonus	-0.421	NA
Bonus: coffee discount	0.025	
Bonus: fast track line	0.396	**
Luggage: 1	0.155	NA
Luggage: 2	-0.155	
Purpose: leisure	-0.015	NA
Purpose: business	0.015	
Travelling alone	-0.024	NA
Travelling with someone	0.024	
Male	0.249	
Female	-0.249	NA
Less than 30 years old	-0.450	
31 to 40 years old	0.030	
Above 41 years old	0.420	NA
Scientific education	0.212	
Other education	-0.212	NA
Lower income	0.495	
Middle income	0.047	
Higher income	-0.293	NA
Household:1 person	0.337	
Household: 2 persons	-0.139	
Household: 3 persons	-0.108	
Household: ≥4 persons	-0.09	NA
Full time job	-0.016	
Other job	0.016	NA

Tab. 4.3. 5 MNL results alternative Bus-hailing

4.3.2. ML model

Two types of Mixed Logit models have been estimated for this research: The Random Parameter ML model to measure taste variation, Error Components ML model to measure for similarities. The estimations from the Random Parameter model are neglected from this research since no significant difference in tastes were observed. The result from the Error Components model is mentioned in the following section.

4.3.2.1 Error Component model

Error Components Mixed Logit model allows for similarities to existing between alternatives. In this research, three random components are added to the model. It is considered that the alternatives Bus + Bus-hailing have the common components of using public transport towards Eindhoven Airport. The second common component is considered to be the Car+ Taxi as a private commute to Eindhoven Airport. Lastly, it can be considered that there is a common component of the Car + E-carsharing for driving towards the Eindhoven Airport.

In model estimation, the standard deviation is calculated for the error components and determines the similarities that might exist between the alternatives. The higher values of standard deviation suggest an increase in similarities between the alternatives and as a result, the probabilities of the alternatives decrease. In this study, a normal distribution is assumed for the error components and are drawn using 1000 Halton draws. The McFadden's rho-square value(ρ^2) of the model is 0.193, which suggests an acceptable goodness-of-fit. The AIC of the model is 1448.9, which is almost the same amount as the MNL model. The complete output can be found in the Appendix XI. The 'error' components are individual random effects that are distributed among alternatives according to a tree structure.

Table 4.3.6 shows the standard deviations of the Error Components ML model, and as can be seen, only one similarity exists. The standard deviation for the driving component (Car+ E-carsharing) has the highest value and is significant. The significant similarities in choice behavior between two alternatives suggest that introducing E-car-sharing pick up and drop off points in Eindhoven Airport can substitute the use of private car.

Attributes	Std.dev.	Significance
Public transport component	1.322	
Private commute component	1.766	
Driving component	2.781	**

Tab. 4.3. 6 Standard deviation Error Component model

4.4. CONCLUSION

This chapter discussed the results of the SC experiment. Data has been collected between the 20^{th} of December and the 27^{th} of January, resulting in 372 respondents which 173 of them completed the questionnaire, and 137 were in the target group. Hence, this data is used in different statistical approaches. First, the sample is described and compared to Dutch society using a Chi-square representative test. It can be seen from the chi-square values that characteristics of gender, household size, and employment are representative of the Dutch population. However, characteristics of age, education, and income are not representative of the Dutch population.

In the second part of the descriptive analysis, the responses to the purpose of the trip, distance to the nearest transport, and weekly use of different transport modes were discussed. In can be concluded that the majority of trips purposes are for holidays and visiting family/friends and the business trips are scarce in Eindhoven Airport. This is consistent with previous research and emphasizes that airports with lower cost airlines are used more often for recreational purposes. The most used transport mode to go to Eindhoven Airport is public transport in the sample, which contradicts the previous research on the modal share of travelers to the airport that found private vehicle as the most used. This can be the result of data collection period during Christmas and new year holidays where a lot of students and expats, whom do not have a car, use Eindhoven Airport to visit their families.

Taxi is used most when the trip purpose is business and getting a ride is more popular when the purpose of the trip is a holiday or visiting, family/friends. The crosstab analysis of distance to the nearest transport hub and the transport mode used showed that the modal share of public transport drops drastically for distances longer than 1.5 kilometer and modal share of taxi and car increase. This finding suggests that first mile commute might have a strong influence on mode choice of travelers to Eindhoven Airport. The future research should investigate the effect of distance to transport hub as a latent variable in the modeling process. Regarding the average weekly use of different transport modes, it was observed that active modes (car, train, bus) are used mostly between 1 to 3 days and the active mode of the bike is the most popular for everyday use. The high share of daily bike users and high modal share of public transport as a mode of commuting to Eindhoven airport suggest that the data sample is not car dependent.

In the third part of descriptive analysis, transportation factors, and stress level upon arrival were analyzed. The result showed that the reliability of transport mode is the most important factor for the respondents. The environmental concern, however, showed the least importance. The majority of respondents determined that they prefer to be in the airport 2 hours before their flight and at least half of the respondents are stressed to some degree to arrive on time at the airport.

The fourth part of descriptive analysis combined the responses to attitudinal questions with socio-demographic characteristics by means of crosstabs. It can be concluded that the majority of the sample agreed on all statements, which means that the respondents are conscious regarding environmental issues. However, people with less than 30 years old, who are have scientific education are more willing to adopt an environmentally friendly lifestyle.

The fifth and last part of the descriptive analysis combined the analysis of the Likert scale statements about Eindhoven airport with socio-demographic characteristics. It can be concluded that higher-income respondents, who are between 31 and 40 years old are more satisfied with the security services at Eindhoven Airport. What is more, the analysis of the statement regarding the ambiance of the airport showed that one-person household and three-persons household respondents find the ambiance of Eindhoven Airport more pleasant. On the contrary, respondents with 2-persons households were the least to agree with this statement. Additionally, the analysis showed that respondents with a part-time job and lower-income find the ambiance of Eindhoven Airport more pleasant to spend time in comparison with respondents with a full-time job and higher income. Regarding the accessibility of the airport, female respondents, lower-income, and less than 30 years old respondents agree more with the statement that Eindhoven Airport is better accessible by car. Finally, the analysis showed that respondents with lower education enjoy more to drive to the airport in comparison with higher educated respondents.

Consequently, the stated choice data was analyzed after the descriptive analysis. The SC experiment focused on the choice behavior of individuals to determine which attributes are vital in the respondent's travel mode decision towards Eindhoven Airport. First, an MNL model was applied to the sample. Based on the results, multiple conclusions can be drawn for the alternatives. For the base alternative of car, the estimations suggested that the parking price is the most important factor for individuals. Consequently, the estimations for the alternative taxi showed that having two luggage and trip purpose of business can increase the respondent's preference towards this alternative. On the contrary, longer travel times showed to have a negative effect on preference towards Taxi, which might suggest that travel time is a determinate factor for choosing a taxi. What is more, lower-income respondents showed a negative preference towards the alternative taxi, which might be a result of higher travel tariffs of this alternative. Regarding the alternative E-carsharing, the model estimation showed a positive preference towards this alternative in comparison with the base alternative of the car. Incentives, as one of the focuses of this research, showed a positive result for the overall utility of this alternative. Meaning that offering a coffee discount at Eindhoven Airport can incline individuals towards using E-carsharing. However, higher travel times and travel costs negatively affect the utility of this alternative. Socio-demographic characteristics seemed to be not significant for choice behavior towards this alternative. Regarding the alternative bus, the estimation showed a general negative preference in comparison with the base alternative of the car. Younger single people (less than 40 years old) showed more preference to choose this alternative to travel to Eindhoven Airport. Regarding the alternative bus hailing, travel time showed an important factor in preference towards this alternative. What is more, incentives showed a positive effect in preference towards this alternative.

5 CONCLUSION

This thesis aimed to gain more insights into the factors influencing the mode choice behavior of commuters to Eindhoven Airport. The research focuses on the effect of travel context scenarios and travel incentives on the travel behavior adaptation towards sustainable mobility alternatives (car-sharing, demand-responsive transport) with regarding the socio-demographic and attitudinal characteristics of commuters to the airport. For the scientific relevance, the five sub-questions are explained to contribute to answering the main research question. Furthermore, societal relevance and research limitations and recommendations for future research are discussed in this chapter.

5.1. SCIENTIFIC RELEVANCE

This research contributes to the understating of infrequent mode choice behavior, focusing on using incentives to make sustainable alternatives more attractive. Previous researches have focused on frequent travel behavior such as home to work commuting and overlooked the incidental travel behavior. Furthermore, the is gap in research regarding effectiveness of incentives as a trigger for using sustainable modes of transport in incidental travels.

Regarding the mode choice to access the airports, the previous research is focused on traditional modes of transport such as car, taxi and bus. Sustainable modes such as E-carsharing are not existing in airport studies. Furthermore, very little research has been done to comprehend air passenger's mode choice in a Dutch context.

Therefore, this research project adds knowledge about the factors influencing commuter's decisions to switch to more sustainable alternatives in the context of traveling to Eindhoven Airport.

SQ1. What is the effect of state-of-the-art sustainable mobility concepts on travel behavior?

Sustainable mobility can be defined as the reflection of sustainable development in the transportation and planning sector. According to the literature review, the last technological advancement in sustainable mobility alternatives is electric vehicles (EV), car-sharing services, shared micro-mobility (bike-sharing), shared autonomous vehicle (SAV), and demand-responsive transport. Among these alternatives, SAV is still not commercially available and has the potential to make a big leap in modern transportation. Table 2.1 summarizes the effect of the sustainable mobility concepts on travel behavior based on literature review. What is more, mobility-as-a-service is an ICT based technology that can provide integrated sustainable mobility services within one platform. The most mentioned effect of MaaS in travel behavior is the reduction in private vehicle dependency/ownership and an increase in modal share of public transport and shared mobility services. Younger urban generations are expected to be the early adopters of MaaS in the near future.

SQ2. What influence the mode choice behavior of travelers to Eindhoven Airport?

According to the literature study, individuals' travel behavior is dependent on habits, attitudes, socio-demographic attributes, and utility of transport alternatives. What is more, previous research on the mode choice to travel to the airports have mainly focused on conventional transport modes of car, taxi, bus and train. The most important factors mentioned in the research for traveling to the airports are summarized in Table 2.2. In this research, an SC is executed, and a questionnaire is distributed, which includes five alternatives: car, taxi, car-sharing, bus, bus hailing. According to the results, several conclusions can be drawn. First, regarding the attitudinal analysis, the result showed that the reliability of transport is the most important, and environmental concern is the least important factor for travelers to Eindhoven Airport. Second, according to the constant estimation in the overall model, car-sharing is significantly preferred over the base alternative of car, and the alternative bus is negatively preferred compared to the alternative car. This implies that providing car-sharing points in Eindhoven Airport can be a successful policy to reduce car use. What is more, estimations for travel attributes suggest that in general, travel time and travel costs are the most important determinants for the mode choice. Despite frequent travel mode choice studies, socio-demographic attributes and travel contexts (travel scenarios) showed to have little impact on mode choice behavior to Eindhoven Airport except for two alternatives: the alternative bus is preferred by younger single people below 40 years old and alternative taxi is preferred for trips with more than one luggage and among higher-income people as expected.

SQ3. To what extent the travel behavior of visitors of Eindhoven Airport is influenced by the incentives for sustainable transport mode alternatives?

In designing the SC experiment of this study, a three-level incentive attribute is added to sustainable modes of car-sharing, bus, and bus hailing. The levels are specified with consulting of Eindhoven Airport and consist of: no bonus, coffee discount, and fast track line. The result from model estimations showed that for the alternative car-sharing, the coffee discount has a significant influence on the respondent's mode choice. For the alternative bus hailing, offering a fast track line incentive has a significant preference of respondents. On the other hand, the results showed that incentives have no significant result in the alternative bus suggesting that public transport users are less sensitive to the effect of incentives.

MQ. To what extent is the willingness of travelers to Eindhoven Airport to switch to sustainable modes of transport?

To answer the main research question, the literature on travel behavior theories, sustainable mobility, and Eindhoven Airport accessibility is reviewed and a stated choice experiment is executed. The literature review showed car-sharing services and demand-responsive transport (bus hailing) as promising alternatives for a means of sustainable transport to and from Eindhoven Airport. According to the analysis and model estimations, reliability is the most important travel factor for travelers to the airport and environmental concern is the last important factor. What is more, the result from the MNL model showed that there is a significant preference towards car-sharing services compare to the base alternative of car. What is more, the ML model showed similarities in taste between the alternative's car and car-sharing, which suggests a willingness to use such services if they are available at the airport. What is more, incentives showed to have a positive effect on the willingness of choosing the car-sharing and bus hailing services. Socio-demographic characteristics and travel context, on the other hand, showed to have little impact on the willingness of travelers in choosing sustainable alternatives.

5.2. SOCIETAL RELEVANCE

On the societal level, this research provides Eindhoven Airport and Royal HaskoningDHV with insights to the detriment of travel behavior of travelers to the airport with the implementation of travel incentives. Eindhoven Airport has the goal to keep airport transportation fast and accessible while reducing the emissions and eventually eliminate them by 2050. However, the current modal share of trips to Eindhoven Airport shows a high share of private vehicle use. Sustainable mobility alternatives of car-sharing and demand-responsive transport are proposed, while these services are accompanied by travel incentives. The data and models generated for the research are specifically applied to the Eindhoven Airport. Based on the results and findings of the research, a few suggestions for improving the current transport to Eindhoven Airport can be made:

1. Realizing E-carsharing service points in the Eindhoven Airport. The model estimations showed that there is a strong preference for this non-existing alternative, which can help to reduce the modal share of the private car and increase sustainability. The airport can make agreements with carsharing service providers to use the official parking spaces and recoup some of the lost revenue due to a reduction in parking use.
2. Increasing parking prices for private cars can reduce the preference for this mode of transport. However, this policy can affect the revenue of the airport. Allocating entry charges for kiss & ride and pick-up can help to recoup some of the revenue and can also reduce the preference towards these options.
3. Realizing bus-hailing service or extending the existing Bravo-flex service to Eindhoven Airport might also reduce the preference towards the private car.
4. Incentives can be used to make a trigger to use sustainable modes of transport. The result showed that using "coffee discount" for the alternative E-carsharing and "fast tack line" for bus-hailing can positively increase the preference towards these alternatives. The alternative bus, however, does not incentives.
5. Integrating the new services in a MaaS environment with a single payment for booking the transport mode. Results from the literature review showed that there is potential in MaaS for incidental trips such as traveling to the airports. What is more, using a MaaS platform to book the transport to the airport and receiving incentives can also

work as a trial period of the MaaS platform for travelers. Hence, travelers might adapt to a MaaS subscription after using it for the transport to Eindhoven Airport.

Finally, the knowledge identified in this thesis can be used as underpinning for the decision-making process to realize car-sharing services in the parking's of the airport and including demand responsive transport (bus-hailing) station.

5.3. LIMITATIONS AND RECOMMENDATIONS

In the research process, several limitations have been identified and are mentioned in this section followed by recommendations for future research.

First, the SC design used in this research was difficult for the respondents to compare to the usual SC experiments, which mostly include two or three alternatives with varying attributes. However, in this research respondents were given five or four transportation alternatives, which included alternative specific attributes, general attributes, and travel scenarios as context attributes. Hence, respondents had to process a lot of information especially for the respondents in the airport, which had a flight to board. Secondly, the SC experiment was designed in the Limesurvey environment, which despite the changes in the user interface was not adaptable to the screen size of smartphones. Consequently, most of the respondents dropped out during the questionnaire due to the incompatibility of the environment with phone screens. A solution would be reducing the size of the SC experiment and replacing the Limesurvey survey system. Furthermore, half of the SC experiment data, the 30 km experiment, was lost from the Limesurvey environment. Efforts to finds the reason and retrieving the data were not successful. As a result, the preference of respondents and mode choice behavior for longer distance and the comparison with short distance travel behavior was neglected from research due to data loss.

Moreover, as already discussed in Chapter 4, the sample of this thesis is overrepresented by highly educated people. This has probably influenced the results as these respondents are more willing to use car-sharing services. Another limitation of the method is the possible difference in choosing choice scenarios in the SC experiment and the actual behavior of respondents. For instance, people might choose buses in the SC experiment as a socially desirable behavior but use their car for the actual trip.

Recommendations for further research are to focus on the multi-modal trips from longer distances to Eindhoven Airport using sustainable mobility alternatives, in which travelers use more than one specific mode during the trip. Moreover, this research is focused on departing passengers and future research should also consider the mode choice of arriving passengers to the airport. Furthermore, research with a larger data sample needs to be done conducted to be able to observe the exact effect of the determinants used in this thesis. Hence, it becomes possible to use LC models to find clusters, which help to develop in detail policies for different target groups. Another line of research that should be considered is the effect of

COVID-19 outbreak on the preference and mode choice of travelers. The negative attitude towards public transport and decrease in private vehicle sales due to economic crisis can open new opportunities for alternatives such as MaaS and car-sharing services, which needs to be further investigated.

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APPENDIX

APPENDIX I:NGENE CODE FOR 5KM DESIGN

```
? sequential orthogonal design for the 5km experiment

Design

;alts = Car, Taxi, Ecar, Bus, Bushailing

;rows = 72

;ort=seq

;model:

U(Car) = b0 + b1* TTc[10,15,20] + b2*TCc[0.25,0.5,1] + b3*Twalk[0,5,10] + b4*ParkingCar[0,20,30]/


U(Taxi) = b1*TTc + b5*TCt[7.5,10,12]/


U(Ecar) = b1*TTc + b6*TCsh[2,3,5] + b3*Twalk + b7.dummy[0.0|0.0]*Bonus[1,2,3]/


U(Bus) = b8*TTb[25,30,35] + b9*TCb[2,3,4] + b10*TWAITb[3.5,5,10] + b11*Transf[0,1,2] + b7.dummy[0.0|0.0]*Bonus[1,2,3]/


U(Bushailing) = b12*TTbh[10,15,20] + b13*TCbh[2.5,5,7.5] + b10*TWAITb + b7.dummy[0.0|0.0]*Bonus[1,2,3]


$
```

APPENDIX II: EXPERIMENT DESIGN 5KM

Alternative Variables																				Context variables					
Choice situation	**car.ttc**	**car.tcc**	**car.twalk**	**car.parkingcar**	**taxi.ttc**	**taxi.tct**	**ecar.ttc**	**ecar.tcsh**	**ecar.twalk**	**ecar.bonus**	**bus.ttb**	**bus.tcb**	**bus.twaitb**	**bus.transf**	**bus.bonus**	**bushailing.ttbh**	**bushailing.tcbh**	**bushailing.twaitb**	**bushailing.bonus**	**Purpose**	**Travel accompany**	**Luggage**	**Distance Km**	**Block number alternative**	**Block number context**
2	20	0.5	0	20	15	12	20	3	5	3	35	2	3.5	2	3	10	2.5	20	1	Business	alone	1	5	1	1
9	15	0.5	0	30	10	12	10	2	5	1	30	4	3.5	2	1	10	5	10	2	Business	with another person	2	5	1	2
22	20	0.5	10	0	15	10	10	2	10	3	25	3	3.5	0	2	20	2.5	10	2	leisure	alone	2	5	1	3
37	10	0.25	5	0	15	7.5	15	5	5	3	30	3	10	2	2	10	5	15	2	leisure	with another person	1	5	1	4
43	15	0.25	10	30	15	10	20	3	0	1	30	2	5	0	2	20	5	20	2	Business	alone	1	5	1	1
52	15	1	0	20	15	7.5	10	3	5	1	25	4	10	1	2	20	7.5	15	1	Business	with another person	2	5	1	2
6	15	1	10	20	15	12	20	5	10	2	30	3	5	0	1	10	2.5	15	1	leisure	alone	2	5	2	3
17	10	0.25	0	0	15	10	10	5	0	1	35	4	3.5	2	1	15	2.5	15	3	leisure	with another person	1	5	2	4
23	10	0.5	10	20	10	7.5	15	5	0	1	35	2	5	1	1	10	7.5	20	2	Business	alone	1	5	2	1
32	20	0.5	5	0	10	12	20	5	10	1	25	4	10	1	2	15	5	20	1	Business	with another person	2	5	2	2
40	15	0.25	5	20	10	10	10	3	10	2	35	4	5	1	3	15	2.5	10	2	leisure	alone	2	5	2	3
59	10	1	5	30	15	12	15	2	10	1	35	3	10	1	3	20	2.5	20	3	leisure	with another person	1	5	2	4
7	10	1	10	30	20	10	15	3	5	3	35	2	3.5	1	2	15	5	10	1	Business	alone	1	5	3	1
12	10	0.5	0	0	20	7.5	20	3	0	2	25	2	10	0	3	15	2.5	15	2	Business	with another person	2	5	3	2
15	20	0.25	5	0	20	7.5	20	2	5	1	30	2	5	1	1	20	2.5	10	3	leisure	alone	2	5	3	3

29	15	0.5	5	30	20	7.5	10	2	0	3	35	3	5	2	3	20	7.5	15	1	leisure	with another person	1	5	3	4
42	20	0.25	10	20	20	12	15	2	5	2	25	3	3.5	1	1	15	7.5	15	2	Business	alone	1	5	3	1
72	15	1	10	0	20	12	10	3	10	3	30	2	10	2	1	15	7.5	20	3	Business	with another person	2	5	3	2
3	10	0.5	0	30	20	10	15	5	10	2	30	4	10	0	1	20	7.5	10	1	leisure	alone	2	5	4	3
14	10	0.25	5	30	10	12	10	3	0	2	25	3	3.5	0	2	10	7.5	20	3	leisure	with another person	1	5	4	4
20	15	0.25	0	20	10	7.5	15	2	10	3	25	2	10	0	3	10	5	10	3	Business	alone	1	5	4	1
49	20	1	0	0	10	10	15	2	0	2	30	3	5	2	3	15	5	20	1	Business	with another person	2	5	4	2
58	20	1	5	20	20	10	20	5	0	3	25	4	5	2	2	10	7.5	10	3	leisure	alone	2	5	4	3
69	20	1	10	30	10	7.5	20	5	5	2	35	4	3.5	0	3	20	5	15	3	leisure	with another person	1	5	4	4
4	20	0.25	5	30	20	10	15	5	10	2	30	2	3.5	2	3	10	2.5	20	2	Business	alone	1	5	5	1
26	10	1	5	30	20	7.5	10	5	10	1	25	3	5	0	1	15	5	10	2	Business	with another person	2	5	5	2
33	20	1	5	0	15	7.5	15	3	10	2	35	2	5	0	2	15	7.5	15	3	leisure	alone	2	5	5	3
46	10	1	0	20	20	12	15	3	0	1	30	4	5	1	3	10	5	15	3	leisure	with another person	1	5	5	4
61	15	0.5	10	20	20	10	20	2	10	1	35	4	3.5	0	3	15	7.5	20	3	Business	alone	1	5	5	1
67	20	0.5	0	0	20	12	10	5	5	2	35	3	10	1	3	10	7.5	10	3	Business	with another person	2	5	5	2
11	15	0.25	10	0	20	7.5	20	3	0	2	25	4	3.5	2	1	10	5	10	1	leisure	alone	2	5	6	3
30	20	0.25	0	30	20	7.5	10	2	0	3	35	4	10	1	2	15	5	20	2	leisure	with another person	1	5	6	4
41	15	0.5	5	20	20	12	15	2	5	2	25	2	5	0	2	20	5	20	1	Business	alone	1	5	6	1
47	15	1	0	30	15	10	20	2	5	2	25	3	10	2	2	15	2.5	10	3	Business	with another person	2	5	6	2
56	10	1	10	20	15	7.5	10	2	0	2	30	2	3.5	2	3	20	7.5	10	2	leisure	alone	2	5	6	3
64	20	0.5	10	30	15	12	15	5	0	3	25	2	10	2	1	20	5	15	3	leisure	with another person	1	5	6	4
24	20	0.25	0	20	10	7.5	15	5	0	1	35	3	3.5	0	2	20	2.5	10	1	Business	alone	1	5	7	1
31	15	0.25	0	0	10	12	20	5	10	1	25	3	5	2	3	20	7.5	15	2	Business	with another person	2	5	7	2
36	15	1	5	20	10	10	10	5	5	3	30	3	3.5	1	1	20	5	20	3	leisure	alone	2	5	7	3

39	10	0.5	10	20	10	10	10	3	10	2	35	3	10	2	2	10	5	15	1	leisure	with another person	1	5	7	4
53	20	1	10	0	10	10	15	3	5	1	25	4	10	0	1	10	2.5	20	2	Business	alone	1	5	7	1
66	10	0.5	0	30	10	7.5	20	3	10	3	30	4	5	2	2	20	2.5	20	3	Business	with another person	2	5	7	2
1	10	0.25	5	20	15	12	20	3	5	3	35	4	10	0	1	20	7.5	10	2	leisure	alone	2	5	8	3
10	10	0.25	10	30	10	12	10	2	5	1	30	2	10	0	3	15	2.5	15	1	leisure	with another person	1	5	8	4
21	10	0.25	0	0	15	10	10	2	10	3	25	2	5	1	1	10	7.5	20	1	Business	alone	1	5	8	1
27	15	1	5	0	10	12	20	2	0	3	35	2	3.5	1	2	10	2.5	15	2	Business	with another person	2	5	8	2
38	15	0.5	10	0	15	7.5	15	5	5	3	30	4	5	1	3	15	2.5	10	1	leisure	alone	2	5	8	3
44	20	0.5	5	30	15	10	20	3	0	1	30	3	3.5	1	1	15	7.5	15	1	leisure	with another person	1	5	8	4
13	20	1	0	30	10	12	10	3	0	2	25	2	5	1	1	20	2.5	10	1	Business	alone	1	5	9	1
19	10	1	5	20	10	7.5	15	2	10	3	25	4	3.5	2	1	15	2.5	15	1	Business	with another person	2	5	9	2
28	10	0.5	10	0	10	12	20	2	0	3	35	3	5	0	1	15	5	10	3	leisure	alone	2	5	9	3
50	15	0.25	10	0	10	10	15	2	0	2	30	4	10	1	2	20	7.5	15	3	leisure	with another person	1	5	9	4
57	10	0.25	10	20	20	10	20	5	0	3	25	3	10	1	3	20	2.5	20	1	Business	alone	1	5	9	1
70	15	0.25	5	30	10	7.5	20	5	5	2	35	2	10	2	1	15	7.5	20	1	Business	with another person	2	5	9	2
8	15	0.25	0	30	20	10	15	3	5	3	35	3	5	0	1	10	2.5	15	3	leisure	alone	2	5	10	3
16	10	1	0	0	20	7.5	20	2	5	1	30	3	3.5	0	2	10	7.5	20	1	leisure	with another person	1	5	10	4
35	20	0.5	0	20	10	10	10	5	5	3	30	2	5	0	2	15	7.5	15	2	Business	alone	1	5	10	1
54	10	0.5	5	0	10	10	15	3	5	1	25	2	3.5	2	3	20	7.5	10	3	Business	with another person	2	5	10	2
65	20	1	10	30	10	7.5	20	3	10	3	30	3	10	1	3	10	7.5	10	2	leisure	alone	2	5	10	3
71	20	0.25	5	0	20	12	10	3	10	3	30	4	3.5	0	3	20	5	15	1	leisure	with another person	1	5	10	4
5	10	0.25	0	20	15	12	20	5	10	2	30	2	3.5	1	2	15	5	10	3	Business	alone	1	5	11	1
18	15	1	5	0	15	10	10	5	0	1	35	2	10	0	3	10	5	10	1	Business	with another person	2	5	11	2
48	10	0.5	5	30	15	10	20	2	5	2	25	4	5	1	3	10	5	15	2	leisure	alone	2	5	11	3

55	20	0.5	5	20	15	7.5	5	2	0	2	30	4	10	0	1	10	2.5	20	3	leisure	with another person	1	5	11	4
60	20	0.25	10	30	15	12	15	2	10	1	35	4	5	2	2	10	7.5	10	1	Business	alone	1	5	11	1
63	15	1	0	30	15	12	15	5	0	3	25	4	3.5	0	3	15	7.5	20	2	Business	with another person	2	5	11	2
25	15	0.5	10	30	20	7.5	10	5	10	1	25	2	3.5	1	2	10	2.5	15	3	leisure	alone	2	5	12	3
34	15	0.5	0	0	15	7.5	15	3	10	2	35	3	3.5	1	1	20	5	20	2	leisure	with another person	1	5	12	4
45	15	0.5	5	20	20	12	15	3	0	1	30	3	10	2	2	15	2.5	10	2	Business	alone	1	5	12	1
51	20	0.25	10	20	15	7.5	10	3	5	1	25	3	5	2	3	15	5	20	3	Business	with another person	2	5	12	2
62	20	1	0	20	20	10	20	2	10	1	35	2	10	2	1	20	5	15	2	leisure	alone	2	5	12	3
68	10	1	10	0	20	12	10	5	5	2	35	4	5	2	2	20	2.5	20	2	leisure	with another person	1	5	12	4

Correlations

Attribute	car.ttc	car.tcc	car.twalk	car.parkingcar	taxi.ttc	taxi.tct	ecar.ttc	ecar.tcsh	ecar.twalk	ecar.bonus	bus.ttb	bus.tcb	bus.twaitb	bus.transf	bus.bonus	bushailing.ttbh	bushailing.tcbh	bushailing.twaitb	bushailing.bonus	Block
car.ttc	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
car.tcc	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
car.twalk	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
car.parkingcar	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
taxi.ttc	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
taxi.tct	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ecar.ttc	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
ecar.tcsh	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
ecar.twalk	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
ecar.bonus	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
bus.ttb	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
bus.tcb	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
bus.twaitb	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
bus.transf	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
bus.bonus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
bushailing.ttbh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
bushailing.tcbh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
bushailing.twaitb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
bushailing.bonus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Block	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Appendix III: Parameter specification-30km

Attributes	Car	Taxi	E-Carsharing	Public Transport
Travel Time	β 1	β 1	β 1	β 12
Travel Cost	β 2	β 5	β 6	β 13
Parking Cost	β 4			
Waiting Time				β 14
Walking Time Last Mile	β 3		β 3	
Bonus			β 7	β 7
Transfers				β 11

Variable	Type of Variable	Abbreviate
X1	Travel time for car	TTc
X2	Travel cost for car	TCc
X3	Walking time last mile	TWalk
X4	Parking cost for car	ParkingCar
X5	Travel cost for taxi	TCt
X6	Travel cost E-carsharing	TCsh
X7	Bonus	Bonus
X9	Travel cost	TCb
X11	Number of transfers	Transf
X12	Travel time public transport	TTmm
X13	Travel cost for public transport	TCmm
X14	Waiting time for public transport	TWAITmm

$$V_{Car} = \beta_{0Car} + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4$$

$$V_{Taxi} = \beta_1 X_1 + \beta_5 X_5$$

$$V_{E-carsharing} = \beta_1 X_1 + \beta_3 X_3 + \beta_6 X_6 + \beta_7 X_7$$

$$V_{Public\ transport} = \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_9 X_9 + \beta_{13} X_{13} + \beta_{14} X_{14} + \beta_7 X_7$$

APPENDIX IV: NGINE CODE FOR 30-KILOMTER EXPERIMENT

? sequential orthogonal factorial design for 30km experiment

```
Design
;alts = Car, Taxi, Ecar, MultiM
;rows = 72
;orth = sim
;block = 12
;model:
```

U(Car) = b0 + b1* TTc[30,60,90] + b2*TCc[1.5,3,6] + b3*Twalk[0,5,10] + b4*ParkingCar[0,10,25]/

U(Taxi) = b1*TTc + b5*TCt[45,60,72]/

U(Ecar) = b1*TTc + b6*TCsh[7.5,15,30] + b3*Twalk + b7.dummy[0.0|0.0]*Bonus[1,2,3]/

U(MultiM) = b11*Transf + b12*TTmm[50,60,75] + b13*TCmm[7,9,11] + b14*TWAITmm[15,20,30] + b7.dummy[0.0|0.0]*Bonus[1,2,3]

Appendix V: Experiment design 30-kilomter

Alternative Variables																Context Variables					
Choice situation	car.ttc	car.tcc	car.twalk	car.parkingcar	taxi.ttc	taxi.tct	ecar.ttc	ecar.tcsh	ecar.twalk	ecar.bonus	multim.ttmm	multim.tcmm	multim.twaitmm	multim.transf	multim.bonus	Purpose	Travel accompany	Luggage	Distance Km	Block_A	Block _B
2	80	6	0	0	80	72	60	15	10	3	60	7	20	1	1	Business	alone	1	30	1	1
9	40	6	0	30	60	45	60	7.5	0	3	75	7	20	0	2	Business	with another person	2	30	1	2
22	60	4	0	20	40	72	80	7.5	0	2	50	11	20	1	2	leisure	alone	2	30	1	3
37	60	6	10	20	60	72	60	30	5	1	50	9	15	1	2	leisure	with another person	1	30	1	4
43	60	4	5	0	60	45	40	15	10	2	75	11	15	1	2	Business	alone	1	30	1	1
52	60	5	10	30	40	45	60	15	0	1	60	7	30	1	1	Business	with another person	2	30	1	2
6	40	4	5	20	60	60	80	30	10	3	60	11	30	1	1	leisure	alone	2	30	2	3
17	40	6	0	30	80	45	40	30	0	2	50	7	15	1	3	leisure	with another person	1	30	2	4
23	40	5	5	0	80	45	40	30	5	1	60	11	20	0	2	Business	alone	1	30	2	1
32	60	5	10	30	40	45	80	30	10	3	50	9	20	0	1	Business	with another person	2	30	2	2
40	80	5	5	30	80	60	80	15	0	2	60	9	15	0	2	leisure	alone	2	30	2	3
59	80	5	10	20	80	45	80	7.5	5	3	75	9	30	1	3	leisure	with another person	1	30	2	4
7	60	5	0	0	80	72	60	15	5	2	75	11	30	2	1	Business	alone	1	30	3	1
12	80	4	10	0	40	60	40	15	10	1	50	7	20	2	2	Business	with another person	2	30	3	2
15	40	5	5	0	60	45	60	7.5	10	1	50	9	15	2	3	leisure	alone	2	30	3	3
29	80	6	5	20	80	72	40	7.5	0	1	75	9	20	2	1	leisure	with another person	1	30	3	4
42	40	5	0	20	40	60	60	7.5	5	3	60	11	15	2	2	Business	alone	1	30	3	1
72	40	6	10	0	60	72	80	15	0	3	50	11	30	2	3	Business	with another person	2	30	3	2
3	40	4	10	30	60	60	80	30	5	2	75	7	20	2	1	leisure	alone	2	30	4	3

14	60	4	0	20	40	60	40	15	0	3	75	9	15	0	3	leisure	with another person	1	30	4	4
20	80	4	10	0	40	72	80	7.5	5	1	60	7	15	0	3	Business	alone	1	30	4	1
49	80	6	5	20	60	60	40	7.5	5	2	50	7	30	0	1	Business	with another person	2	30	4	2
58	60	6	5	30	40	72	40	30	10	2	60	9	30	2	3	leisure	alone	2	30	4	3
69	80	4	0	30	80	60	60	30	10	1	75	11	30	0	3	leisure	with another person	1	30	4	4
4	80	6	0	0	60	60	80	30	5	2	75	9	15	2	2	Business	alone	1	30	5	1
26	40	4	5	20	40	45	80	30	0	1	75	9	30	2	2	Business	with another person	2	30	5	2
33	60	4	5	0	80	60	80	15	5	1	50	9	30	1	3	leisure	alone	2	30	5	3
46	80	5	5	30	60	45	40	15	5	3	60	7	30	2	3	leisure	with another person	1	30	5	4
61	80	4	0	30	80	45	80	7.5	10	2	60	11	20	2	3	Business	alone	1	30	5	1
67	80	5	10	20	80	60	60	30	0	3	50	7	20	2	3	Business	with another person	2	30	5	2
11	40	6	0	30	40	60	40	15	10	1	50	11	15	2	1	leisure	alone	2	30	6	3
30	60	5	10	30	80	72	40	7.5	0	1	75	7	15	2	2	leisure	with another person	1	30	6	4
41	60	4	5	0	40	60	60	7.5	5	3	60	9	20	2	1	Business	alone	1	30	6	1
47	60	6	10	20	40	60	60	7.5	10	2	75	7	30	1	3	Business	with another person	2	30	6	2
56	80	6	0	0	60	60	40	7.5	0	1	60	11	30	1	2	leisure	alone	2	30	6	3
64	40	6	10	0	40	72	40	30	5	3	75	11	20	1	3	leisure	with another person	1	30	6	4
24	60	4	0	20	80	45	40	30	5	1	60	7	15	0	1	Business	alone	1	30	7	1
31	80	6	5	20	40	45	80	30	10	3	50	7	15	0	2	Business	with another person	2	30	7	2
36	40	5	0	20	60	72	60	30	0	2	60	9	30	0	3	leisure	alone	2	30	7	3
39	60	6	10	20	80	60	80	15	0	2	60	11	20	0	1	leisure	with another person	1	30	7	4
53	40	4	10	30	40	45	60	15	5	2	50	11	30	0	2	Business	alone	1	30	7	1
66	60	6	5	30	60	72	80	15	10	1	75	7	20	0	3	Business	with another person	2	30	7	2
1	40	4	10	30	80	72	60	15	10	3	60	9	15	1	2	leisure	alone	2	30	8	3
10	80	4	10	0	60	45	60	7.5	0	3	75	11	15	0	1	leisure	with another person	1	30	8	4
21	40	5	5	0	40	72	80	7.5	0	2	50	7	15	1	1	Business	alone	1	30	8	1
27	60	5	0	0	80	72	40	7.5	10	3	50	9	30	0	2	Business	with another person	2	30	8	2
38	80	5	5	30	60	72	60	30	5	1	50	11	20	1	1	leisure	alone	2	30	8	3
44	40	5	0	20	60	45	40	15	10	2	75	9	20	1	1	leisure	with another person	1	30	8	4
13	40	5	5	0	40	60	40	15	0	3	75	7	30	0	1	Business	alone	1	30	9	1

19	40	6	0	30	40	72	80	7.5	5	1	60	9	30	0	1	Business	with another person	2	30	9	2
28	40	4	5	20	80	72	40	7.5	10	3	50	11	20	0	3	leisure	alone	2	30	9	3
50	60	5	10	30	60	60	40	7.5	5	2	50	11	15	0	3	leisure	with another person	1	30	9	4
57	80	5	10	20	40	72	40	30	10	2	60	11	15	2	1	Business	alone	1	30	9	1
70	40	6	10	0	80	60	60	30	10	1	75	9	15	0	1	Business	with another person	2	30	9	2
8	40	4	5	20	80	72	60	15	5	2	75	7	15	2	3	leisure	alone	2	30	10	3
16	60	4	0	20	60	45	60	7.5	10	1	50	7	30	2	1	leisure	with another person	1	30	10	4
35	60	4	5	0	60	72	60	30	0	2	60	7	20	0	2	Business	alone	1	30	10	1
54	80	6	0	0	40	45	60	15	5	2	50	9	20	0	3	Business	with another person	2	30	10	2
65	80	5	10	20	60	72	80	15	10	1	75	11	30	0	2	leisure	alone	2	30	10	3
71	80	4	0	30	60	72	80	15	0	3	50	9	15	2	1	leisure	with another person	1	30	10	4
5	60	5	0	0	60	60	80	30	10	3	60	7	15	1	3	Business	alone	1	30	11	1
18	80	4	10	0	80	45	40	30	0	2	50	9	30	1	1	Business	with another person	2	30	11	2
48	80	5	5	30	40	60	60	7.5	10	2	75	9	20	1	2	leisure	alone	2	30	11	3
55	40	4	10	30	60	60	40	7.5	0	1	60	9	20	1	3	leisure	with another person	1	30	11	4
60	60	6	5	30	80	45	80	7.5	5	3	75	11	15	1	1	Business	alone	1	30	11	1
63	80	4	0	30	40	72	40	30	5	3	75	7	30	1	2	Business	with another person	2	30	11	2
25	60	5	0	0	40	45	80	30	0	1	75	11	20	2	3	leisure	alone	2	30	12	3
34	40	5	0	20	80	60	80	15	5	1	50	7	20	1	2	leisure	with another person	1	30	12	4
45	60	6	10	20	60	45	40	15	5	3	60	9	20	2	2	Business	alone	1	30	12	1
51	80	6	5	20	40	45	60	15	0	1	60	11	15	1	3	Business	with another person	2	30	12	2
62	40	6	10	0	80	45	80	7.5	10	2	60	7	30	2	2	leisure	alone	2	30	12	3
68	60	6	5	30	80	60	60	30	0	3	50	11	30	2	2	leisure	with another person	1	30	12	4

Correlations

Attribute	car.ttc	car.tcc	car.twalk	car.parkingcar	taxi.ttc	taxi.tct	ecar.ttc	ecar.tcsh	ecar.twalk	ecar.bonus	multim.ttmm	multim.tcmm	multim.twaitmm	multim.transf	multim.bonus	Block
car.ttc	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
car.tcc	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
car.twalk	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
car.parkingcar	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
taxi.ttc	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
taxi.tct	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
ecar.ttc	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
ecar.tcsh	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
ecar.twalk	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
ecar.bonus	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
multim.transf	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
multim.ttmm	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
multim.tcmm	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
multim.twaitmm	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
multim.bonus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Block	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

APPENDIX VI: QUESTIONNAIRE DESIGN

Language: English ▼ Change the language

Your Transport to Eindhoven Airport

How do you travel to Eindhoven Airport?

we would like to know your opinions!

This survey works **ONLY** on devices with **6inch dispaly** size and bigger : Laptops,Tablets, Smartphones: Samsung galaxy Note and S plus, Iphone Plus and Xs, 10 and11. Please **rotate** your phone. Do not continue if you see distorted tables on your phone.

Among the respondents that fill out the questionnaire entirely, 2 gift cards from Bol.com with 50 Euro credit in each will be raffled:

This survey is anonymous.

The record of your survey responses does not contain any identifying information about you, unless a specific survey question explicitly asked for it.

If you used an identifying token to access this survey, please rest assured that this token will not be stored together with your responses. It is managed in a separate database and will only be updated to indicate whether you did (or did not) complete this survey. There is no way of matching identification tokens with survey responses.

The survey has been developed at the Eindhoven University of Technology and is a part of the graduation project "Travel behavior of passengers of Eindhoven Airport". We aim to get better insight into transport mode choice of passengers. Your answers to the survey help us collect information about your travel preferences.

The target group of this survey includes people who have been in Eindhoven airport previously. The survey takes around 10 minutes to complete.

Taking part in this survey is **entirely voluntary.** We would encourage you to take part as the more participants there are, the more robust the research.

In the survey, you will be presented with several choices concerning your travel behavior. The survey also includes some background questions (e.g your gender, age, education level), to make it possible to look at differences across group.

The data will be **aggregated to a group level**, analyzed and published for **scientific purposes**, such as research papers, reports and articles. No individual responses to the survey will be made public. The data will be used for **research purposes only**.

In case of any questions, please send an email to **s.khoda.bakhsh.reshad@student.tue.nl**

By completing this survey I give my **consent** to the research program to use the data I provide for research purposes for the period of 10 years, on the understanding that the **information I supply can not be traced back to me in the reports on this research.**

December 2019 - January 2020

I agree with the data policy conditions ☑

Next

TARGET GROUP SELECTION

*Have you been in Eindhoven Airport in the past 12 months?

Yes | No

*What was the purpose of your last trip to Eindhoven Airport?

Choose one of the following answers

- A holiday trip
- A business trip
- Visiting family or friends
- Other:

*Do you have a driving license?

Yes | No

*How did you go to Eindhoven Airport last time?

Choose one of the following answers

- I drove myself
- Someone I know gave me a ride
- Public transport
- Taxi
- Other:

Consider your current travel if you are now in the Eindhoven Airport

*In case you used a car for this trip, what type was it?

Choose one of the following answers

- Private car
- Company car
- Borrowed car from family/friends
- Shared-car services
- Rental cars
- I did not use car
- Other:

*Do you have a physical limitation that prevents you from using Bus and Train?

Yes | No

Is the car you used an Electric car?

Yes | No

How did you find this survey?

Check all that apply

- QR code banner at the Eindhoven Airport
- Email
- Social media
- Other

Previous | Next

Travel Behavior

*How stressed are you to arrive in the airport on time?

Choose one of the following answers

- Not stressed
- Slightly stressed
- Moderately stressed
- Very stressed
- Extremely stressed

*To what extend do you agree or disagree with the statements below regarding travelling to the Eindhoven Airport?

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Previously, I always used car to go to the Eindhoven Airport	○	○	○	○	○
I enjoy driving to the Eindhoven Airport.	○	○	○	○	○
I think the Eindhoven Airport is better accessible with car than public transport	○	○	○	○	○
I think the ambiance of the Eindhoven Airport is pleasant for me to spend time in	○	○	○	○	○
I think the security services (security check) in the Eindhoven Airport is efficient	○	○	○	○	○

*How soon before your flight do you wish to be in Eindhoven Airport?

Choose one of the following answers

- 1 to 1.5 hours before
- 1.5 to 2 hours before
- 2 to 2.5 hours before
- 2.5 to 3 hours before

*How important are the factors mentioned below for your trip to Eindhoven Airport?

	Unimportant	Of little importance	Moderately important	Very important
Availability of alternative transport options	◯	◯	◯	◯
Environmental Concern	◯	◯	◯	◯
Safety of Transport Mode	◯	◯	◯	◯
Reliability	◯	◯	◯	◯

*How often do you use the following transport modes during a normal week?

	No use in a normal week	1 to 3 days per week	3 to 5 days per week	5 to 7 days per week
Normal bike	◯	◯	◯	◯
Electric bike	◯	◯	◯	◯
Bus	◯	◯	◯	◯
Train	◯	◯	◯	◯
Private car	◯	◯	◯	◯

*To what extend do you agree or disagree with the following statements?

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I am worried about global warming	◯	◯	◯	◯	◯
The majority of the population is not acting environmentally consciously	◯	◯	◯	◯	◯
I am prepared to pay more for environmental friendly transport	◯	◯	◯	◯	◯
I am willing to adopt a more environmental friendly lifestyle	◯	◯	◯	◯	◯

*How far is the nearest transport hub (Bus station ,Train staton or Car sharing point) to your home?

Choose one of the following answers

◯ Less than 500 meters

◯ 500 meters to 1 kilometer

◯ 1 to 1.5 kilometer

◯ More than 1.5 kilometer

INTRODUCTION TO CONCEPTS

Please read the explanation below before starting choice tasks

In this section of survey you will be presented with 6 **imaginary** situations and you are asked to choose the one you think is best for you.

In each choice task you will see a **scenario** that shows the contexts of your trip to the Eindhoven Airport. Based on the scenario you will see a table with 4 or 5 **transport alternatives.** These alternatives are : **Car, Taxi, E-SharedCar*, Bus, Bus Hailing*, Public Transport.**

Please consider the **scenario** as your **initial situation** and then select the transport alternative that you find the most suiteable.

As a preparation to the choice task, the following concepts are introduced briefly:

E-CarSharing: Electric cars that you do not own personally, but can pick them and drop them from different locations. You will pay for the time duration that you use these electric cars.

Bus Hailing: A bus service that can be requested. Imagine an Uber style service but only with shuttle/bus. For example, BravoFlex is the provider of this type of public transport service in Eindhoven region. Pick up and drop off is possible only at certain statoins (similar to traditional public bus services).

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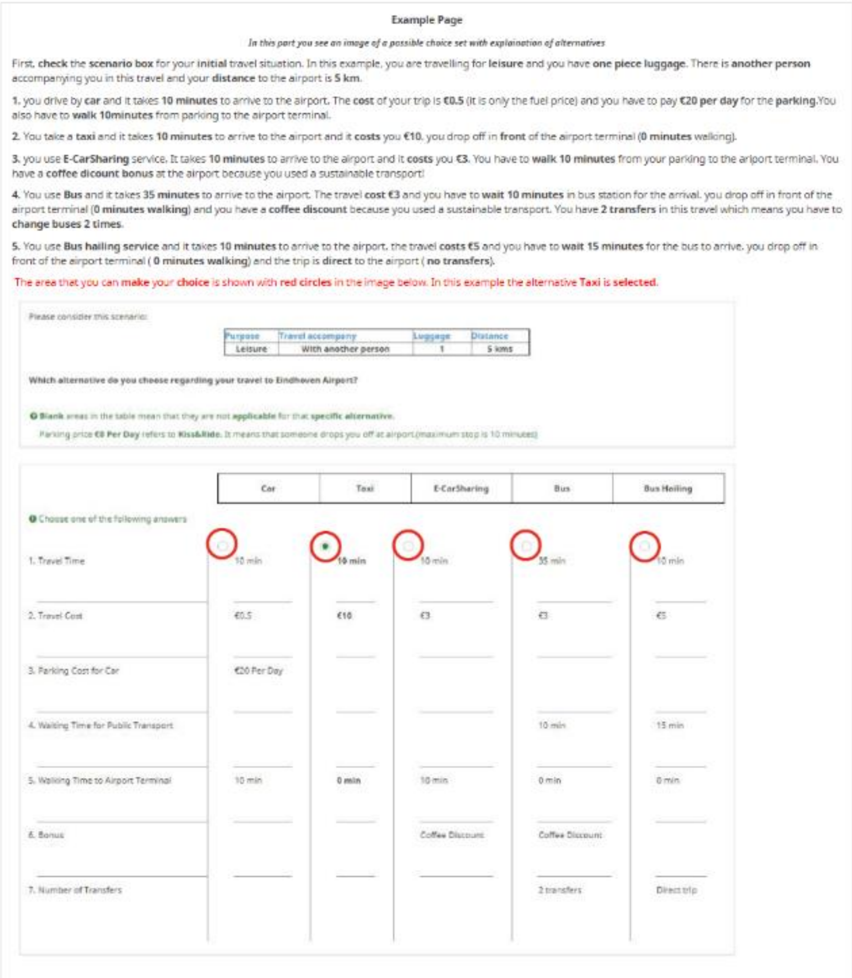
EXAMPLE PAGE



Example Page

In this part you see an image of a possible choice set with explaination of alternatives

First, **check** the **scenario box** for your **initial** travel situation. In this example, you are travelling for **leisure** and you have **one piece luggage**. There is **another person** accompanying you in this travel and your **distance** to the airport is **5 km**.

1. you drive by **car** and it takes **10 minutes** to arrive to the airport. The **cost** of your trip is **€0.5** (it is only the fuel price) and you have to pay **€20 per day** for the **parking.**You also have to **walk 10minutes** from parking to the airport terminal.

2. You take a **taxi** and it takes **10 minutes** to arrive to the airport and it **costs** you **€10**. you drop off in **front** of the airport terminal (**0 minutes** walking).

3. you use **E-CarSharing** service. It takes **10 minutes** to arrive to the airport and it **costs** you **€3**. You have to **walk 10 minutes** from your parking to the arlport terminal. You have a **coffee dicount bonus** at the airport because you used a sustainable transport!

4. You use **Bus** and it takes **35 minutes** to arrive to the airport. The travel **cost €3** and you have to **wait 10 minutes** in bus station for the arrival. you drop off in front of the airport terminal (**0 minutes walking**) and you have a **coffee discount** because you used a sustainable transport. You have **2 transfers** in this travel which means you have to **change buses 2 times**.

5. You use **Bus hailing service** and it takes **10 minutes** to arrive to the airport. the travel **costs €5** and you have to **wait 15 minutes** for the bus to arrive. you drop off in front of the airport terminal (**0 minutes walking**) and the trip is **direct** to the airport (**no transfers**).

The area that you can **make** your **choice** is shown with **red circles** in the image below. In this example the alternative **Taxi is selected**.

Please consider this scenario:

Purpose	Travel accompany	Luggage	Distance
Leisure	With another person	1	5 kms

Which alternative do you choose regarding your travel to Eindhoven Airport?

Blank areas in the table mean that they are not **applicable** for that **specific alternative**.

Parking price **€0 Per Day** refers to **Kiss&Ride**. It means that someone drops you off at airport.(maximum stop is 10 minutes)

Choose one of the following answers

	Car	Taxi	E-CarSharing	Bus	Bus Hailing
1. Travel Time	10 min	**10 min**	10 min	35 min	10 min
2. Travel Cost	€0.5	€10	€3	€3	€5
3. Parking Cost for Car	€20 Per Day				
4. Walking Time for Public Transport				10 min	15 min
5. Walking Time to Airport Terminal	10 min	**0 min**	10 min	0 min	0 min
6. Bonus			Coffee Discount	Coffee Discount	
7. Number of Transfers				2 transfers	Direct trip

PREPARATION FOR CHOICE TASKS

This was the **introduction**. The choice task will begin now. In the **first 3 questions**, your **distance** to Airport is **5 kilometers**! You can see that in your given **scenario**.

Please press next!

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Choice task (repeated for 3 times)

Please consider this scenario:

Purpose	Travel accompany	Luggage	Distance
Business	Alone	1	5 km

Which alternative do you choose regarding your travel to Eindhoven Airport?

Blank areas in the table mean that they are not **applicable** for that **specific alternative.**

Parking price **€0 Per Day** refers to **Kiss&Ride.** It means that someone drops you off at airport.(maximum stop is 10 minutes)

*

Choose one of the following answers

	Car	Taxi	E-CarSharing	Bus	Bus Hailing
1. Travel Time	10 min	15 min	20 min	35 min	20 min
2. Travel Cost	€0.25	€12	€3	€4	€7.5
3. Parking Cost for Car	€20 Per Day				
4. Waiting Time Public Transport				10 min	10 min
5. Walking Time to Airport Terminal	5 min	0 min	5 min	0 min	0 min
6. Bonus			Fast Track Line		Coffee Discount
7. Number of Transfers				Direct trip	Direct trip

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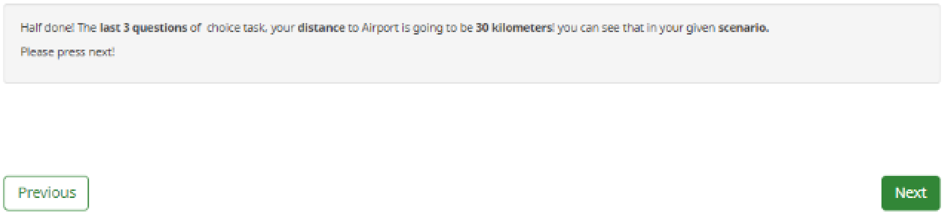
PREPRATION FOR CHOICE TASK



CHOICE TASK (REPEATED FOR 3 TIMES)

Please consider this scenario:

Purpose	Travel accompany	Luggage	Distance
Business	With Another Person	2	30 km

Which alternative do you choose regarding your travel to Eindhoven Airport?

Blank areas in the table mean that they are not **applicable** for that **specific alternative.**

Parking price **€0 Per Day** refers to **Kiss&Ride.** It means that someone drops you off at airport.(maximum stop is 10 minutes)

*

Choose one of the following answers

	Car	Taxi	E-CarSharing	Public Transport
1. Travel Time	80 min	40 min	40 min	50 min
2. Travel Cost	€4	€60	€15	€7
3. Parking Cost for Car	€0 Per Day			
4. Waiting Time for Public Transport				20 min
5. Walking Time to Airport Terminal	10 min	0 min	10 min	0 min
6. Bonus			No Bonus	Coffee Discount
7. Number of Transfers				2 transfers

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SOCIO-DEMOGRAPHICS

*What is your gender?

Choose one of the following answers

- Female
- Male
- Other

*What is your birth date?

Please complete all parts of the date.

Day ▼ . Month ▼ . Year ▼

*What is your highest completed education level?

Choose one of the following answers

- Primary School
- Secondary School
- Vocational education (MBO)
- Bachelors Degree (HBO)
- Bachelors Degree (WO)
- Masters Degree (WO)
- PhD or higher

*What is your yearly net income?

Choose one of the following answers

- Less Than €10000
- €10000 To €19000
- €20000 To €29000
- €30000 To €39000
- €40000 To €49000
- €50000 To €99000

*What is your household size?

Choose one of the following answers

Please choose... ▼

*What is your employement status?

Choose one of the following answers

- Full time employed (40 hours)
- Part time employed (less than 40 hours)
- Student or intern
- Unemployed or looking for a job
- Retired
- I prefer not to share

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SUBMIT PAGE

You have reached the end of the questionnaire.

Thank you for your interest and participation!

If you want to have a chance of winning one of the Bol.com gift cards, please fill-in your Email address below.

(This information will only be used to let you know if you have won one of the gift cards, and will be removed immediatey afterwards).

Please check the format of your answer.

Do you have any comments regarding this questionnaire?

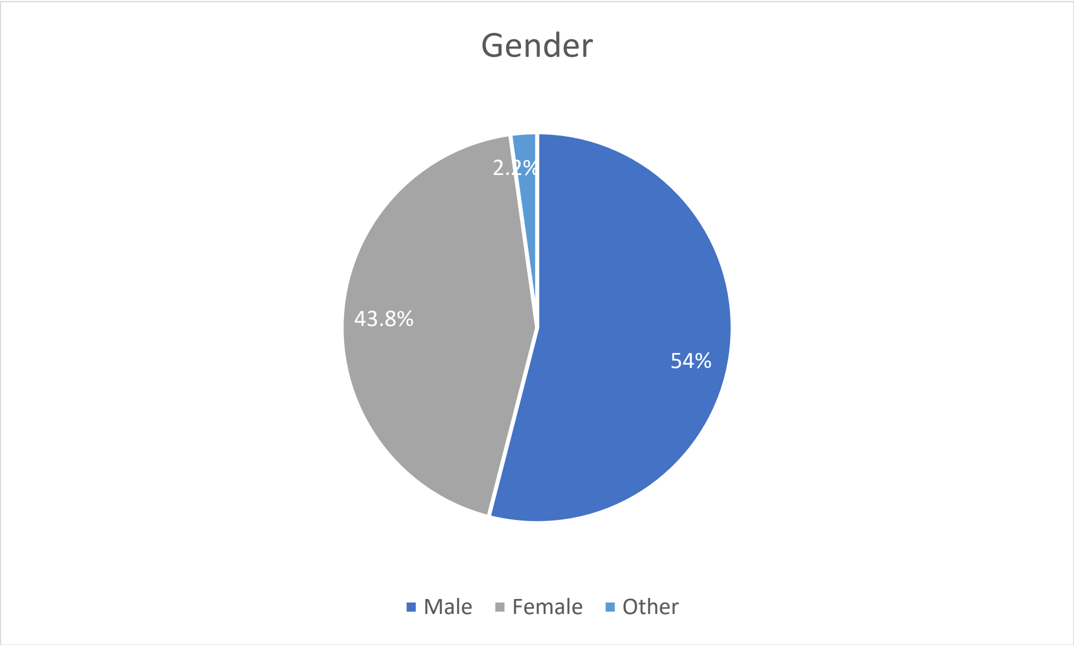
Fill in when applicable

Previous

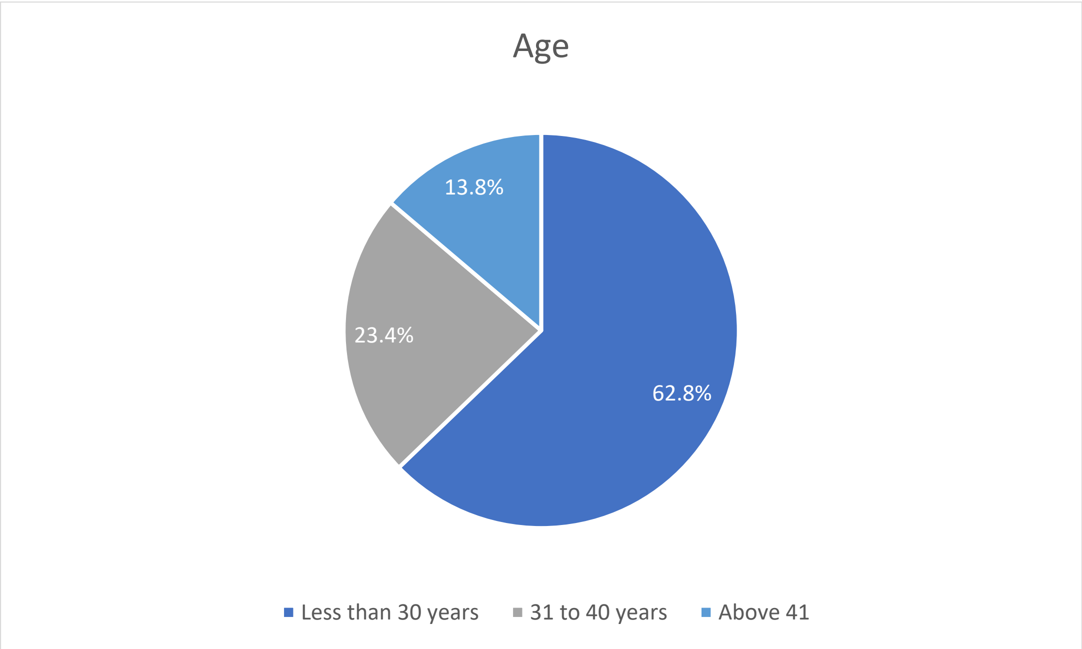
Submit

APPENDIX VII: DESCRIPTIVE ANALYSIS

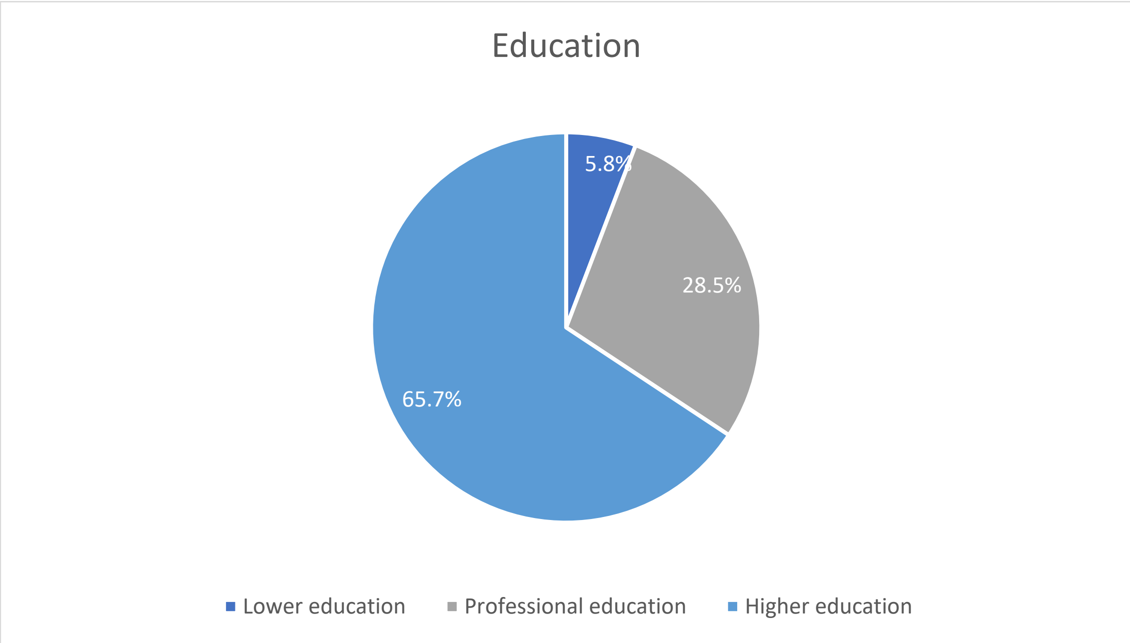
Gender:



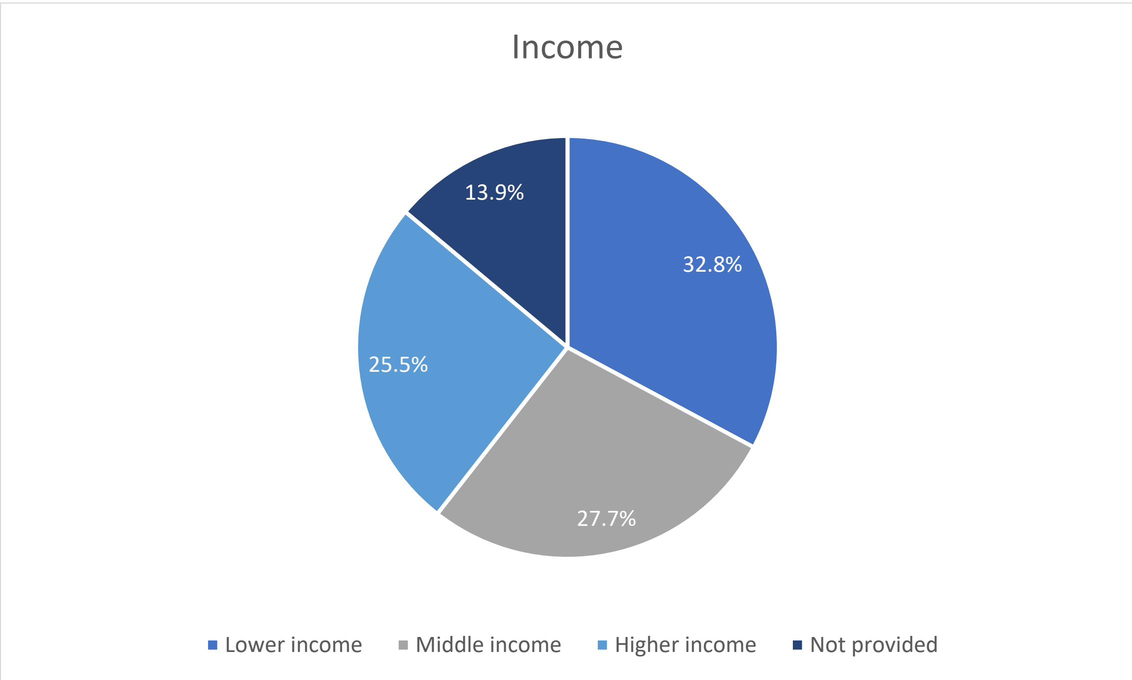
Age:



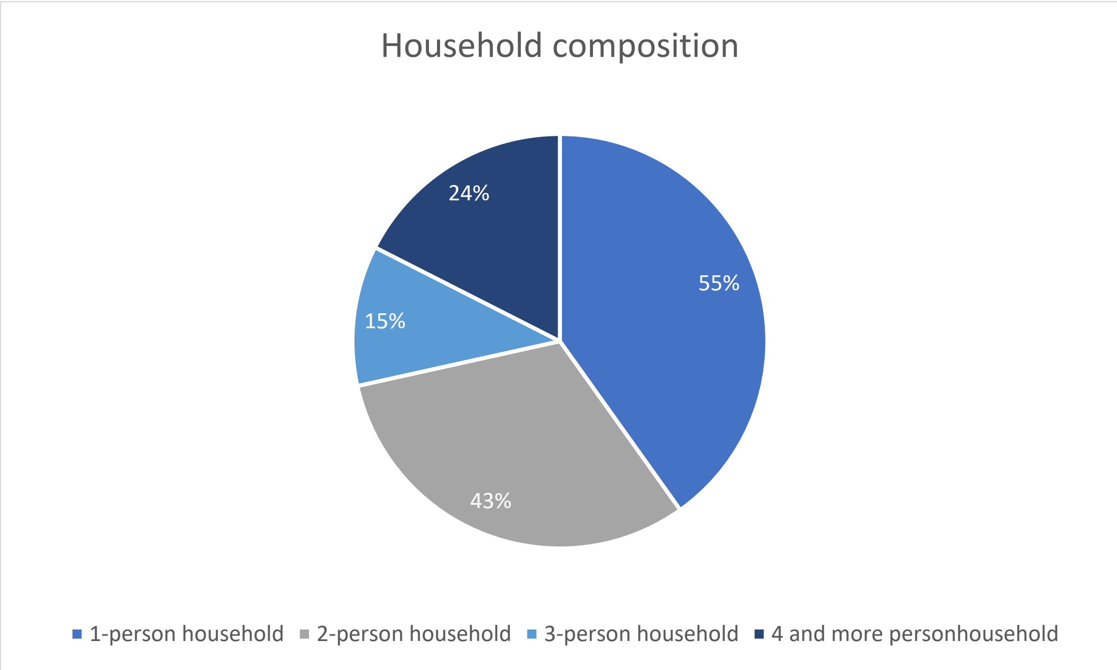
Education:



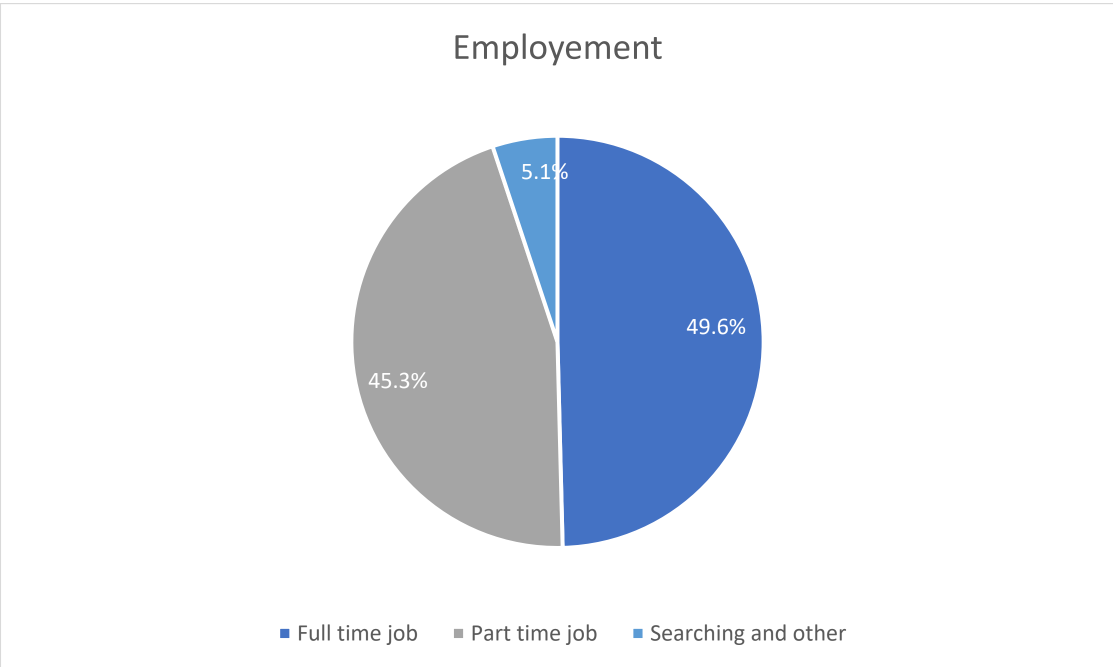
Income:



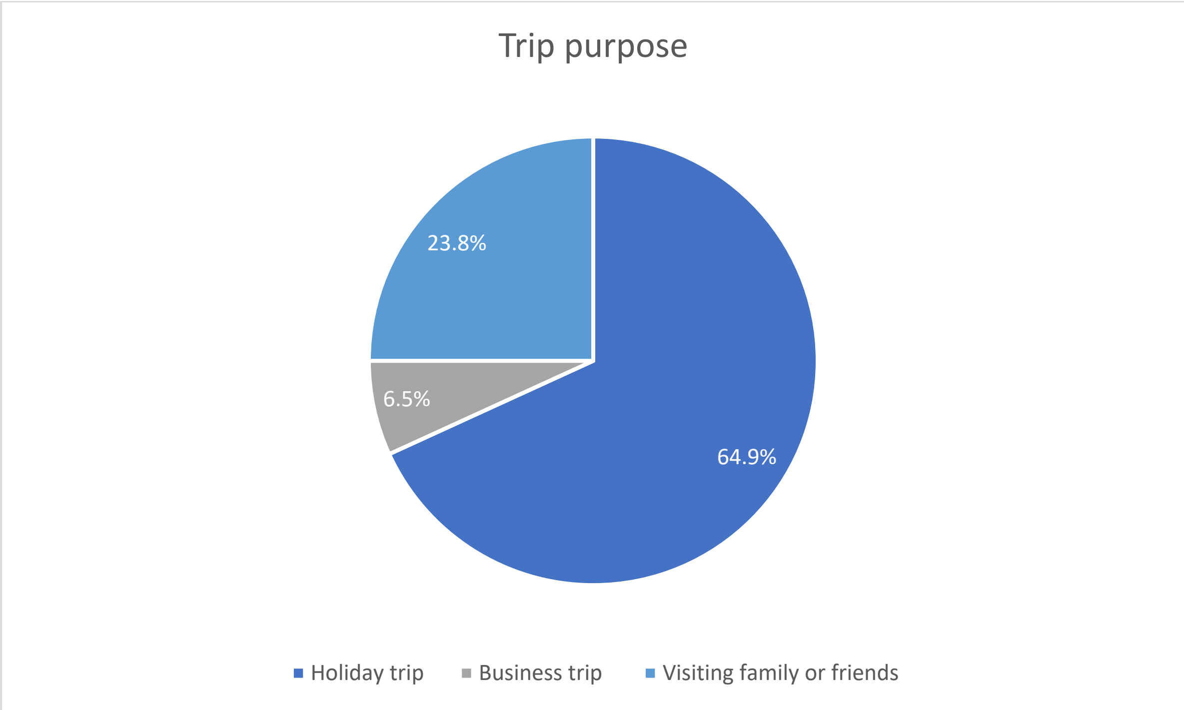
Household composition:



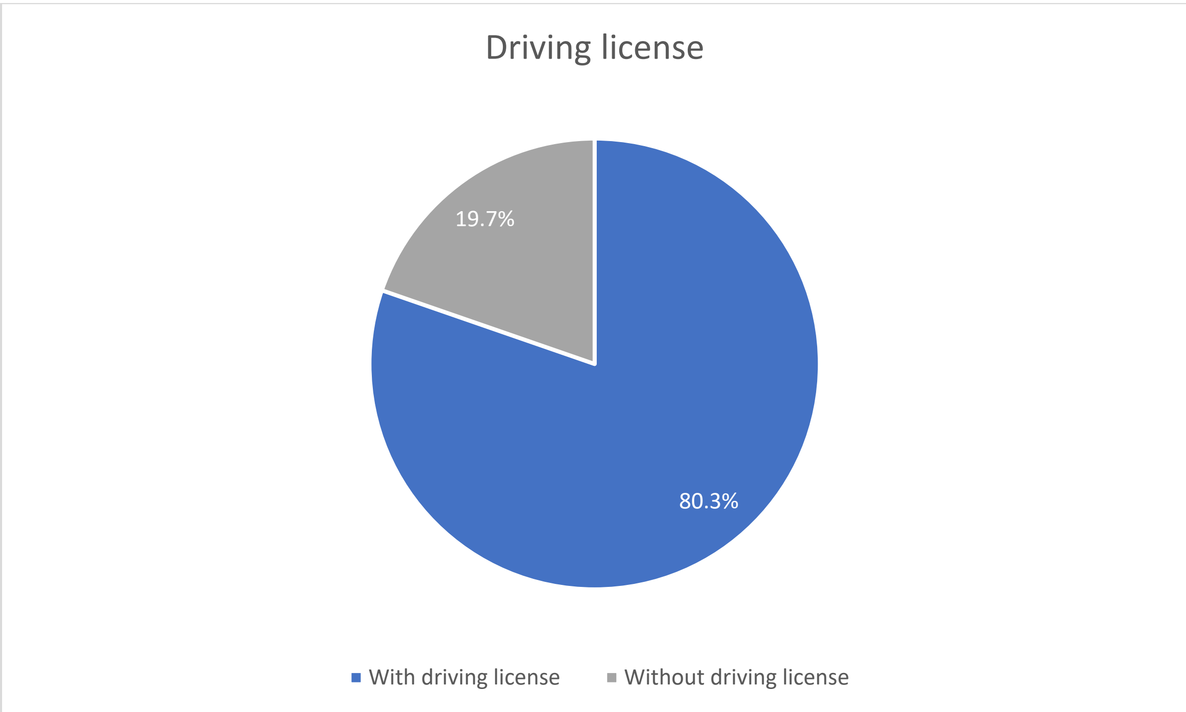
Employment:



Trip purpose:



Driving license:



APPENDIX VIII: CHI SQUARE REPRESENTATIVE SAMPLE TEST

Gender

	Observed N	Expected N	Residual
Female	60	69.2	-9.2
Male	74	67.1	6.9
Other	3	.7	2.3
Total	137		

Test Statistics

	Gender
Chi-Square	9.746[a]
df	2
Asymp. Sig.	.008

a. 1 cells (33.3%) have expected frequencies less than 5. The minimum expected cell frequency is .7.

Age

	Observed N	Expected N	Residual
less than 30	86	54.8	31.2
31-40	32	19.3	12.7
41-50	18	21.0	-3.0
51-70	1	41.9	-40.9
Total	137		

Test Statistics

	Age
Chi-Square	66.395[a]
df	3
Asymp. Sig.	.000

a. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 19.3.

Education

	Observed N	Expected N	Residual
Lower Education	8	90.8	-82.8
Professional education	39	29.0	10.0
Scientific education	90	17.1	72.9
Total	137		

Test Statistics

	Education
Chi-Square	389.066[a]
df	2
Asymp. Sig.	.000

a. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 17.1.

Income

	Observed N	Expected N	Residual
Lower income	45	35.2	9.8
Middle income	38	66.8	-28.8
Higher income	40	21.0	19.0
Total	123		

Test Statistics

	Income
Chi-Square	32.256[a]
df	2
Asymp. Sig.	.000

a. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 21.0.

Household size

	Observed N	Expected N	Residual
1 Person	55	52.1	2.9
2 Persons	43	44.7	-1.7
3 Persons	15	16.3	-1.3
4 persons and more	24	24.0	.0
Total	137		

Test Statistics

	size
Chi-Square	.332[a]
df	3
Asymp. Sig.	.954

a. 0 cells (.0%) have expected frequencies less than 5.
The minimum expected cell frequency is 16.3.

Employment

	Observed N	Expected N	Residual
Full time	68	65.8	2.2
Part time	62	64.4	-2.4
other	7	6.9	.1
Total	137		

Test Statistics

	Employement
Chi-Square	.168[a]
df	2
Asymp. Sig.	.919

a. 0 cells (.0%) have expected frequencies less than 5.
The minimum expected cell frequency is 6.9.

APPENDIX IX: CROSS TABS-ATTITUDES

Statement 1: I am worried about global warming.

Attribute	Level	Disagree	Neutral	Agree	Total
Gender	Male	10	12	52	74
		13.5%	16.2%	70.3%	100%
	Female	2	10	48	60
		3.3%	16.7%	80.0%	100%
	Other	0	0	3	3
		0.0%	0.0%	100.0%	100%
Age	Less than 30 years	23	18	45	86
		26.7%	20.9%	52.3%	100%
	31 years and older	12	13	26	51
		23.5%	25.5%	51.9%	100%
Education	Lower education	2	2	4	8
		25.0%	25.0%	50.0%	100%
	Professional education	3	11	25	39
		7.7%	28.2%	64.1%	100%
	Scientific Education	7	9	74	90
		7.8%	10.0%	82.2%	100%
Household size	1 person	4	7	44	55
		7.3%	12.7%	80.0%	100%
	2 persons	5	7	31	43
		11.6%	16.3%	72.1%	100%
	3 persons	0	5	10	15
		0.0%	33.3%	66.7%	100%
	4 and more persons	3	3	18	24
		12.5%	12.5%	75.0%	100%
Employment	Other	1	0	6	7
		14.3%	0.0%	85.7%	100%
	Part time	4	7	51	62
		6.5%	11.3%	82.3%	100%
	Full time	7	15	46	68
		10.3%	22.1%	67.6%	100%
Income	Lower income	3	5	37	45
		6.7%	11.1%	82.2%	100%
	Middle income	5	7	26	38
		13.2%	18.4%	68.4%	100%
	Higher income	1	7	27	35
		2.9%	20.0%	77.1%	100%
	Not provided	3	3	13	19
		15.8%	15.8%	68.4%	100%

Attribute	Chi-Square	df	Significance
Gender	5.354	4	0.253
Age	0.431	2	0.805
Education	10.502	4	0.033
Household size	5.967	6	0.427
Employment	5.360	4	0.252
Income	5.347	6	0.500

Statement 2: The majority of the population is not acting environmentally conscious.

Attribute	Level	Disagree	Neutral	Agree	Total
Gender	Male	8 10.8%	7 9.5%	59 79.7%	74 100%
	Female	8 13.3%	8 13.3%	44 73.3%	60 100%
	Other	0 0.0%	1 33.3%	2 66.7%	3 100%
Age	Less than 30 years	23 26.7%	18 20.9%	45 52.3%	86 100%
	31 years and older	12 23.5%	13 25.5%	26 51.0%	51 100%
Education	Lower education	2 25.0%	2 25.0%	4 50.0%	8 100%
	Professional education	6 15.4%	6 15.4%	27 69.2%	39 100%
	Scientific Education	8 8.9%	8 8.9%	74 82.2%	90 100%
Household size	1 person	5 9.1%	7 12.7%	43 78.2%	55 100%
	2 persons	5 11.6%	6 14.0%	32 74.4%	43 100%
	3 persons	3 20.0%	2 13.3%	10 66.7%	15 100%
	4 and more persons	3 12.5%	1 4.2%	20 83.3%	24 100%
Employment	Other	1 14.3%	0 0.0%	6 85.7%	7 100%
	Part time	5 8.1%	8 12.9%	49 79.0%	62 100%
	Full time	10 14.7%	8 11.8%	50 73.5%	68 100%
Income	Lower income	4 8.9%	5 11.1%	36 80.0%	45 100%
	Middle income	3 7.9%	7 18.4%	28 73.7%	38 100%
	Higher income	5 14.3%	2 5.7&	28 80.0%	35 100%
	Not provided	4 21.1%	2 10.5%	13 68.4%	19 100%

Attribute	Chi-Square	df	Significance
Gender	2.413	4	0.660
Age	0.435	2	0.805
Education	5.934	4	0.204
Household size	3.036	6	0.804
Employment	2.373	4	0.668
Income	5.307	6	0.505

Statement 3: I am willing to adopt a more environmentally friendly lifestyle.

Attribute	Level	Disagree	Neutral	Agree	Total
Gender	Male	8 10.8%	9 12.2%	57 77.0%	74 100%
	Female	2 3.3%	4 6.7%	54 90.0%	60 100%
	Other	0 0.0%	1 33.3%	2 66.7%	3 100%
Age	Less than 30 years	7 8.1%	3 3.5%	76 88.4%	86 100%
	31 years and older	3 5.9%	11 21.6%	37 72.5%	51 100%
Education	Lower education	2 25.0%	0 0.0%	6 75.0%	8 100%
	Professional education	4 10.3%	8 20.5%	27 69.2%	39 100%
	Scientific Education	4 4.4%	6 6.7%	80 88.9%	90 100%
Household size	1 person	3 5.5%	5 9.1%	47 85.5%	55 100%
	2 persons	2 4.7%	4 9.3%	37 86.0%	43 100%
	3 persons	1 6.7%	3 20.0%	11 73.3%	15 100%
	4 and more persons	4 16.7%	2 8.3%	18 75.0%	24 100%
Employment	Other	1 14.3%	1 14.3%	5 71.4%	7 100%
	Part time	3 4.8%	5 8.1%	54 87.1%	62 100%
	Full time	6 8.8%	8 11.8%	54 79.4%	68 100%
Income	Lower income	3 6.7%	3 6.7%	39 87.7%	45 100%
	Middle income	4 10.5%	4 10.5%	30 78.9%	38 100%
	Higher income	2 5.7%	6 17.1%	27 77.1%	35 100%
	Not provided	1 5.3%	1 5.3%	17 89.5%	19 100%

Attribute	Chi-Square	df	Significance
Gender	6.114	4	0.191
Age	11.436	2	0.003
Education	12.211	4	0.016
Household size	5.595	6	0.470
Employment	2.094	4	0.718
Income	3.840	6	0.698

Statement 4: I am prepared to pay more for environmentally friendly transport.

Attribute	Level	Disagree	Neutral	Agree	Total
Gender	Male	18 24.3%	16 21.6%	40 54.1%	74 100%
	Female	16 26.7%	15 25.0%	29 48.3%	60 100%
	Other	1 33.3%	0 0.0%	2 66.7%	3 100%
Age	Less than 30 years	23 26.7%	18 20.9%	45 52.3%	86 100%
	31 years and older	12 23.5%	13 25.5%	26 51.0%	51 100%
Education	Lower education	3 37.5%	1 12.5%	4 50.0%	8 100%
	Professional education	13 33.3%	11 28.2%	15 38.5%	39 100%
	Scientific Education	19 21.1%	19 21.1%	52 57.8%	90 100%
Household size	1 person	12 21.8%	14 25.5%	29 52.7%	55 100%
	2 persons	12 27.9%	11 25.6%	20 46.5%	43 100%
	3 persons	3 20.0%	4 26.7%	8 53.3%	15 100%
	4 and more persons	8 33.3%	2 8.3%	14 58.3%	24 100%
Employment	Other	3 42.9%	1 14.3%	3 42.9%	7 100%
	Part time	11 17.7%	16 25.8%	35 56.5%	62 100%
	Full time	21 30.9%	14 20.6%	33 48.5%	68 100%
Income	Lower income	7 15.6%	13 28.9%	25 55.6%	45 100%
	Middle income	12 31.6%	8 21.1%	18 47.4%	38 100%
	Higher income	9 25.7%	8 22.9%	18 51.4%	35 100%
	Not provided	7 36.8%	2 10.5%	10 52.6%	19 100%

Attribute	Chi-Square	df	Significance
Gender	1.345	4	0.854
Age	0.435	2	0.805
Education	5.021	4	0.285
Household size	4.224	6	0.646
Employment	4.181	4	0.382
Income	5.570	6	0.473

APPENDIX X: CROSS TABS- AIRPORT STATEMENTS

Statement 1: I think security services at Eindhoven Airport are efficient.

Attribute	Level	Disagree	Neutral	Agree	Total
Gender	Male	13 17.6%	36 48.6%	25 33.8%	74 100%
	Female	15 25%	31 51.7%	14 23.3%	60 100%
	Other	0 0%	1 33.3%	2 66.7%	3 100%
Age	Less than 30 years	19 22.1%	47 54.7%	20 23.3%	86 100%
	31 years and older	9 17.6%	21 41.2%	21 41.2%	51 100%
Education	Lower education	1 12.5%	5 62.5%	2 25%	8 100%
	Professional education	9 23.1%	16 41.0%	14 35.9%	39 100%
	Higher Education	28 20.4%	68 49.6%	41 29.9%	137 100%
Household size	1 person	10 18.2%	28 50.9%	17 30.9%	55 100%
	2 persons	11 25.6%	23 53.5%	9 20.9%	43 100%
	3 persons	2 13.3%	9 60.0%	4 26.7%	15 100%
	4 and more persons	5 20.8%	8 33.3%	11 45.8%	24 100%
Employment	Other	1 14.3%	3 42.9%	3 42.9%	7 100%
	Part time	14 26.6%	35 56.5%	13 21.0%	62 100%
	Full time	13 19.1%	30 44.1%	25 36.8%	68 100
Income	Lower income	9 20.0%	26 57.8%	10 22.2%	45 100%
	Middle income	7 18.4%	23 60.5%	8 21.1%	38 100%
	Higher income	6 31.6%	7 36.8%	6 31.6%	19 100%

Attribute	Chi-Square	df	Significance
Gender	4.340	4	0.362
Age	4.916	2	0.086
Education	2.027	4	0.731
Household size	6.085	6	0.414
Employment	4.505	4	0.342
Income	11.192	6	0.083

Statement 2: I think the ambiance of Eindhoven Airport is pleasant.

Attribute	Level	Disagree	Neutral	Agree	Total
Gender	Male	7 9.5%	32 43.2%	35 47.3%	74 100%
	Female	8 13.3%	23 38.3%	29 48.3%	60 100%
	Other	0 0.0%	0 0.0%	3 100%	3 100%
Age	Less than 30 years	12 14.0%	29 33.7%	45 52.3%	86 100%
	31 years and older	3 5.9%	26 51.0%	22 43.1%	51 100%
Education	Lower education	0 0.0%	3 37.5%	5 62.5%	8 100%
	Professional education	4 10.3%	19 48.7%	16 41.0%	39 100%
	Scientific Education	11 12.2%	33 36.7%	46 51.1%	90 100%
Household size	1 person	4 7.3%	17 30.9%	34 61.8%	55 100%
	2 persons	5 11.6%	25 58.1%	13 30.2%	43 100%
	3 persons	3 20.0%	4 26.7%	8 53.3%	15 100%
	4 and more persons	3 12.5%	9 37.5%	12 500%	24 100%
Employment	Other	0 0.0%	2 28.6%	5 71.4%	7 100%
	Part time	6 9.7%	17 27.4%	39 62.9%	62 100
	Full time	9 13.2%	36 52.9%	23 33.8%	68 100%
Income	Lower income	4 8.9%	10 22.2%	31 68.9%	45 100%
	Middle income	3 7.9%	20 52.6%	15 39.5%	38 100%
	Higher income	4 11.4%	17 48.6%	14 40.0%	35 100%
	Not provided	4 21.4%	8 42.1%	7 36.8%	19 100%

Attribute	Chi-Square	df	Significance
Gender	3.865	4	0.425
Age	4.833	2	0.089
Education	2.912	4	0.573
Household size	12.236	6	0.057
Employment	13.064	4	0.011
Income	13.489	6	0.036

Statement 3: I think Eindhoven Airport is better accessible with car.

Attribute	Level	Disagree	Neutral	Agree	Total
Gender	Male	24 32.4%	21 28.4%	29 39.2%	74 100%
	Female	12 20.0%	8 13.3%	40 66.7%	60 100%
	Other	1 33.3%	1 33.3%	1 33.3%	3 100%
Age	Less than 30 years	19 22.1%	16 18.6%	51 59.3%	86 100%
	31 years and older	18 35.3%	14 27.5%	19 37.3%	51 100%
Education	Lower education	2 25.0%	1 12.5%	5 62.5%	8 100%
	Professional education	16 41.0%	9 23.1%	14 35.9%	39 100%
	Scientific Education	19 21.1%	20 22.2%	51 56.7%	90 100%
Household size	1 person	12 21.8%	16 29.1%	27 49.1%	55 100%
	2 persons	10 23.3%	7 16.3%	26 60.5%	43 100%
	3 persons	6 40.0%	3 20.0%	6 40.0%	15 100%
	4 and more persons	9 37.5%	4 16.7%	11 45.8%	24 100%
Employment	Other	0 0.0%	1 14.3%	6 85.7%	7 100%
	Part time	14 22.6%	12 19.4%	36 58.1%	62 100%
	Full time	23 33.8%	17 25.0%	28 41.2%	68 100%
Income	Lower income	9 20.0%	9 20.0%	27 60.0%	45 100.0%
	Middle income	10 26.3%	9 23.7%	19 50.0%	38 100.0%
	Higher income	17 48.6%	10 28.6%	8 22.9%	35 100%
	Not provided	1 5.3%	2 10.5%	16 84.2%	19 100%

Attribute	Chi-Square	df	Significance
Gender	10.635	4	0.031
Age	6.256	2	0.044
Education	6.873	4	0.143
Household size	6.206	6	0.401
Employment	7.718	4	0.102
Income	22.388	6	0.001

Statement 4: I enjoy driving to Eindhoven Airport.

Attribute	Level	Disagree	Neutral	Agree	Total
Gender	Male	12 16.2%	13 17.6%	49 66.2%	74 100%
	Female	9 15.0%	11 18.3%	40 66.7%	60 100
	Other	1 33.3%	1 33.3%	1 33.3%	1 33.3%
Age	Less than 30 years	15 17.4%	14 16.3%	57 66.3%	86 100%
	31 years and older	7 13.7%	11 21.6%	33 64.7%	51 100%
Education	Lower education	0 0.0%	1 12.5%	7 87.5%	8 100%
	Professional education	4 10.3%	12 30.8%	23 59.0%	39 100%
	Scientific Education	18 20.0%	12 13.3%	60 66.7%	90 100%
Household size	1 person	11 20.0%	9 16.4%	35 63.6%	55 100%
	2 persons	7 16.3%	10 23.3%	26 60.5%	43 100%
	3 persons	0 0.0%	2 13.3%	13 86.7%	15 100%
	4 and more persons	4 16.7%	4 16.7%	16 66.7%	24 100%
Employment	Other	1 14.3%	0 0.0%	6 85.7%	7 100%
	Part time	11 17.7%	12 19.4%	39 62.9%	62 100%
	Full time	10 14.7%	13 19.1%	45 66.2%	68 100%
Income	Lower income	10 22.2%	6 13.3%	29 64.4%	45 100%
	Middle income	4 10.5%	10 26.3%	24 63.2%	38 100%
	Higher income	7 20.0%	6 17.1%	22 62.9%	35 100%
	Not provided	1 5.3%	3 15.8%	15 78.9%	19 100%

Attribute	Chi-Square	df	Significance
Gender	1.484	4	0.830
Age	0.778	2	0.678
Education	8.520	4	0.074
Household size	5.0099	6	0.531
Employment	2.051	4	0.726
Income	6.143	6	0.407

APPENDIX XI: MODEL ESTIMATIONS

MNL MODEL

```
Start values obtained using MNL model
Dependent variable                Choice
Log likelihood function        -626.96398
Estimation based on N =     480, K =   98
Inf.Cr.AIC  =    1449.9 AIC/N =     3.021
---------------------------------------
            Log likelihood R-sqrd R2Adj
Constants only   -755.5401  .1702 .1241
Note: R-sqrd = 1 - logL/Logl(constants)
---------------------------------------
Chi-squared[94]          =     257.15217
Prob [ chi squared > value ] =    .00000
Response data are given as ind. choices
Number of obs.=    480, skipped    0 obs
```

CHOICE	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
TTCAR15	.03017	.18770	.16	.8723	-.33771	.39805
TTCAR20	-.17445	.19478	-.90	.3705	-.55620	.20731
TCCAR05	.02816	.18635	.15	.8799	-.33708	.39341
TCCAR1	.05680	.19394	.29	.7696	-.32332	.43692
CARPRK20	.06022	.22464	.27	.7886	-.38007	.50051
CARPRK30	-.98047***	.26104	-3.76	.0002	-1.49209	-.46885
CARWLK5	-.34300	.21465	-1.60	.1101	-.76370	.07771
CARWLK10	-.07853	.21098	-.37	.7097	-.49205	.33498
TAX	-.13741	.26994	-.51	.6107	-.66648	.39165
TTTAX15	.09337	.19716	.47	.6358	-.29305	.47979
TTTAX20	-.62404***	.23006	-2.71	.0067	-1.07494	-.17313
TCTAX10	-.13395	.21084	-.64	.5252	-.54718	.27928
TCTAX12	-.18520	.21377	-.87	.3863	-.60419	.23379
LUGGTAX	.33528*	.19944	1.68	.0927	-.05561	.72618
PURPTAX	.41030*	.21498	1.91	.0563	-.01105	.83165
ACCMTAX	-.18931	.21482	-.88	.3782	-.61034	.23173
MTAX	-.01943	.18386	-.11	.9158	-.37979	.34093
AGETAX1	-.16907	.28257	-.60	.5496	-.72290	.38476
AGETAX2	.17062	.29737	.57	.5661	-.41222	.75346
EDUTAX	-.13608	.18691	-.73	.4666	-.50241	.23025
INCTAX1	-.89265**	.41230	-2.17	.0304	-1.70075	-.08456
INCTAX2	-.17952	.34923	-.51	.6072	-.86399	.50495
INCTAX3	.25138	.36377	.69	.4895	-.46159	.96435
HOUSETX1	.14455	.34492	.42	.6752	-.53148	.82058
HOUSETX2	.28687	.29007	.99	.3227	-.28165	.85539
HOUSETX3	-.03908	.40756	-.10	.9236	-.83788	.75972
JOBTAX	.04084	.25231	.16	.8714	-.45369	.53536
ESHARE	.70221***	.22319	3.15	.0017	.26477	1.13965
TTSHR15	.16781	.15978	1.05	.2936	-.14536	.48097
TTSHR20	-.40244**	.16427	-2.45	.0143	-.72441	-.08047
TCSH3	.16759	.16450	1.02	.3083	-.15482	.48999
TCSH5	-.43816**	.17322	-2.53	.0114	-.77767	-.09865
SHCOFE	.44178***	.15772	2.80	.0051	.13265	.75090
SHFSTK	-.29373*	.16236	-1.81	.0704	-.61195	.02448
SHWLK5	.11735	.15873	.74	.4597	-.19375	.42845
SHWLK10	-.22744	.16455	-1.38	.1669	-.54994	.09507
LUGSHRE	.03545	.16265	.22	.8275	-.28333	.35423

PURPSHR|	.22736	.18083	1.26	.2087	-.12707	.58179
ACCMSHR|	.22560	.17484	1.29	.1969	-.11707	.56828
MSHARE|	-.11134	.15415	-.72	.4701	-.41347	.19079
AGESHR1|	-.04770	.24572	-.19	.8461	-.52930	.43390
AGESHR2|	-.05321	.27699	-.19	.8476	-.59610	.48967
EDUSHR|	.10757	.16423	.66	.5124	-.21431	.42945
INCSHR1|	.08461	.31700	.27	.7895	-.53669	.70591
INCSHR2|	-.25744	.31107	-.83	.4079	-.86714	.35225
INCSHR3|	-.22448	.32714	-.69	.4926	-.86565	.41670
HOUSESH1|	.07980	.26968	.30	.7673	-.44877	.60837
HOUSESH2|	-.11972	.25458	-.47	.6382	-.61868	.37924
HOUSESH3|	-.04627	.34440	-.13	.8931	-.72128	.62873
JOBSHARE|	-.08967	.22480	-.40	.6900	-.53027	.35094
BUS|	-.85413**	.36609	-2.33	.0196	-1.57165	-.13660
TTBUS30|	-.01555	.19163	-.08	.9353	-.39114	.36003
TTBUS35|	-.49574**	.20473	-2.42	.0155	-.89699	-.09448
TCBUS3|	-.41103*	.22037	-1.87	.0622	-.84295	.02089
TCBUS4|	.01085	.20293	.05	.9574	-.38688	.40859
WTBUS5|	-.00509	.21266	-.02	.9809	-.42190	.41172
WTBUS10|	-.09231	.21929	-.42	.6738	-.52211	.33749
TRNSF1|	-.16718	.20848	-.80	.4226	-.57581	.24144
TRNSF2|	-.29599	.22018	-1.34	.1789	-.72752	.13555
BUSCOFE|	.00113	.19351	.01	.9954	-.37814	.38039
BUSFST|	.12382	.18906	.65	.5125	-.24674	.49437
LUGBUS|	-.22581	.18996	-1.19	.2346	-.59812	.14650
PURPBUS|	.07682	.20288	.38	.7050	-.32083	.47446
ACCMBUS|	-.22223	.22125	-1.00	.3152	-.65587	.21140
MBUS|	-.13815	.17124	-.81	.4198	-.47379	.19748
AGEBUS1|	1.02362***	.36540	2.80	.0051	.30744	1.73980
AGEBUS2|	.68997*	.36879	1.87	.0614	-.03285	1.41278
EDUBUS|	-.00894	.18814	-.05	.9621	-.37770	.35981
INCBUS1|	.19736	.36665	.54	.5904	-.52126	.91598
INCBUS2|	-.64700*	.35858	-1.80	.0712	-1.34981	.05581
INCBUS3|	.33347	.37463	.89	.3734	-.40079	1.06773
HOUSB1|	.74695**	.29944	2.49	.0126	.16005	1.33384
HOUSB2|	-.41351	.31763	-1.30	.1930	-1.03606	.20905
HOUSB3|	.58146	.39210	1.48	.1381	-.18705	1.34996
JOBBUS|	.35455	.27363	1.30	.1951	-.18176	.89086
HAIL|	-.18872	.27957	-.68	.4997	-.73667	.35924
TTHAI15|	.54363**	.23503	2.31	.0207	.08298	1.00428
TTHAI20|	-.69910***	.24530	-2.85	.0044	-1.17989	-.21831
TCHAI5|	-.08104	.23071	-.35	.7254	-.53321	.37114
TCHAI75|	-.55689**	.23165	-2.40	.0162	-1.01092	-.10286
WTHAI15|	-.08689	.21133	-.41	.6809	-.50109	.32730
WTHAI20|	-.08787	.20248	-.43	.6643	-.48472	.30899
HAICOFE|	.02517	.20459	.12	.9021	-.37582	.42616
HAIFST|	.39651**	.20175	1.97	.0494	.00109	.79193
LUGHAIL|	-.15541	.18719	-.83	.4064	-.52229	.21148
PURPHAI|	.01543	.20254	.08	.9393	-.38155	.41240
ACCMHAI|	.02419	.20549	.12	.9063	-.37857	.42694
MHAIL|	.24961	.18811	1.33	.1845	-.11909	.61831
AGE1HAI|	-.45077	.29315	-1.54	.1241	-1.02533	.12379
AGE2HAI|	.03032	.31768	.10	.9240	-.59232	.65295
EDUHAI|	.21233	.19599	1.08	.2786	-.17179	.59646
INCHAI1|	.49508	.38701	1.28	.2008	-.26345	1.25361
INCHAI2|	.04740	.37832	.13	.9003	-.69410	.78890
INCHAI3|	-.29390	.40522	-.73	.4683	-1.08812	.50032
HOUHA1|	.33740	.31810	1.06	.2888	-.28606	.96085
HOUHA2|	-.13991	.30489	-.46	.6463	-.73749	.45767
HOUHA3|	-.10836	.41251	-.26	.7928	-.91687	.70014
JOBHAIL|	-.01632	.27461	-.06	.9526	-.55456	.52191

```
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***, **, * ==>  Significance at 1%, 5%, 10% level.
Model was estimated on May 20, 2020 at 00:14:40 PM
```

Error Component model:

```
Random Parms/Error Comps. Logit Model
Dependent variable               CHOICE
Log likelihood function      -623.42927
Restricted log likelihood    -772.53020
Chi squared [101](P= .000)    298.20185
Significance level               .00000
McFadden Pseudo R-squared      .1930034
Estimation based on N =    480, K = 101
Inf.Cr.AIC  =   1448.9 AIC/N =    3.018
---------------------------------------
            Log likelihood R-sqrd R2Adj
No coefficients  -772.5302  .1930 .1482
Constants only   -755.5401  .1749 .1290
At start values  -626.9640  .0056-.0496
Note: R-sqrd = 1 - logL/Logl(constants)
---------------------------------------
Response data are given as ind. choices
Replications for simulated probs. = 100
Pseudo random draws (Mersenne twister).
BHHH estimator used for asymp. variance
Number of obs.=   480, skipped    0 obs
--------+---------------------------------------------------------------------
--
        |                  Standard            Prob.      95% Confidence
  CHOICE|  Coefficient       Error       z    |z|>Z*         Interval
--------+---------------------------------------------------------------------
--
        |Nonrandom parameters in utility
functions...........................
 TTCAR15|     .04909         .31166       .16  .8748     -.56175    .65993
 TTCAR20|    -.24203         .32484      -.75  .4562     -.87870    .39464
 TCCAR05|     .10079         .30178       .33  .7384     -.49069    .69228
  TCCAR1|     .07224         .31612       .23  .8192     -.54735    .69183
CARPRK20|     .05573         .35574       .16  .8755     -.64150    .75296
CARPRK30|   -1.32941***      .49968     -2.66  .0078    -2.30877   -.35005
 CARWLK5|    -.66588         .41953     -1.59  .1125    -1.48815    .15639
CARWLK10|    -.05288         .34735      -.15  .8790     -.73367    .62791
     TAX|    -.40384         .50523      -.80  .4241    -1.39408    .58640
 TTTAX15|     .16958         .36545       .46  .6426     -.54668    .88585
 TTTAX20|   -1.00189**       .48498     -2.07  .0388    -1.95242   -.05135
 TCTAX10|    -.12803         .36549      -.35  .7261     -.84438    .58832
 TCTAX12|    -.44771         .41355     -1.08  .2790    -1.25826    .36283
 LUGGTAX|     .55627         .42322      1.31  .1887     -.27322   1.38577
 PURPTAX|     .72451*        .43085      1.68  .0926     -.11994   1.56897
 ACCMTAX|    -.49234         .46162     -1.07  .2862    -1.39709    .41241
    MTAX|     .00932         .35873       .03  .9793     -.69378    .71241
 AGETAX1|    -.32420         .54988      -.59  .5555    -1.40195    .75355
 AGETAX2|     .42765         .60347       .71  .4785     -.75513   1.61044
  EDUTAX|    -.22056         .35723      -.62  .5370     -.92071    .47959
 INCTAX1|   -1.34316         .92176     -1.46  .1451    -3.14978    .46345
 INCTAX2|    -.10171         .73171      -.14  .8895    -1.53583   1.33242
 INCTAX3|     .52736         .78510       .67  .5018    -1.01142   2.06614
HOUSETX1|     .50867         .68141       .75  .4554     -.82687   1.84420
HOUSETX2|     .39794         .54036       .74  .4615     -.66114   1.45703
HOUSETX3|    -.15931         .73339      -.22  .8280    -1.59674   1.27811
```

JOBTAX|	.06750	.56969	.12	.9057	-1.04907	1.18408
ESHARE|	1.01683**	.49137	2.07	.0385	.05377	1.97990
TTSHR15|	.10589	.29027	.36	.7153	-.46302	.67480
TTSHR20|	-.54071	.32948	-1.64	.1008	-1.18648	.10506
TCSH3|	.25981	.28897	.90	.3686	-.30655	.82617
TCSH5|	-.75714**	.36420	-2.08	.0376	-1.47096	-.04333
SHCOFE|	.64368**	.31849	2.02	.0433	.01945	1.26790
SHFSTK|	-.38843	.29899	-1.30	.1939	-.97443	.19757
SHWLK5|	.10551	.28091	.38	.7072	-.44506	.65608
SHWLK10|	-.27920	.29215	-.96	.3392	-.85180	.29340
LUGSHRE|	-.02711	.25842	-.10	.9164	-.53360	.47938
PURPSHR|	.29997	.31591	.95	.3423	-.31920	.91913
ACCMSHR|	.34994	.32086	1.09	.2754	-.27894	.97882
MSHARE|	-.18076	.25935	-.70	.4858	-.68907	.32755
AGESHR1|	-.03701	.37810	-.10	.9220	-.77807	.70406
AGESHR2|	-.07503	.42232	-.18	.8590	-.90277	.75271
EDUSHR|	.20765	.27015	.77	.4421	-.32183	.73713
INCSHR1|	.15663	.53931	.29	.7715	-.90040	1.21366
INCSHR2|	-.30921	.52485	-.59	.5558	-1.33790	.71947
INCSHR3|	-.15578	.48881	-.32	.7500	-1.11383	.80227
HOUSESH1|	.15008	.44168	.34	.7340	-.71559	1.01575
HOUSESH2|	-.17121	.41166	-.42	.6775	-.97806	.63563
HOUSESH3|	-.07502	.50209	-.15	.8812	-1.05910	.90906
JOBSHARE|	-.18188	.39047	-.47	.6414	-.94718	.58342
BUS|	-1.04435	.91740	-1.14	.2550	-2.84243	.75372
TTBUS30|	.03267	.28126	.12	.9075	-.51859	.58393
TTBUS35|	-.72260**	.31530	-2.29	.0219	-1.34058	-.10462
TCBUS3|	-.50495	.32687	-1.54	.1224	-1.14560	.13570
TCBUS4|	.04114	.31660	.13	.8966	-.57938	.66167
WTBUS5|	-.19655	.28794	-.68	.4949	-.76089	.36779
WTBUS10|	.04973	.32223	.15	.8773	-.58182	.68128
TRNSF1|	-.37140	.31733	-1.17	.2418	-.99335	.25054
TRNSF2|	-.20213	.32104	-.63	.5289	-.83136	.42710
BUSCOFE|	.08684	.28074	.31	.7571	-.46339	.63707
BUSFST|	.15968	.27176	.59	.5568	-.37296	.69233
LUGBUS|	-.31038	.35508	-.87	.3821	-1.00632	.38557
PURPBUS|	.13556	.38677	.35	.7260	-.62250	.89361
ACCMBUS|	-.60000	.46710	-1.28	.1990	-1.51549	.31550
MBUS|	-.17671	.35987	-.49	.6234	-.88204	.52863
AGEBUS1|	1.38506*	.76170	1.82	.0690	-.10785	2.87797
AGEBUS2|	1.12769	.74577	1.51	.1305	-.33400	2.58938
EDUBUS|	.03331	.37354	.09	.9289	-.69882	.76544
INCBUS1|	.37306	.71726	.52	.6030	-1.03274	1.77886
INCBUS2|	-.82630	.69076	-1.20	.2316	-2.18017	.52757
INCBUS3|	.72902	.75692	.96	.3355	-.75451	2.21255
HOUSB1|	1.29348*	.67280	1.92	.0545	-.02519	2.61215
HOUSB2|	-.92224	.68493	-1.35	.1782	-2.26468	.42020
HOUSB3|	.79607	.74576	1.07	.2858	-.66559	2.25773
JOBBUS|	.52259	.51843	1.01	.3134	-.49352	1.53869
HAIL|	-.19633	.74127	-.26	.7911	-1.64920	1.25654
TTHAI15|	.68746*	.36732	1.87	.0613	-.03248	1.40740
TTHAI20|	-.90563***	.34470	-2.63	.0086	-1.58123	-.23003
TCHAI5|	.01843	.33171	.06	.9557	-.63171	.66856
TCHAI75|	-.72268**	.35800	-2.02	.0435	-1.42434	-.02101
WTHAI15|	-.20663	.33429	-.62	.5365	-.86183	.44857
WTHAI20|	-.16164	.32918	-.49	.6234	-.80683	.48355
HAICOFE|	.26007	.31198	.83	.4045	-.35139	.87154
HAIFST|	.37799	.31377	1.20	.2283	-.23699	.99297
LUGHAIL|	-.30603	.35173	-.87	.3843	-.99540	.38335
PURPHAI|	.06811	.38284	.18	.8588	-.68223	.81846
ACCMHAI|	-.20092	.44371	-.45	.6507	-1.07057	.66873

```
  MHAIL|     .28065          .37959       .74  .4597     -.46333   1.02463
 AGE1HAI|    -.42187          .56145      -.75  .4524    -1.52228    .67854
 AGE2HAI|     .14922          .63637       .23  .8146    -1.09803   1.39648
  EDUHAI|     .22284          .38908       .57  .5668     -.53975    .98542
 INCHAI1|     .50504          .86472       .58  .5592    -1.18979   2.19986
 INCHAI2|     .00447          .74019       .01  .9952    -1.44628   1.45523
 INCHAI3|     .00782          .82931       .01  .9925    -1.61759   1.63323
  HOUHA1|    1.06378          .71756      1.48  .1382     -.34260   2.47017
  HOUHA2|    -.26541          .59590      -.45  .6560    -1.43336    .90254
  HOUHA3|    -.22230          .80308      -.28  .7819    -1.79630   1.35170
 JOBHAIL|     .03239          .63440       .05  .9593    -1.21101   1.27579
        |Standard deviations of latent random
effects........................
SigmaE01|    1.32224         1.25081      1.06  .2905    -1.12931   3.77379
SigmaE02|    1.76658         1.22379      1.44  .1489     -.63200   4.16517
SigmaE03|    2.78138**       1.37789      2.02  .0435      .08078   5.48199
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***, **, * ==>  Significance at 1%, 5%, 10% level.
Model was estimated on May 20, 2020 at 00:15:48 PM
----------------------------------------------------------------------------
 Random Effects Logit Model
 Appearance of Latent Random Effects in Utilities
 Alternative   E01 E02 E03
+--------------+---+---+---+
|  CAR         |   | * | * |
+--------------+---+---+---+
|  TAXI        |   | * |   |
+--------------+---+---+---+
|  ESHARED     |   |   | * |
+--------------+---+---+---+
|  BUS         | * |   |   |
+--------------+---+---+---+
|  HAILING     | * |   |   |
+--------------+---+---+---+
```