

Understanding Transport Mode Choice for Business-Related Trips Among SME Employees

A Stated Choice Experiment at the KeileCollectief

L.D. Kondova



Understanding Transport Mode Choice for Business-Related Trips Among SME Employees

A Stated Choice Experiment at the
KeileCollectief

by

L.D. (Lia) Kondova

in fulfillment of the requirements for the degree
MSc Transport, Infrastructure & Logistics
at
Delft University of Technology



Student number: 5838185

Graduation Committee:

Prof.dr.ir. B. (Bart) van Arem, TU Delft, Chair T&P
Vincent Joanknecht, Supervisor Gemeente Rotterdam
Dr. J.A. (Jan Anne) Annema, TU Delft, Supervisor TPM
Dr.ir. AJ (Arjan) van Binsbergen, TU Delft, Supervisor T&P

Preface

This thesis was a part-time project that I began in October 2024 and finished in June 2025. My motivation for joining this project was that I'm a big fan of greenery in cities and not such a big fan of cars parked on the street. I distinctly remember three cars parked in my neighborhood back in Bulgaria. Three cars, past which I walked for almost 20 years until I moved to the Netherlands, and they never moved from their spots. I am not entirely sure about who owned them, but whoever did, the cars remained unused. And although these were only three cars that I noticed, I am sure there were and still are many more. I will leave it to the imagination to the reader about the countless opportunities that could have been possible if such vehicles did not take space on the street. Because even when used, private cars are parked on the street for over 90% of the time.

This general dislike of mine towards the abundance of personal cars tied well within the initiative SCARCITY, which I came to know about through Bart. He was also the one to introduce me to Vincent and the Municipality's project centering around the KeileCollectief, after which Jan Anne and Arjan also became part of the my graduation project due to their association with shared mobility.

This gave the initial start of my thesis project, which process-wise was quite challenging, as I did not have much experience with the method I decided to use. But this was exactly what I wanted - to try and learn something new. This, besides complicating my work, made the process interesting from an academic standpoint. I had to face many methodological challenges, which I addressed either through further research, by reworking my models tens of times, or via contacting experts in the field. In the end, I rose above at least some of these challenges.

And although this was an individual project, I would like to thank my supervisors, both on the University and the Municipality side for their support and guidance. I would also like to thank my family and friends for supporting me, both financially and emotionally, in the journey of completing this degree. A special thanks goes to Dispuut Verkeer for providing me with an environment in which I could learn, thrive and meet new people. Because of all of this I had a wonderful time studying in this University and in this city and as sad as I am to leave all of this behind, I'm excited for what the future has in store for me!

On that note, I leave you, the reader, with my thesis and I can only hope it is an enjoyable reading material.

*Lia Kondova
Delft, August 2025*

Summary

Introduction

As car use in cities continues to grow, causing issues such as congestion, air pollution, and the inefficient use of public space, Municipalities across the Netherlands are working to address this by promoting alternatives like shared mobility. For this purpose, certain policies are in place, but not when it comes to small-to-medium-sized enterprises (SMEs). Thus, to investigate the mobility needs and the factors affecting mode choice for business-related trips, the KeileCollectief in Rotterdam is taken as a practical case study.

The reviewed literature shows that mode choice is shaped by a combination of socio-demographic factors (such as age, gender, income, education, household type, and vehicle ownership), operational and context-related aspects (including parking availability, booking requirements, travel time, and weather), and psychological influences (for example, driving pleasure, environmental responsibility, and habit). Studies also suggest that a strong sense of community can encourage prosocial and sustainable behavior, although direct empirical links between workplace culture and shared mobility adoption remain underexplored. This gap in the literature, combined with the practical need for SME-specific policy insights, forms the basis for this research. And to address this, the following main research is formulated:

How do the employees of small-to-medium-sized enterprises (SMEs) make transport mode choices for business trips?

To aid answering this question, three sub-research questions are formulated, namely:

- Which factors are relevant when it comes to choosing between shared mobility options and private car usage at the KeileCollectief?
- How do these factors, in combination with the aspect of workplace community values, shape mode choice for the KeileCollectief employees?
- What lessons from the KeileCollectief pilot can inform the design of shared mobility policies targeting SMEs?

Methodology

To answer the research questions, a mixed-method approach was used, combining expert interviews and a stated choice experiment (SCE). The first step involved defining the key variables through a combination of literature review and interviews with experts who are familiar with the KeileCollectief mobility strategy. Based on the outcomes of the interviews, three attributes were selected: parking distance, advanced booking time, and estimated arrival time. The SCE simulated realistic business trip choices between different transport modes, namely private car, shared car/van, shared cargo bike, which were most relevant for the KeileCollectief pilot. Survey respondents had to go through two separate choice scenarios: one for small cargo (with private car, shared car, and shared cargo bike as options), and one for large cargo (with only private car and shared car as options). The survey also included a socio-demographic section capturing information such as age, gender, education level, income, employment status, and the importance of community at work. Lastly, the Multinomial Logit (MNL) Model was utilized to provide a deeper understanding of mode choice by determining which factors are influential when selecting a given alternative.

Results

Due to the lower than expected explanatory power of the initial models, which only included the attributes as main effects, two extended models (one per scenarios) were created. These models also included the covariates age, gender and community sensitivity, which arose as most important during the expert interviews. The key findings can be seen in Table 1. In a nutshell, both models showed that the internal motivation for choosing shared mobility for the sake of the KeileCollectief community was not a driving factor for a successful transition. Even in a progressive and environmentally-conscious community as the KeileCollectief, the biggest contributors to considering shared mobility were external - removing parking spots, increasing the ease-of-use of shared mode, and other actions.

Table 1: Scenario Results: Small cargo vs. Big cargo

Scenario 1: Small cargo	Scenario 2: Big cargo
Increased booking-in-advance time lowers the utility of the shared modes	There is no baseline preference for the private car
Perceived “late” arrival lowers the utility of the shared modes	Perceived “late” arrival lowers the utility of the shared car/van
Perceived “late” arrival hardly affects the utility of the private car	Perceived “late” arrival significantly lowers the utility of the private car
Increasing the distance to parking decreases the utility of the private car	Increasing the distance to parking decreases the utility of the private car
All age groups prefer the private car by default, but are open to the shared car/van	There is no clear evidence that longer booking time reduces the shared car/van utility
All age groups show little interest towards the shared cargo bike	Respondents aged 65+ show a strong preference for the private car over the shared car/van
Community values do not appear to be a strong determinant in mode choice	Community values do not appear to be a strong determinant in mode choice
Gender does not appear to play a role in mode choice in the KeileCollectief context	All genders , as well as respondents under 65 , show no significant preference for shared car/van over private car or vice versa

Discussion

Despite the intuitive results for the operational factors, the model outcomes for the other aspects contradicted the reviewed literature. These outcomes challenged the assumption that progressive work environments or community-oriented branding would lead to more sustainable behavior in terms of mobility. This was also enhanced by the lack information regarding shared mobility among the KeileCollectief employees. When considering these outcomes, however, the aspect of certain model limitation should not be forgotten. Such limitation include the modest sample size, which lead to a lower explanatory power of the models. Despite this, the findings provide useful insights into the kinds of operational improvements and behavioral levers that would need to be addressed for shared mobility adoption to grow in SME environments.

Conclusion and Recommendation

In conclusion, in order to improve the adoption of shared mobility in SME settings, vehicle usability must be prioritized in order to tip the scales away from private cars and more towards shared mobility. The shared options must not be just as convenient - they should be more convenient than the private car in order to be truly competitive. This means reducing the need to plan far in advance, ensuring vehicles are readily available, and locating them closer to users' points of departure. Shared mobility should also be made visible and accessible within the physical and social space of the workplace. One approach could be to treat shared cars and bikes as part of a company's own fleet - vehicles that are familiar, always nearby, and used regularly. This is also in line with the community values, that SMEs usually exhibit. Infrastructure changes such as priority parking spots or designated areas for shared vehicles near office entrances could help normalize their presence.

Information and engagement also play an important role - companies and municipalities should organize interactive events such as info markets, workshops, or short demo sessions where employees can see, try, and discuss the use of shared mobility in a casual and open way. The aim is not just to inform, but to involve people in the initiative and create positive associations with the shared options available. This could also strengthen the community values within the workspace, which could then result in an increase shared mobility usage. In addition, this research shows that not all commonly assumed behavioral drivers, such as age, gender, or even community sensitivity, are universally relevant. In practice, shared mobility behavior is shaped more by contextual and operational constraints, which implies that models should favor simplicity and empirical relevance over theoretical exhaustiveness. Most importantly - policy makers and the individuals, for whom policies are made, should work together to achieve the transition towards shared mobility.

Contents

Preface	i
Summary	ii
Nomenclature	ix
1 Introduction	1
1.1 Background	1
1.2 Present Day	1
1.3 Case Study	2
1.4 Literature Review	4
1.5 Problem Formulation	6
1.6 Thesis Scope and Outline	6
2 Methodology	7
2.1 Expert Interviews	7
2.2 Stated Choice Experiments	10
2.2.1 Basic Terminology	10
2.2.2 Alternatives and Scenarios	10
2.2.3 Attributes and Attribute Levels	11
2.2.4 Choice Situations Generation	12
2.3 Survey	13
2.3.1 Survey Design	13
2.3.2 Survey Distribution	15
2.4 Data Analysis	16
2.4.1 Data Processing	16
2.4.2 Model Specification	16
2.4.3 Number of Respondents	17
3 Results	18
3.1 Data Sample	18
3.1.1 Sample Size	18
3.1.2 Socio-demographic Composition	18
3.2 Model Outcomes	26
3.2.1 Scenario 1: Model 1 Results	28
3.2.2 Scenario 1: Model 2 Results	29
3.2.3 Scenario 2: Model 1 Results	31
3.2.4 Scenario 2: Model 2 Results	31
4 Discussion	33
4.1 Reflection on Model Setup Design	33
4.2 Discussion of Model Outcomes	34
4.2.1 Scenario 1: Outcomes	34
4.2.2 Scenario 2: Outcomes	35
4.3 Reflection on Research Methodology Choice	36
4.4 Contribution to Scientific Literature	36
5 Conclusion and Recommendations	38
5.1 Answering the Formulated Research Questions	38
5.1.1 Answer to Subresearch Question 1	38
5.1.2 Answer to Subresearch Question 2	39
5.1.3 Answer to Subresearch Question 3	39

5.1.4 Answering the Main Research Question	39
5.2 Recommendations for Future Work	40
5.3 Closing Remarks	41
Bibliography	42
A Survey promotion poster	46
B Survey printout	48
C Ngene code	70
D Choice tasks	71
D.1 Choice tasks for scenario 1	71
D.2 Choice tasks for scenario 2	71
E Python code for the MNL models	72
E.1 Scenario 1: Small amount of cargo	72
E.1.1 Model 1.1: Base model	72
E.1.2 Model 1.2: Extended model	74
F Scientific Paper	78

List of Figures

1.1	The location of the KeilePand on the MerweVierHavens [22]	3
1.2	The KeilePand [22]	3
2.1	Factors affecting the choice of shared modes among SME employees	9
2.2	Stated choice experiments terminology [48]	10
2.3	Visual elements used in the survey	14
2.4	Re-imagining Google Street View images of the parking spots around the KeilePand with AI	14
3.1	Age distribution of respondents	19
3.2	Gender distribution of respondents	19
3.3	Education levels of respondents	20
3.4	Household composition	20
3.5	Presence of physical limitations among respondents	21
3.6	Yearly income levels of respondents	21
3.7	Employment type of respondents	22
3.8	Driver's license possession among respondents	22
3.9	Number of cars in household	23
3.10	Distance between respondents' homes and the workplace	23
3.11	Frequencies of commuting with own car	23
3.12	Business trip distance distribution	24
3.13	Business trip frequency distribution	24
3.14	The importance of a community at the workplace	25
3.15	Respondents' levels of environmental considerations when choosing a transport mode for commuting between their home and the workplace	25
3.16	Respondents' levels of considerations for their health when choosing a transport mode for commuting between their home and the workplace	25
3.17	Respondents' sensitivity to weather conditions when choosing a transport mode for commuting between their home and the workplace	25
3.18	Scenario 1, Model 1: Parameter estimates	28
3.19	Scenario 1, Model 2: Parameter estimates	29
3.20	Scenario 2, Model 1: Parameter estimates	31
3.21	Scenario 2, Model 2: Parameter estimates	32
D.1	Choice tasks for scenario 1	71
D.2	Choice tasks for scenario 2	71

List of Tables

1	Scenario Results: Small cargo vs. Big cargo	iii
1.1	Factors from the reviewed literature	5
3.1	Attribute levels and socio-demographic variable coding used in the choice models	27

Nomenclature

Abbreviations

Abbreviation	
ASC	Alternative Specific Constant
M4H	MerweVierHavens
MNL	Multinomial Logit
SCE	Stated Choice Experiment
SME	Small and Medium-sized Enterprise



Introduction

1.1. Background

Throughout the 20th century, the automobile has played a key role in the development of our society - a role that can be characterized not just by its technological dimension, but also by its economic, environmental, social, cultural and political ones. [1] Initially only available for those of high social status, [2] the attitudes towards the automobile changed as it became an object of mass production through the invention of the assembly line in the early 1910s. The now faster-produced and reasonably-priced automobiles became accessible also for the working class population and revolutionized their patterns of working, living and leisure. [2] [3] People were no longer bound by public transport's schedule or fixed routes, or by the inconveniences of slow speed and bad weather that were not accounted for in active modes of transportation. The automobile ensured that one could travel at greater distances at their own convenience and comfort, which is why it became synonymous with freedom and independence. [4] [5] [6] [7]

These seemingly endless possibilities that the automobile promised lead to a shift in urban planning to accommodate for a car-dependent society. As cars became more abundant in cities, the congestion and environmental issues became significant problems. [8] More space had to be opened for the new and bigger roads and parking facilities, and these changes were at the expense of other street-users. As green spaces and recreational facilities became more scarce by the mid-20th century, pedestrians were pushed to the margins of the street. [4] This shift, however, was not optimal for society and in the late 1960s and 1970s, concepts such as the "woonerf" (from Dutch: "living street") arose as a response to the situation. [9] This concept aimed at reclaiming the street as a safe and social space, vital for social interaction, communal engagement and cultural enrichment. The "living street" should also contribute to the mitigation of environmental issues by incorporating green infrastructure for an enhanced urban aesthetic, as well as improving air quality, and contributing to a healthier lifestyle. [10]

1.2. Present Day

The aim towards friendlier-to-people streets continues to be a popular topic in present day. This is especially the case for countries like the Netherlands, which face an increasing demand for space due to the economic growth, population expansion, and urgent sustainability transitions. [11] Especially in big cities, such as Rotterdam, travel patterns and habits can be greatly influenced by land use planning. Questions are raised towards the future vision of the city, when it comes to the living, working and recreational aspects. [12] In response, and with the aim of ensuring that Rotterdam's future will be resilient, the Municipality of Rotterdam has formulated an Environmental Vision for "the City of Change" (from Dutch: De Veranderstad). This vision describes goals related to the improvement of buildings, water, soil, air, transport infrastructure and nature within the city. Balancing these goals is a difficult task, however, as the Municipality has to choose how to make more space available while also re-

specting the living environment of the residents and nature. These space considerations, coupled with environmental concerns, is how the Mobility Approach for the city of Rotterdam has been formulated. [13]

The main goal of this approach is to make mobility in general emissions-free in terms of freight transport (in collaboration with carriers, forwarders, shippers, governments, knowledge institutes, and more), the Municipality's own fleet (garbage containers, maintenance vehicles, etc.) and personal mobility. [12] Further, the Mobility Approach aims at creating more space for pedestrians, cyclists and public transport, as well as reducing the amount of traffic in the city, by introducing car-limited zones, reducing the speed limit to 30 km/h in the city, encouraging walking and cycling for better health, and introducing shared mobility in the forms of bicycles, electric scooters and electric cars. The goal of these shared mobility modes is to replace the private cars, which is a necessary change, as, compared to 1945 where there was one car per thousand inhabitants, there were just over 500 cars per thousand inhabitants as of 2023. This is the equivalent of one car for every two people in the country. By introducing shared mobility, this number can be significantly decreased, as one shared car, for instance, replaces anywhere between 4 to 20 private cars. [14] Subsequently, by decreasing the number of private cars, more space can be opened for other modes, recreational activities, and more.

Adopting shared mobility solutions, however, requires a shift not only in the mobility patterns of their users, but also a behavioral one. This transition from "ownership" and towards "usership", as aforementioned, is guided through different municipal policies related to car-limited zones, speed reductions and more. These policies are usually clearly defined for residential areas and locations of big companies. When it comes to small-to-middle-sized enterprises (SMEs), no shared mobility policies have been defined as of yet. Thus, to better understand the intricacies behind applying these policies, the Municipality has ongoing projects, one of which is the KeileCollectief pilot (which will be discussed in more detail in the next section), which aims to better understand how the employees of SME firms regard shared mobility. The goal is that understanding SMEs like the KeileCollectief better would aid the Municipality into tailoring their policies better according to the needs of such areas, thus filling a practical knowledge gap.

1.3. Case Study

The KeileCollectief pilot, is a project between the Municipality of Rotterdam, BMW and other stakeholders. The pilot takes place at the MerweVierHavens (also known as "Makers District", or simply M4H) - one of many former industrial locations on Rotterdam's port, which are now undergoing redevelopment in terms renewable energy initiatives, sustainable urban agriculture, clean technologies, and improving the quality of life for the users of the area. This redevelopment is thus not only physical, but also a cultural one, in which new spaces are created and old ones are refurbished, all with the idea of balancing residential, commercial and recreational aspects. [15] By refurbishing industrial heritage buildings in the area and repurposing them into testing facilities or shared working spaces, [16] public decision-makers and private actors are stimulated to participate in a long-term -, multi-domain -, multi-actor- and multi-level thinking. [17]

The KeileCollectief pilot began as an initiative driven by innovative entrepreneurs who wanted to redevelop one industrial building, namely - the KeilePand, which can be seen in Figures 1.1 and 1.2. Their idea, however, grew beyond just a shared space for different small-to-medium sized companies and became a collective of like-minded people. Thus, the KeilePand, which was once a pre-war fruit and vegetable shed and a transshipment warehouse, [18] now houses the so called KeileCollectief, which consists of companies, ranging from architecture ones, woodworkers, interior designers, breweries, coffee roasters, cheesemakers and more. [19] What is interesting about these companies is that they combine making, doing and dreaming, which is achieved via workshops, pop-up exhibitions, live music, culinary events and more. All of this aims to stimulate the M4H area users to participate into the transition towards a better future in many different aspects, including mobility.

To achieve this, the KeileCollectief began exploring shared mobility options, which was later seen by the Municipality of Rotterdam and BMW as an opportunity to draw conclusions about certain shared mobility implementation aspects. [18] [20] [21] This is how the KeileCollectief pilot began, guided by the following objectives: "test and understand mobility behavior, particularly how it changes when shared mobility is offered and when other external factors impact the system". The KeileCollectief pilot involves "learning from the experiences of a closed community of employees using shared mobility and stimulating new community behaviors among residents and employees". [20] This change in behavior would ideally prevent traffic overload and reduce on-street parking in the area, ultimately opening space for the realization of other possibilities. And to achieve a shift in mobility patterns, it is necessary to first investigate the factors that affect such a community as the KeileCollectief that play a role in their transport mode choices for business-related trip. [21] [20] To gain more insight, a literature review is conducted, the outcomes of which are described in the following section.

Figure 1.1: The location of the KeilePand on the MerweVierHavens [22]



Figure 1.2: The KeilePand [22]



1.4. Literature Review

Small- and medium-sized enterprises (SMEs) can be defined in terms of gross asset value, turnover rate and number of employees, which is usually less than 250 employees. [23] [24] Another characteristic of SMEs is that they usually cultivate a more innovation-driven workplace culture, in comparison with larger companies, which is caused due to the fact that the employees in SMEs are predominantly entrepreneurs. [25]

This innovation orientation in SMEs can be understood through the lens of innovation theory. It explains how new practices or technologies spread within a social system, namely - they are more likely to be adopted when they are seen as advantageous, compatible with existing values, and easy to try out. [26] In this case, shared mobility can be viewed as a process innovation, which alters the way transport is organized within a workplace. Whether it is adopted in SMEs depends on internal factors such as organizational readiness, perceived utility, and cultural alignment. Such theoretical considerations highlight why some SMEs may be more receptive to shared mobility initiatives than others. And since SMEs account for over 90% of businesses worldwide, [23] [27] contributing significantly to economic, industrial and social development, it becomes crucial to stimulate innovation there in order to grow on the local, regional and national levels.

When discussing innovation, it can take many shapes and forms, but for the purpose of this study, the focus will be on the adoption shared mobility in SMEs. [28] When it comes to the specific enablers, barriers and opportunities for the successful implementation of shared mobility in SMEs, there are academic sources from all over the world, including Switzerland, [29] [30] Bangladesh, [31] the USA, [32] Germany, [33] Canada, [23] Pakistan [27] and others. [34] [35] [36] [28] These sources examine the factors that affect the choice of shared mobility from different angles: some focus on shared mobility as a whole, while others focus on a given mode. Despite this fact, the findings are similar and will be described in the next two paragraphs.

Firstly, according to the aforementioned reviewed literature, there are different socio-demographic factors that could play a role in mode choice in general. These factors are as follows: age, gender, income level, education level, employment status, vehicle ownership, number of cars in the household, household type, household size, marital status, family situation, health, physical limitations (disability). These factors affect mode choice in different ways, for instance - older individuals might be less open to using shared mobility due to technological difficulties or familiarity and habit of using their current mode. Gender can also shape mobility choices, particularly due to differences in perceived safety, time constraints, and trip purposes. For example, women, who are the usually primary caregiver according to traditional societal norms, may favor their own car for providing a much higher comfort level than other modes, when transporting children or elderly people to school or medical appointments.

Further, the income level of an individual directly affects their capacity to choose certain transportation options, for instance - higher income individuals may be more inclined to use private cars due to convenience and affordability, whereas lower-income individuals might be more price-sensitive and open to using shared modes. Education level, on the other hand, may influence individuals' awareness and attitude towards environmental sustainability, and can also influence their understanding of the health benefits that shared mobility can have. Other personal characteristics that can also have an effect are marital status and household type, where household responsibilities or the presence of having younger children can greatly influencing the practicality of shared modes. Finally, when choosing a transport mode for commuting between an individual's house and their workplace, the presence of a private car in their household could greatly affect their choice for shared modes, especially if they are a part-time worker, which is usually associated with the need for more flexibility and time-sensitivity.

All of these socio-demographic factors lead to further considerations, that are mode-based, context-related or psychological. For the mode-based factors, such can be the vehicle purchase price, fuel cost, maximum vehicle range (especially for shared mobility modes), fuel consumption, travel time, commut-

ing expense, availability (also about shared modes), parking availability, parking rate, and ease of use. For instance, the price of the vehicle, as well as the fuel, could influence cost-conscious individuals, particularly those with lower incomes, making shared mobility a more attractive alternative due to its pay-per-use structure. The maximum vehicle range - especially relevant for shared electric vehicles - can be a barrier for longer trips, limiting their appeal. Similarly, vehicle availability can also play a key role: if shared bikes or cars are not reliably available near the home or workplace, or have to be reserved a certain amount of time in advance, they might lose their competitive edge. Here, the reviewed literature sometimes links the booking process and the ease of use of shared vehicles.

Context-related factors include the temperature, precipitation, wind speed, or in other words - weather conditions. Unfavorable conditions can reduce the attractiveness of active or semi-active modes. Another context-related factor could be urban design: in cities with well-developed cycling infrastructure or integrated mobility hubs, shared modes become more viable. In contrast, fragmented bike lanes or unsafe intersections create barriers to their use. Lastly, according to the literature, the psychological factors could be driving pleasure, habit, innovation attitude, privacy, health benefits, perceived safety, environmental responsibility and others. For instance, driving pleasure may cause some individuals to prefer private cars, even when shared options are available. Habit can lead to mode inertia - where individuals continue using their default mode despite knowing better alternatives exist. An individual's attitude toward innovation can affect openness to trying newer services like shared e-scooters or app-based car sharing. Furthermore, concerns about privacy or lack thereof in shared modes may push some users toward private options. On the other hand, perceived health benefits may make certain shared mobility modes more appealing. Lastly, a strong sense of environmental responsibility can increase willingness to use shared or public transport over more polluting private vehicles. All of the aforementioned factors have been visualized in Table 1.1.

Table 1.1: Factors from the reviewed literature

Mode-specific factors	Socio-demographic factors	Contextual factors	Psychological factors
Vehicle purchase price	Age	Temperature	Driving pleasure
Fuel cost	Gender	Precipitation	Habit
Maximum range of the vehicle	Income level	Wind speed	Innovation attitude
Fuel consumption	Education level	Weather conditions	Privacy concerns
Travel time	Employment status	Urban design	Health benefits
Commuting expense	Vehicle ownership		Perceived safety
Vehicle availability	Number of cars in the household		Environmental responsibility
Parking availability	Household type		
Parking rate	Household size		
Ease of use	Marital status		
	Family situation		
	Health		
	Physical limitations		

Despite discussing all of the many aforementioned factors, the literature does not draw direct lines between mode choice and the workplace culture - a factor highlighted as an important driver by shared mobility initiatives, such as the KeileCollectief pilot. On the other hand, it does suggest that when individuals have a stronger sense of community, they are more likely to behave in ways, which presumably benefit the whole group. [37] [38] This assumption finds theoretical backing in studies that link collective identity to greater willingness to engage in prosocial or sustainable behavior, shifting towards shared mobility. [39] [40] More specifically, individuals derive part of their self-concept from the social groups they belong to, which in the case of the KeileCollectief translates to whether they feel a community belonging at their workplace or not. This community belonging can foster prosocial behavior and can act as a motivator for aligning individual choices with collective goals, as suggested by the Social Identity Theory. [41] In this case, such goals are opting for more sustainable and spatially efficient transport modes like shared mobility. Lastly, psychological studies have shown that individuals with stronger community values are more likely to exhibit environmentally responsible behavior due to an increased awareness of others' need, leading to heightened moral obligation and feeling of shared responsibility. [42] [43] The question, however, remains: since it is assumed that SMEs such as the KeileCollectief have a stronger community sense, would these community values also translate to innovative initiatives such as shared mobility? This question encapsulates the literature gap that this research will be aiming to address, tying it with the the practical knowledge gap of the efforts of the Municipality of Rotterdam to better understand how shared mobility is regarded in SMEs like the KeileCollectief.

1.5. Problem Formulation

In order to address the practical and the scientific research gaps, the following main and sub-research questions have been formulated:

How do the employees of small-to-medium-sized enterprises (SMEs) make transport mode choices for business-related trips?

- *Which factors are relevant when it comes to choosing between shared mobility options and private car usage at the KeileCollectief?*
- *How do these factors, in combination with the aspect of workplace community values, shape mode choice for the KeileCollectief employees?*
- *What lessons from the KeileCollectief pilot can inform the design of shared mobility policies targeting SMEs?*

1.6. Thesis Scope and Outline

As it can be derived from the aforementioned, the scope of this thesis are closed communities of SMEs in Rotterdam. Moreover, the criteria of this thesis have been fulfilled over the course of about 40 weeks, which is in line with the part-time nature of this project. The structure of the report is as follows: the background introduction and problem formulation in the current chapter are followed by a description of the methodology used, which can be seen in Chapter 2. Chapter 3 presents the results of the selected methodological approach, which is followed by a critical discussion of the outcomes and a reflection and evaluation the chosen methodology, which can be found in Chapter 4. Finally, Chapter 5 concludes the report by answering the main and sub-research questions and suggesting recommendations for future work.



2

Methodology

This chapter presents the step-by-step process that was followed to derive meaningful insights from this specific case study of the KeileCollectief. First, expert interviews were conducted to gain a deeper understanding of the daily mobility patterns and preferences of KeileCollectief employees. These insights provided valuable context, confirmed several findings from the literature review, and introduced additional factors that were previously overlooked. Based on the outcomes of these interviews, a stated choice experiment (SCE) was developed to examine how various operational, contextual and psychological factors influence employees' willingness to switch from their private car to shared mobility options for business-related trips. Following this, the chapter outlines how the choice alternatives and experimental scenarios were constructed, how relevant attributes and attribute levels were selected, and how the final choice tasks were generated using Ngene. Furthermore, the design, distribution and implementation of the survey are discussed, as said design formed the primary data collection instrument for the SCE. The final sections describe the process of transforming the collected data into a suitable format for discrete choice modeling using Biogeme, followed by a brief discussion on model specification and estimation of base models. The chapter concludes with an overview of the respondent sample and the necessary considerations made to ensure statistical validity.

2.1. Expert Interviews

To make these factors more relevant for SMEs in Rotterdam, the case of the KeileCollectief became an integral part of this project. As aforementioned, the KeileCollectief houses an abundance of firms, ranging from beer brewers and woodworkers, to architects and interior designers, which makes the differences in transportation needs apparent. To better understand the nuances of these needs, a number of firms within the KeilePand were invited for an interview. In preparation, it was essential to study the key principles of conducting expert interviews to ensure methodological rigor. Expert interviews, by their nature, are a more concentrated and efficient method of gathering data than, for instance, observations, which can take much more time and resources, rendering the project infeasible. Experts are thus seen as a point of "crystallization" for practical insider knowledge, which might be difficult to be gained via said observations or via research. In addition, expert interviews are usually semi-structured and contain open questions with the goal to obtain additional authoritative opinions and professional assessment of a given situation or research topic. Finally, due to the experienced nature of the expert, the data collected during the interviews is considered reliable and does not need additional screening. [44] Thus, the input of the expert interviews conducted at the KeileCollectief became one of the building blocks of a stated choice experiment, as well as its alternatives and attributes. [45]

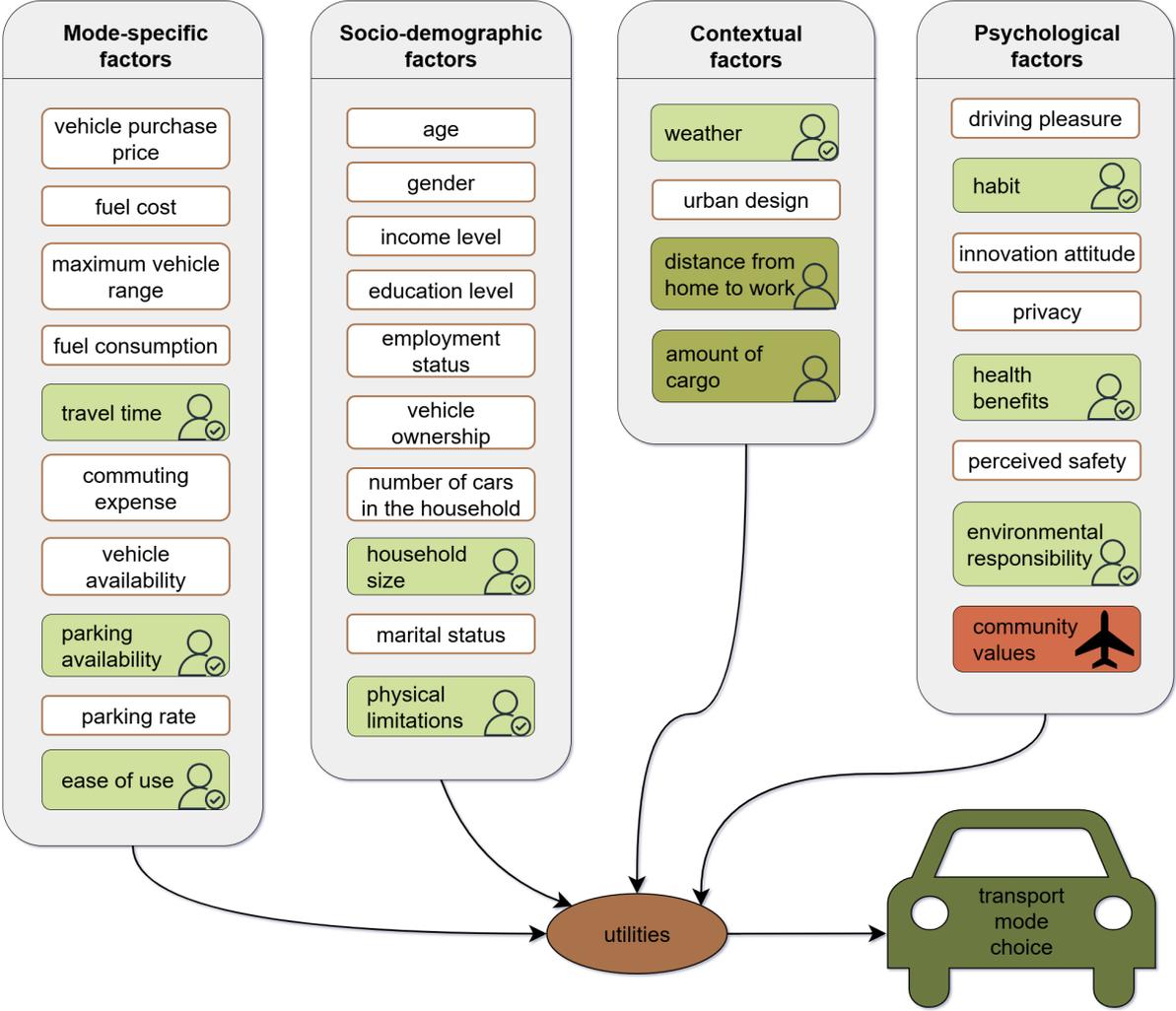
To gather this input, a few firm representatives, from Group A, Woodwave and Rechtstreeks agreed to be interviewed. The interviews were then scheduled and conducted in a semi-formal online setting for about 30-60 minutes between February 20th and March 4th 2025. The following list of questions was presented to the interviewees:

- How do you come to work every day?
- What factors do you consider before choosing your transport mode for reaching your workplace?
- What factors do you consider before choosing your transport mode for a business trip?
- What is the current mobility situation in the KeilePand region, how do employees come to work?
- What do you consider to be enablers and barriers for introducing shared mobility in the region?
- Is there anything you would like to add that was not discussed this far?

The outcome of the interviews were as follows: firstly, when it came to mode-specific factors, the interviewees identified **travel time** to be one of the most important factors affecting the KeileCollectief employees in their daily choice for a transport mode, as it greatly affects the perceived efficiency and practicality of a transport mode). Other such factors were the **parking availability**, as easy access to a close-by parking lot increases the perceived convenience of transport modes, and the **ease of use**, because the easier a mode is to be used (also including aspects such as booking, for instance) the more likely it is that that mode will be chosen. This was also suggested in the reviewed literature. Further, the most important socio-demographic characteristics, according to the interviewees, were the **household situation** of an individual (single/multiple adults, with(out) kids), as well as the potential presence of a **physical limitations**, as these two aspects would greatly affect one's mobility patterns and and before- and after-work activities.

Lastly, certain contextual and psychological factors arose as most important for a community such as the KeileCollectief. Such factors were the **weather conditions** (which in the literature were split into temperature, precipitation and wind speed), the **health benefits** and **environmental effects** that a transport mode could have, and the individual's **habits** (an interesting example here is that one of the interviewees mentioned he had a decade-long habit of smoking in his car, which made shared mobility less attractive for him, as smoking there is usually not allowed). There were also a few factors that were highlighted during the interviews, which were not mentioned explicitly in the reviewed literature were the **amount of cargo** to be brought during a business-related trip, and the **distance from home to work** of an employee, as the greater the distance, the more likely it became that an individual to choose their private car in the morning, and to subsequently use it during the day for business-related trips. To depict more clearly how the interviews and the literature overlap with or complement each other, the following visualization (Figure 2.1) was created, including a legend at the bottom to guide the reader. The figure also includes the most important factor that arose from the KeileCollectief pilot brief, namely - the community values, which are included in the category of psychological factors.

Figure 2.1: Factors affecting the choice of shared modes among SME employees



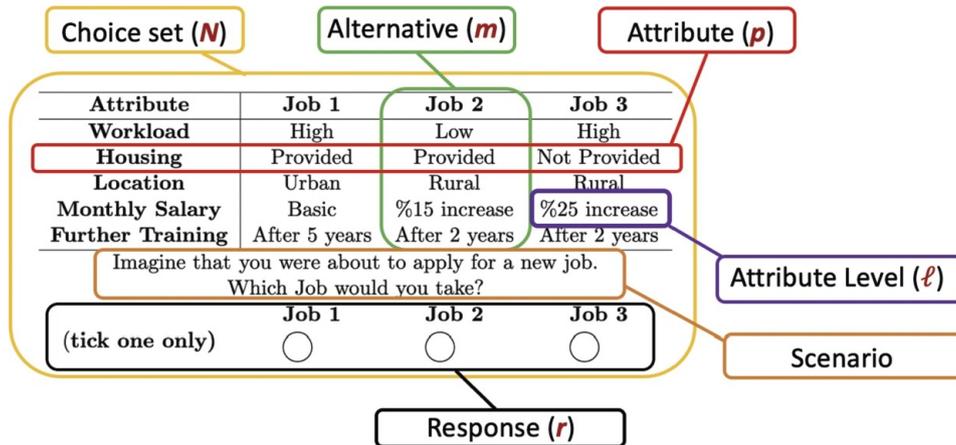
Legend	Effect	general information found through literature research	information confirmed in expert interviews and to be used in the model	information mentioned during the expert interviews, not in the literature	factors mentioned in the pilot brief, not strongly tied to the literature
	→	[white box]	[green box with person icon]	[green box with person icon]	[red box with airplane icon]

2.2. Stated Choice Experiments

2.2.1. Basic Terminology

By narrowing down the factors that could be affecting the employees of the KeileCollectief when making a choice for a transport mode choice, the expert interviews, together with the reviewed literature created a foundation for constructing stated choice experiments (SCE). The aim of such experiments is to explore the trade-offs between these factors, [46] but before diving into that, it is first important to understand how SCEs work. This type of experiments are suitable for situations, in which historical data is not available, which means that the target audience is presented with hypothetical choice scenarios involving two or more alternatives, each of which is described by several attributes. [47] These scenarios describe the context in which a choice must be made, as well as its adjacent elements. Such elements are the choice tasks (or choice situations), each of them containing a set of alternatives that respondents have to choose from. [45] Alternatives can be labeled or unlabeled, depending on whether they refer to inherently different options (such as different modes of transportation) or to generic options (such as different tier plans of a given service), respectively. In turn, each alternative is described by a number of characteristics, known as attributes, which have specific levels. Depending on the desired research objective, these levels can represent qualitative data (such as colors, comfort, education, etc.) or quantitative (temperature, cost, travel time, distance, etc.). [46] Varying the attribute levels until all possible combinations are achieved is how the number of choice tasks is determined. All of these different combinations are encapsulated in the so-called scenario, which describes a hypothetical situation, in which a choice must be made in a stated choice experiment.[45] Figure 2.2 visualizes the relationship between the aforementioned terms.

Figure 2.2: Stated choice experiments terminology [48]



2.2.2. Alternatives and Scenarios

For the purpose of this research, it was first important to understand what type of alternatives there are when it comes to shared mobility. In broad terms, there are many types, for instance - cars, (cargo) bikes, vans, scooters, and many more. The ones which were considered for the purpose of this research, which were also stated in the Municipality’s KeileCollectief Pilot Brief, were the shared van, shared car and shared cargo bike. Here it was important to note that the shared van and shared car were combined in a single alternative. This was done in order to decrease the number of choice tasks, the construction of which will be detailed in further sections. An attempt to decrease the choice tasks will be made continuously in order to achieve statistically significant results with a smaller amount of experiment participants - an expected aspect of conducting experiments at an SME. Thus, the two types of shared alternatives - bigger (car or van) and smaller (cargo bike) were compared to the usage of the KeileCollectief employees’ own car.

The **three alternatives**, which were inherently different in their nature and thus appeared as "labeled" in the SCE, were as follows:

- "own car" (also referred to as "private car" at some points of this report) - where the employee arrives with their own car to work and then uses it during their business trip;
- "shared electric car/van", where the employee arrives to work with public transport or active modes, and would now like to use the shared car/van during their business trip;
- "shared electric cargo bike", where the employee arrives at work by public transport or active modes and would now like to use a shared cargo bike during their business trip.

The distinction bigger versus smaller shared mode became important when considering the amount of cargo that an employee has to transport during a business-related trip. As aforementioned, the amount of cargo was a factor that arose as important for the KeileCollectief employees during the expert interviews. Due to the very different nature of the companies of the KeileCollectief (as described in Section 1.3), it was not difficult to imagine that the employees from the different companies would have different needs when it comes to business-related trips and subsequently - cargo transportation. Thus, this factor shaped the setting in which the experiment's participants would have to make a mode choice. And in order to quantify it, the following **two scenarios** were created, namely - "small amount of cargo" (such as a backpack or a laptop, or in other words - something that can easily be transported also via the shared cargo bike) and "big amount of cargo" (such as a piece of furniture, crates of food, or in other words - cargo not feasible for transportation via the cargo bike).

2.2.3. Attributes and Attribute Levels

After deciding on the alternatives and scenarios, the relevant attributes and their levels were constructed. The attributes were derived from the expert interviews that were conducted at the KeilePand, and were named as follows "parking distance", "estimated arrival time" and "booking in advance". The first attribute was chosen in line with the strategy of the Municipality of Rotterdam and the KeileCollectief to remove the parking spots for private cars that are right next to the KeilePand, and in their place install parking spots for shared vehicles. This would mean that employees would have to walk further to reach their private car, than if they would choose the shared mobility options. How sensitive the employees of the KeilePand would be to the distance between their workplace and the new parking spots for their private car, was explored via the introduction of the following attribute levels:

- "50 meters": This attribute level was chosen as the baseline, since parking within 50 meters of the workplace is widely considered convenient and desirable by car users. According to research, approximately 40% of people are willing to use a car when parking is available within this distance; [49]
- "400 meters": At 400 meters walking to a parking, the willingness of individuals to walk to a parking spot, or in other words - to use their own car, drops to only 5%; [49]
- "200 meters": This attribute level was selected as a middle ground between the other two levels.

The next attribute, "estimated arrival time" was adapted from the factor "travel time", derived from the expert interviews. This adaptation was necessary due to a challenge that was encountered during the construction of this experiment, namely - as different employees would be making business trips to different destinations, it would become impossible to quantify the different amounts of time it would take them to reach said destination. This meant that the attribute levels could not be based on a given distance or vehicle speed, and had to thus be considered not as the trip duration, but as the time difference between an employee's expected arrival time at a given location and their actual arrival time, regardless of the travel distance. The attribute levels were then assigned as "- 10 minutes", "0 minutes" and "+ 10 minutes", meaning that a person arrives 10 minutes earlier than they expected, or exactly when they expected, or 10 minutes later than they expected, respectively.

The reason behind these differences between expectation and reality, as explained in the survey, could be attributed to factors such as traffic or more/less direct routes, the use of high-occupancy vehicle lanes, and others. The reason for choosing the 10-minute threshold was because, according to pedestrian behavior research, it usually takes about 5 to 10 minutes to walk 400 meters, which is the maximum parking distance used in this experiment. This means that in a situation where an individual has to choose between taking their own car, which is parked 400 meters away and is expected to arrive "on time", and a shared car parked in front of the building which is also expected to arrive "on time", the shared car will still be faster, as the walking time to the parking spots for private cars is avoided.

The third and final attribute was based on the factor "ease of use", derived from the expert interviews. Again, in order to quantify it, this factor was adapted into "booking in advance". Another name for this attribute was considered initially, namely - "booking difficulty", however it was later discarded in order to avoid using biased language. Thus, the attribute "booking in advance" was defined as the duration between the booking of a shared vehicle and its actual availability. This attribute was used to better understand the trade-offs between perceived reliability, in terms of vehicle availability when one is needed, and perceived difficulty of booking, in terms of viewing planning ahead as an extra step, thus making shared vehicles presumably more difficult to use. The following attribute levels were selected:

- "0 minutes": In this case, there is an abundance of shared vehicles in front of the KeilePand, thus a reservation in advance is not necessary;
- "30 minutes": Shared vehicles are not always available, thus a booking must be made 30 minutes in advance to ensure vehicle availability;
- "60 minutes": Shared vehicles are not always available, thus a booking must be made 60 minutes in advance to ensure vehicle availability.

And for the creating of the choice situations, which will be described in the following section, the attributes "parking distance" and "estimated arrival time" will be used to create trade-offs for private car in the experiment, while "Booking in advance" and "estimated arrival time" will be used for the shared vehicle alternatives. Once more, it is important to note that many other factors, derived through the literature could have been included in the experiment, at the expense of increasing the number of choice tasks and necessitating more experiment participants. As aforementioned, a conscious effort was made against that, meaning that only the factors mentioned in the reviewed literature and later confirmed in the expert interviews, as well as the unique factors that arose during the expert interviews were considered.

2.2.4. Choice Situations Generation

After selecting the attributes and their levels, it is time to construct the choice tasks. This is done via Ngene - a software tool, which enables the construction of experimental designs that systematically vary alternatives and attribute levels to investigate individual decision-making behavior. [45] Before that can happen, however, a decision must be made regarding the type of estimation the model would be doing, namely - whether main or interaction effects would be estimated. Main effects can be defined as the single attribute on the choice outcome, independent of other attributes. This is reflected in the Ngene code in terms of the utility functions, which in this case includes each attribute separately. In contrast, interaction effects present the combined effect of two or more attributes and occur when the effects of one attribute depends on the level of another. In this case, the utility functions contain products of two variables. Here it is integral to consider the fact that due to their nature, main effects would eventually produce fewer choice tasks, allowing for simpler designs, which can be beneficial in situations with smaller sample sizes. [46] In this research, a decision was made to estimate the main effects, due to the small sample size available. Another reason is that interaction effects are not really relevant when it comes to transportation, thus including them might only add marginal improvements in model fit, while increasing the risk of multicollinearity or overfitting. [50] Lastly, when it comes to creating interpretations for policy and design recommendations, main effects are easier to interpret due to the far-too-complex outputs of adding interaction effects to the model. [51]

Another aspect that can drastically increase the number of choice tasks is the nature of the utility function, or in other words - the overall attractiveness or value of a given option, based on its attributes. The linear utility function can be used for testing more straightforward trade-offs, while the non-linear one can capture increasing/decreasing sensitivity and saturation of complex interactions. The latter also results in an increased number of choice tasks. With this information in mind, a decision was made to test the straightforward trade-offs between the alternatives, and thus the utility functions were made linear. Next, it was time to choose an experimental design, which would determine the number of choice tasks. Such designs are the full factorial design (which contains all possible combinations) or a fractional factorial design (which is a subset of the full factorial design. [46] As aforementioned, interaction effects usually do not exist in the context of transportation and are thus assumed to be zero, not all combinations of attributes are necessary. Therefore, a design is usually deemed efficient even if it exhibits a fraction of all of these alternatives. This also made the orthogonal design, which is a type of fractional factorial design that ensures zero correlation between attributes, most logical to use in this context. [46] [47] And in order to create an orthogonal design, the choice tasks were constructed simultaneously due to the labeled nature of the alternatives. Besides simultaneous choice set construction (which generates a full profile for all alternatives at the same time), there is also another type - sequential choice sets creation (where one alternative is constructed first, after which the others are derived from it). For the purpose of this research, the first type was used due to the fact that the experiment contains labeled alternatives. [46] [47]

All of these aspects were reflected in the Ngene code (which can be seen in Appendix C), and subsequently, in the generated choice tasks, which can be seen in Appendix D. These choice tasks were 21 in total - 12 for the first scenario (small amount of cargo) and 9 for the second (big amount of cargo). And after the process of choice tasks generation was completed, it was time to create the survey, namely - the instrument that was used to capture the experiment subjects' preferences in the different situations.

2.3. Survey

2.3.1. Survey Design

Before creating the survey, certain considerations were made to ensure the clarity of the instructions given, as well as the security of information collected. Decisions were necessary in many aspects of the surveying process, including the very initial one - the selection of an adequate platform for the survey creation. For the purpose of this project, Microsoft Forms was selected due to its compliance with GDPR regulations, [52] as well as its seamless integration within the TU Delft digital environment, ensuring an increased level of data protection. Careful considerations were also made about the aspect of information presentation, which can be split in two sub-aspects, the first one being the language used in the survey. As surveys usually contain a large amount of text explaining the setup and purpose of the experiment, the language used has to be clear, concise and unbiased. Further, complicated sentences and technical jargon must be avoided as much as possible. This is a crucial consideration, that would enable people from different educational backgrounds to easily navigate through the survey. This approach was particularly important because the expert interviews revealed that the KeileCollectief employees had highly diverse professional and personal profiles, meaning that overly technical wording could discourage participation or lead to misinterpretation of the scenarios. An example of how these aspects were considered in the context of this research is the naming of one of the attributes "ease of booking" instead of "booking difficulty", which was mentioned in Section 2.2.3.

The second aspect of information presentation is unsurprisingly the visual one. Here, it was important to consider the underlying logic used when presenting information, not only in terms of consistent text fonts and sizes, and visual heuristics ("middle means typical", "top means first", "near means related"), but also in terms of the symbols used (symbol of a car instead of writing "car") and their color schemes. [53] The symbols used in this survey were sampled from a copyright-free platform [54] and were selected in order to represent the different alternatives and attributes, as can be seen in Figure 2.3. Moreover, certain images were generated with the help of AI, in order to create a better visualization for present versus future scenarios. More specifically - the AI software was presented with a photo of the

area around the KeilePand as seen in 2025, and was asked to re-imagine it in a potential future scenario where the area is repurposed, as can be seen in Figure 2.4. The inclusion of these visuals was based on expert interview feedback that visual clarity and recognizable context (such as actual KeilePand surroundings) would help respondents better relate to the hypothetical scenarios, thus improving the quality of their responses. These considerations and choices made from a design perspective were aimed at enhancing the respondents' experience, ensuring their motivation to participate in the survey and subsequently producing more reliable data.

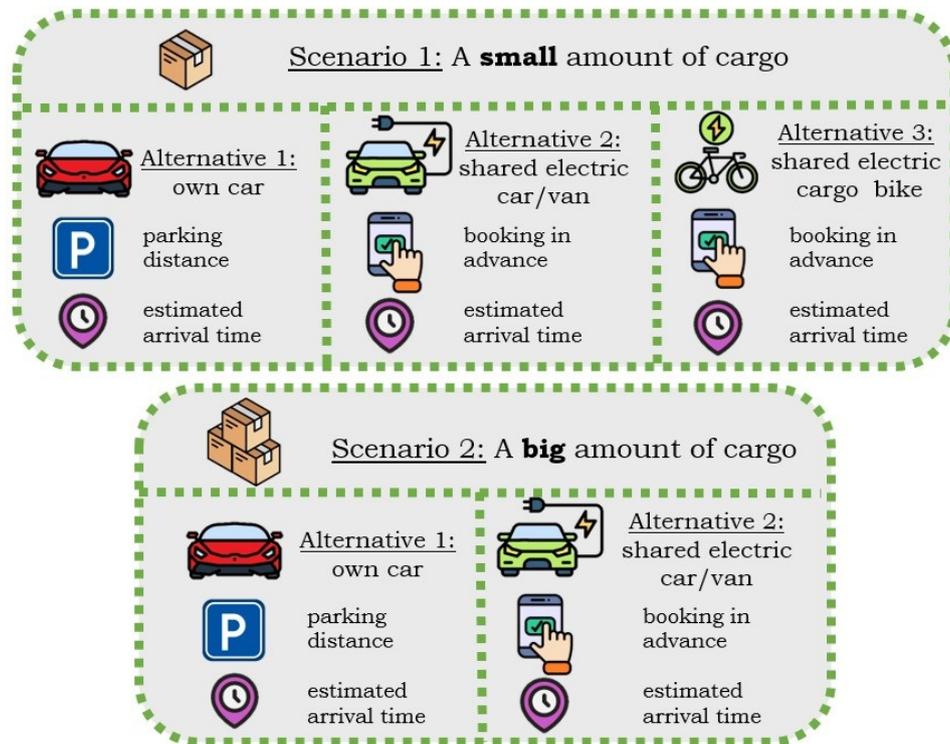


Figure 2.3: Visual elements used in the survey



Figure 2.4: Re-imagining Google Street View images of the parking spots around the KeilePand with AI

When it came to the specific content of the survey, it contained a few parts, each presenting a new set of information, instructions or questions to the respondents. The first part of the survey presented respondents with some background information about the researcher and the purpose of the project, after which an incentive for participation in the experiment was introduced. This incentive would be awarded by the KeileCollectief to four lucky randomly chosen respondents, and would be in the form of a ticket to the popular event "Cinema Culinair". [55] The first part ended with a statement about respondents' consent to voluntarily participate in the survey. The second part gave a detailed explanation about the two scenarios (small and big amount of cargo), and the three alternatives (private car, shared car/van and shared cargo bike) and their characteristics (parking distance, estimated arrival time and booking in advance). These elements were selected directly from the factors identified in the expert interviews as most influential for the KeileCollectief employees' mode choice, ensuring that the scenarios reflected realistic decision-making situations for this specific SME community.

Following these explanations, the participants entered the third part, where they had to experience the 21 choice situations and state their choice about whether to continue using their own car for business-related trips, or to instead switch to one of the shared mobility options. The choice situations were constructed to reflect trade-offs between the factors prioritized in the interviews, allowing the survey to capture respondents' sensitivity to each factor in a controlled way. The fourth part of the survey aimed at collecting socio-demographic data from respondents, such as their age, gender, yearly income, household size and more, which were included because the literature review and expert interviews both indicated that these variables could influence mode choice. The fifth and final part collected information on participants' current travel behavior mode-considerations. The questions presented in that part addressed their primary mode of transport, frequency of business-related trips, personal health- and environmental considerations and others. These final questions were designed to provide context for interpreting the choice experiment results, again reflecting the themes highlighted in the expert interviews. The survey concluded with a gratitude statement, which, along with the rest of the survey, as it was presented to the KeileCollectief, can be seen in Appendix A.

2.3.2. Survey Distribution

The survey design stage was followed by the distribution stage. Before deployment in the targeted setting, it is usually wise to first launch the survey in a pilot version, or in other words - testing setting. This step allows for gathering feedback from both academic peers and personal contacts, thus identifying potential areas of improvement. [53] Thus, a demo-version of the survey was sent out unofficially to people from both academic- and non-academic fields. Their experiences were documented and their feedback, when relevant, was incorporated in order to make the questions of the survey clearer and easier to understand. When these improvements have been implemented, the survey was ready for full deployment. To achieve this, there are different methods that can be considered, according to literature, namely - by telephone, by (e-)mail and/or face-to-face. The latter is usually the most preferred one for this type of research, as it has proven to achieve higher engagement level and response rates than the other methods. After initial contact with the target group is made, the e-mail distribution method can be employed. And although it is deemed as less effective than face-to-face distribution, it can still aid it via providing respondents with more flexibility in terms of participation. [56]

When it came to the distribution of the survey at the KeileCollectief, the main distribution tactic was face-to-face. This part of the research was conducted live in the KeilePand in the middle of May 2025, where respondents were approached during different points of their workday. After a brief introduction of the researcher and the project, they were handed a poster with a summary of the survey goals and a QR-code, which they would be able to scan and be lead to the survey online. The poster was designed to appeal to the creative spirit of the KeileCollectief employees, and thus strayed away from the classical academic design. Bright colors and images were used to capture the attention of potential respondents, regardless of whether the posters were handed to them personally, were put on their coworker's desk or were laying on tables and leisure spots around the KeilePand. The poster, as received by the KeileCollectief employees, can be found in Appendix B.

This face-to-face distribution, however, proved to be challenging as it made it difficult to reach all employees in person. This was due to distribution limitations, timing constraints and irregular office attendance due to remote work arrangements. An important note must be made here: while it was initially presumed that the 400 employees of the KeilePand would be reached, as time went by this became questionable. This was due to the fact that not much support was provided by the KeileCollectief during many of the phases of this project, including the survey distribution one, which differed from the original plan. Thus, the survey distribution relied primarily on the initial face-to-face contact. It was later aided ever so slightly by an office newsletter, which spread the poster to the KeileCollectief employees by e-mail. This, in theory, would have been a helpful measure, as it made it possible for employees to participate in the survey in a more suitable for them time, but also on a larger device. In practice, the newsletter generated about 20% of the survey responses.

2.4. Data Analysis

To perform an analysis of the discrete choices, collected during via surveying at the KeilePand, the Multinomial Logit (MNL) Model was utilized. The idea behind this model is to provide a deeper understanding of mode choice of the experiment's participants. The MNL determines which factors are influential when selecting one of the given alternatives, [57] assuming that there is an observable utility, associated with each alternative, as well as a random identically and independently distributed random error. [58] In order to perform this analysis, however, certain actions had to be taken beforehand, and their detailed description can be found in the following subsections.

2.4.1. Data Processing

In order to analyze the data, Biogeme - a 2003-developed software for estimation of discrete choice models, currently available as a Python package, [59] was utilized. To be loaded with Biogeme however, the respondent-specific choice data had to be converted to a long-format file, where each row corresponds to one choice situation, experienced by a given respondent. The columns, on the other hand, represented the specific characteristics per choice situation per respondent, thus containing the respondent ID, the choice situation ID, the chosen alternative (1 being private car, 2 - shared car, 3 - shared bike), the attribute levels for each alternative, as well as the socio-demographic covariates coded as binary dummy variables. This long-format structure made it possible to estimate the utility functions that capture how the different attributes and individual-level characteristics influenced mode choice.

2.4.2. Model Specification

Due to the fact that there were two distinct scenarios, namely - small and big amount of cargo, it was necessary to create two separate base models, consisting of the main attribute-level effects (parking distance, estimated arrival time, booking in advance) only. Equations 2.1, 2.2 and 2.3 illustrate how the utility functions were constructed. Here it is important to mention that the all the last utility function, namely - for the shared cargo bike was used only in the first scenario, as the second one does not contain that alternative. After creating the utility functions, the two base models follow to be estimated via MNL. In such experiments, a Rho-square value of 0.2 to 0.4 is considered indicative of an excellent model fit, meaning that the model succeeds at explaining the choices that respondents made. [60]

$$V_1 = ASC_{pc} + \beta_{pd}^{pc} \cdot private_car_parking_distance + \beta_{at}^{pc} \cdot private_car_arrival_time \quad (2.1)$$

$$V_2 = ASC_{sc} + \beta_{ab}^{sc} \cdot shared_car_advanced_booking + \beta_{at}^{sc} \cdot shared_car_arrival_time \quad (2.2)$$

$$V_3 = ASC_{sb} + \beta_{ab}^{sb} \cdot shared_bike_advanced_booking + \beta_{at}^{sb} \cdot shared_bike_arrival_time \quad (2.3)$$

2.4.3. Number of Respondents

Lastly, before moving onto the results of the models, it is important to address a topic mentioned multiple times during this chapter, namely - the number of respondents. In other words - to ensure that the results of the models would be statistically significant, it was important that enough responses would be collected. Thus, assuming a minimum number of responses was necessary. This number was calculated via Equation 2.4, where t is the number of choice tasks in the experiment, a is the number of alternatives, c is the maximum number of attribute levels in any attribute, and n is the minimum number of respondents. [61]

$$\frac{n \cdot t \cdot a}{c} \geq 500 \quad (2.4)$$



3

Results

3.1. Data Sample

3.1.1. Sample Size

Following Equation 2.4 from Chapter 2, where t (the number of choice tasks in the experiment) equals 21 (12 from the first scenario and 9 from the second), a (the number of alternatives) equals 3, and c (the maximum number of attribute levels in any attribute) equals 3, it is possible to calculate the minimum number of respondents n . This can be seen in Equation 3.1, which shows that the minimum number of respondents to the survey must be at least 24. This condition was satisfied, as the survey got 57 respondents. Later, two of them were excluded due to suspicion of untruthful participation - only the first option of each question was selected. After this exclusion, 55 respondents were left.

$$n \geq \frac{500 \cdot c}{t \cdot a} = \frac{500 \cdot 3}{21 \cdot 3} = 23,8 \quad (3.1)$$

3.1.2. Socio-demographic Composition

According to the survey results, the sample population is composed of about the same percentage of women and men and a very small amount of people who identified as "other". More specifically, about 47% of survey respondents were women and about 52% were men, which matches perfectly the gender distribution of the Dutch workforce. [62] The biggest respondent age group was the 25 to 34 year olds with about a third of the population, followed by the 25 to 44 and 45 to 54 year olds. This is similar to the typical age composition within SMEs and workplaces in general, where the biggest age group is usually the 45 to 54 year olds, followed by the 25 to 34 and 35 to 44 age brackets. [63] The predominance of younger people, however, may cause very slight biases in the results. However, the most important thing here is that the statistically smallest groups of people younger than 24 years old or older than 55 years old were not overrepresented in the survey sample, avoiding having bigger biases.

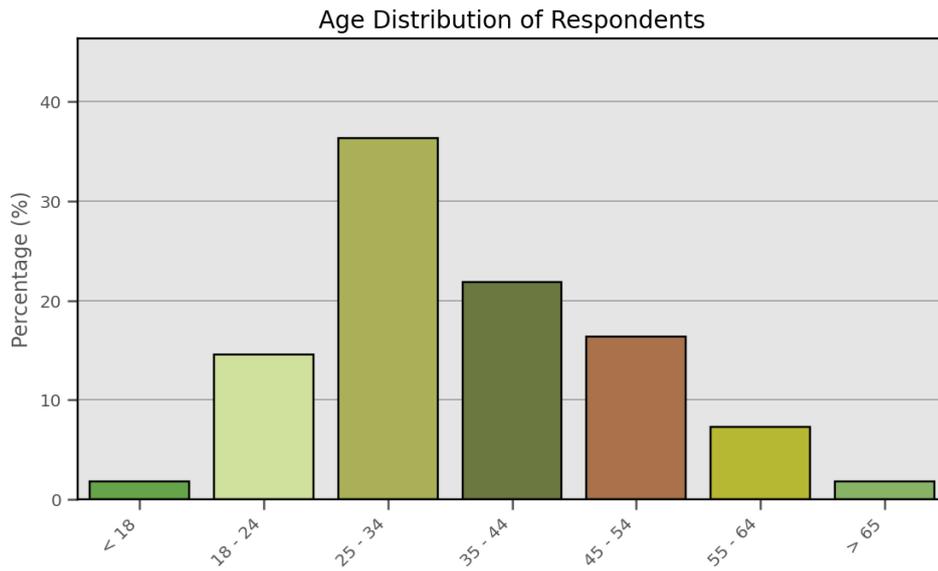


Figure 3.1: Age distribution of respondents

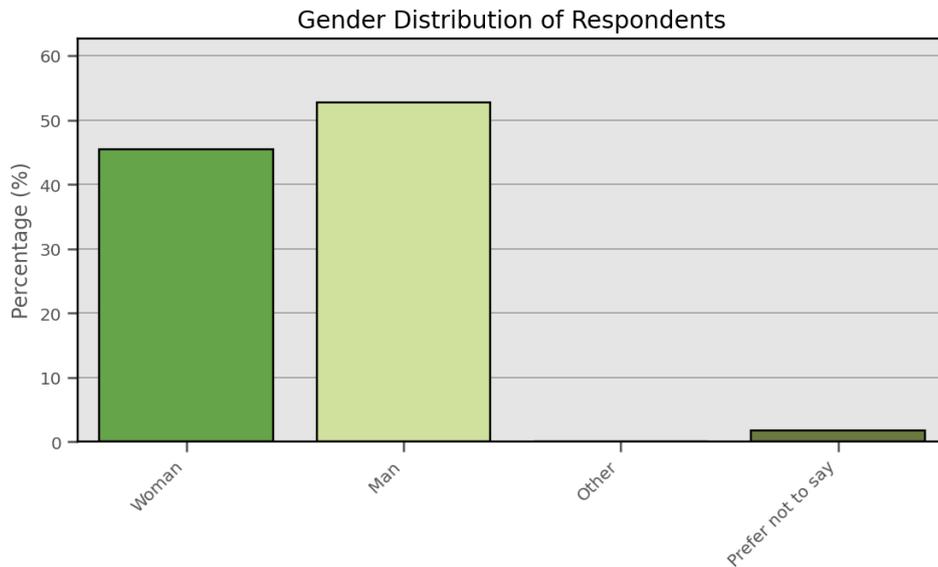


Figure 3.2: Gender distribution of respondents

Education-wise, the biggest group was that of the employees with a higher education, representing over 75% of the population, with about 15% of respondents indicating a completed intermediate vocational education, leaving those with a lower education than that at less than 10%. These percentages differ significantly from the statistical data about the Dutch workforce, which reports 37%, 37% and 27% for each of the three educational categories mentioned, respectively. [64] This means that the sample of respondents is more highly educated than what is expected on average, which might skew the results by over- or underrepresenting certain socio-demographic groups.

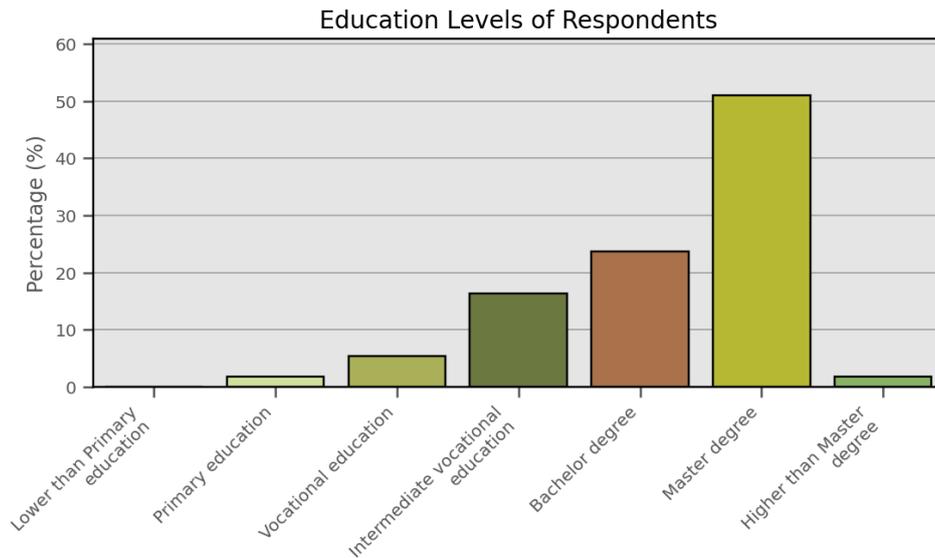


Figure 3.3: Education levels of respondents

The majority of the employees, or more specifically - about 80% also indicated that they live in households with no children under 13 years old. An important note here is that not having children under 13 does not necessarily mean that a household does not have any children, on the contrary - they might just be older. This distinction of under versus over 13 years of age was initially made with the assumption that children under 13 might require more care from the parent(s), in the form of transport to and from school and other such activities. [65] Such caregiving responsibilities can influence transport choices, as parents may need to factor in additional stops or time flexibility, making the use of a personal vehicle more appealing. For example, individuals who drive their own car to drop off children at school in the morning might continue using that same car for business-related trips during the day, rather than switching to a shared mobility option. [33] It was difficult, however, to draw conclusions about how the household composition of the KeileCollectief employees compares to the average Dutch household. This was because in the national statistics households are characterized based on whether there are children at all, without making a difference about their age, or whether a household was composed by a single or multiple people. [66]

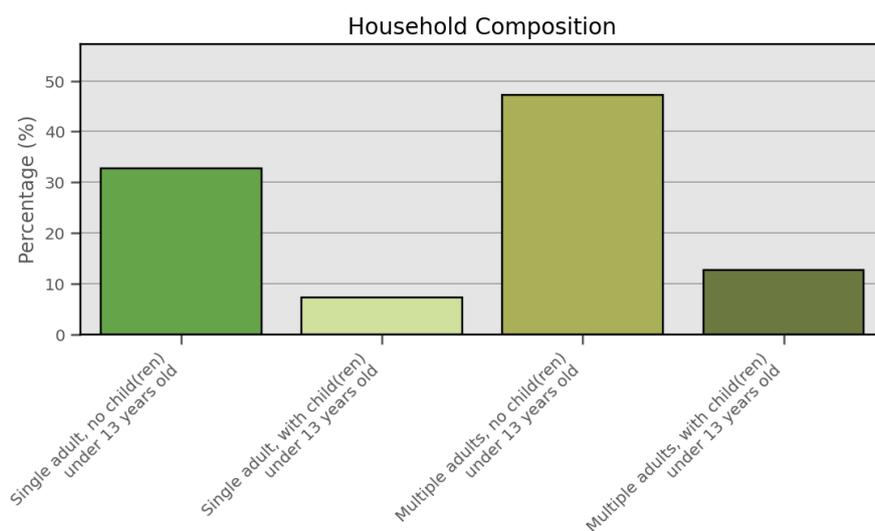


Figure 3.4: Household composition

Another aspect that was difficult to compare was the physical limitations aspect, where 10% of employees indicated the presence of such disability. The survey question, however, was not specific enough as to how a physical limitation was defined, namely - whether the respondent has a condition which could somehow affect their mobility patterns. It was possible, on the other hand, to compare the KeileCollectief income levels with the statistically average ones for the Netherlands. According to the survey results, the biggest income bracket among the KeileCollectief employees was the €20K to €40K one with around 38%, followed by all other brackets with about 15%, except those employees earning over €80K annually, who represented about 5% of all employees. This, more or less, matches the data from national statistics. [67] What did not match, however, was the distribution between part-time and full-time workers, which was about 25% to 70%, respectively. This differed from the national statistics, which reported almost equal levels of part-time and full-time employees. This difference should be taken into account when drawing conclusions later.

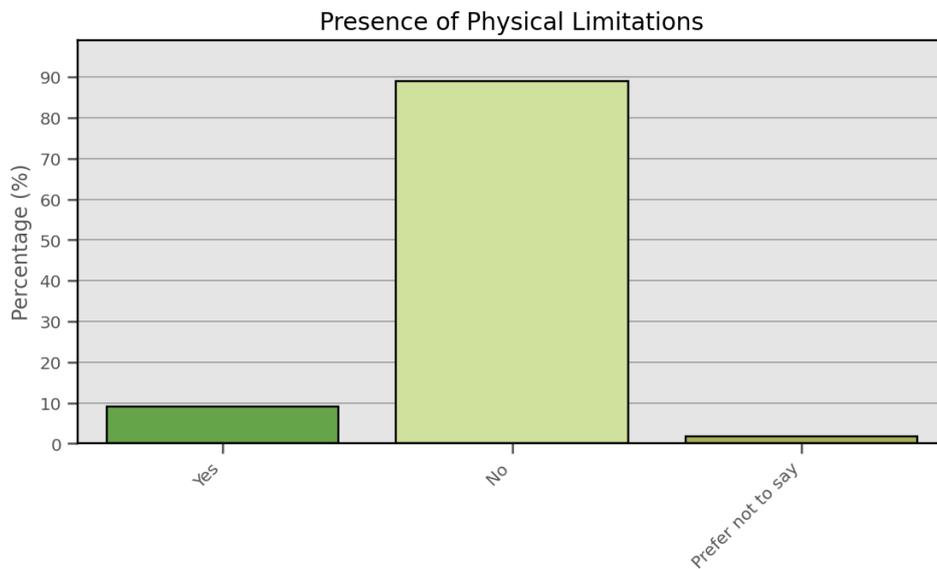


Figure 3.5: Presence of physical limitations among respondents

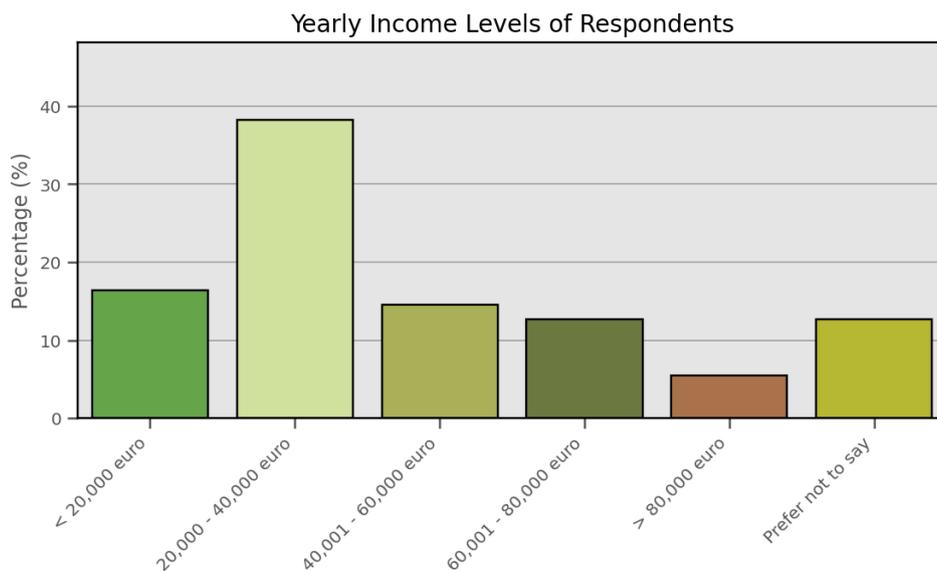


Figure 3.6: Yearly income levels of respondents

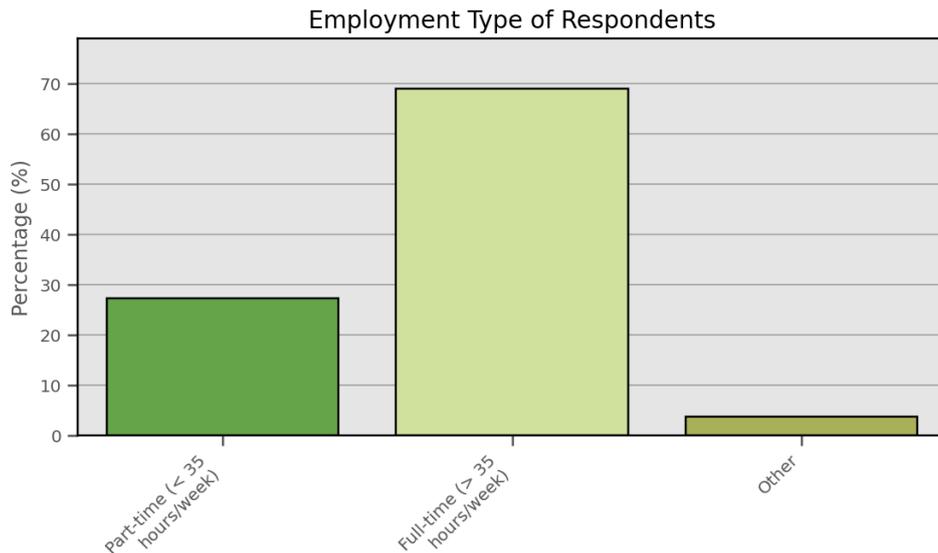


Figure 3.7: Employment type of respondents

When it came to mobility patterns, around 80% of the KeileCollectief employees reported having a driver's license, which matches the percentage reported by the National Bureau of Statistics in the Netherlands. [68] Surprisingly, despite almost half of the population living within 5 kilometers of their work place, about 50% of employees indicated they drive to work either on a daily basis, or less regularly. This matches the data reported by national statistics. [69] This overwhelming percentage was also in line with the fact that a bit over half of the employees indicated they have at least one private car in their household. In contrast, the average amount of cars per capita in the Netherlands is about 1 car per every 2 people, [70] meaning that the survey sample has more car-free households. As for making business trips during work-hours, the biggest group was those who traveled over 20 kilometers, representing a third of the entire sample population. However, business trips in general were a rare event for about half of the population, with a fifth of it never having to make such trips.

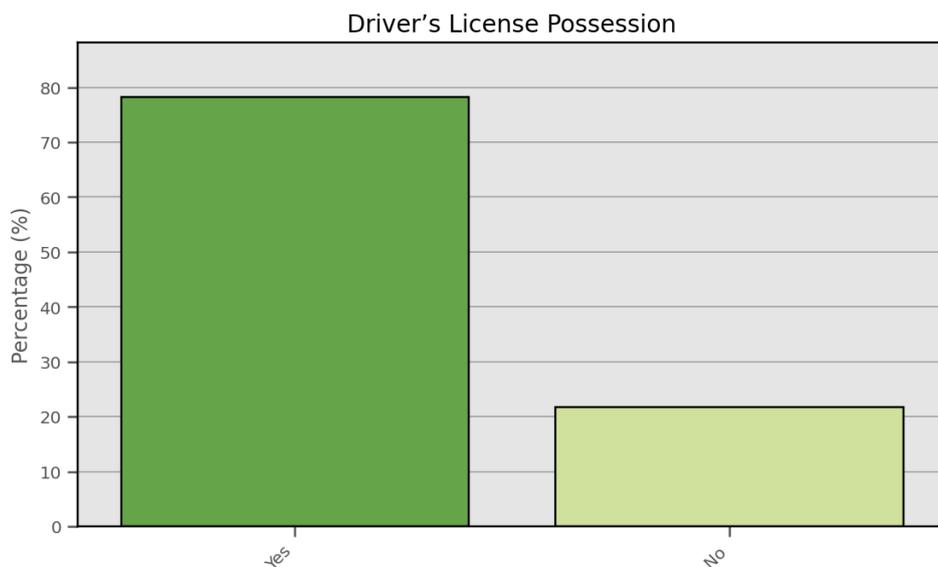


Figure 3.8: Driver's license possession among respondents

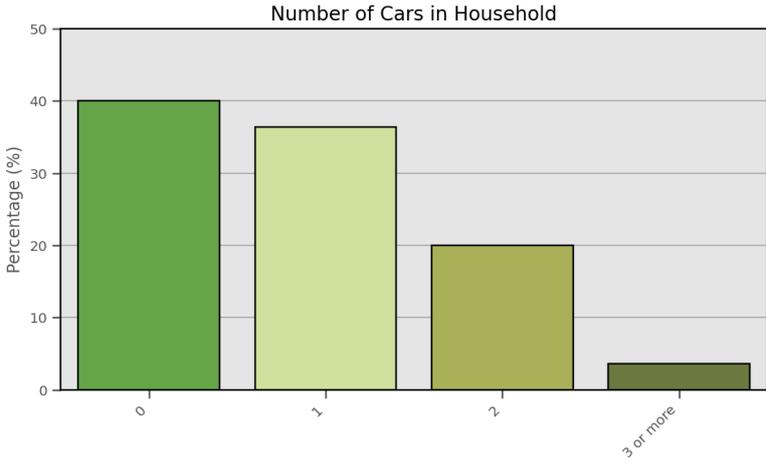


Figure 3.9: Number of cars in household

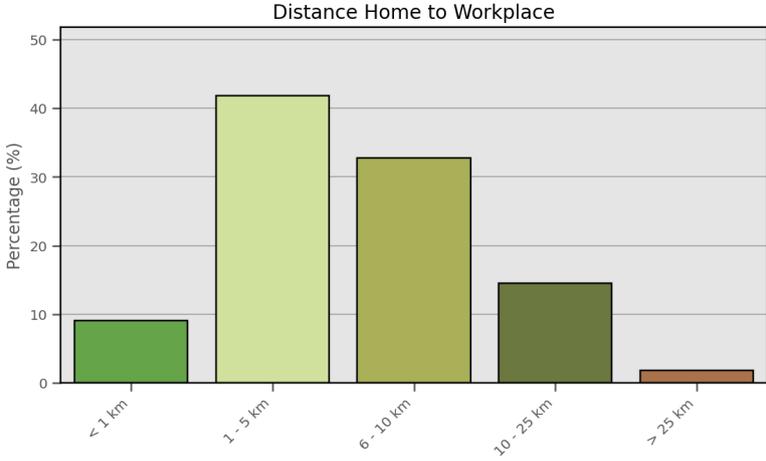


Figure 3.10: Distance between respondents' homes and the workplace

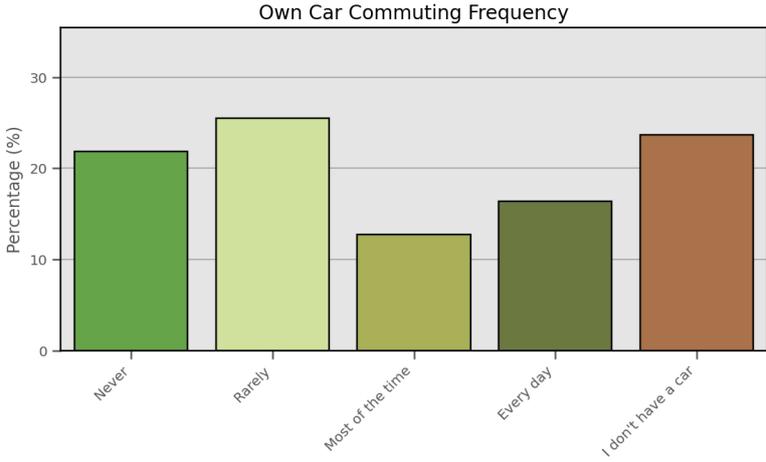


Figure 3.11: Frequencies of commuting with own car

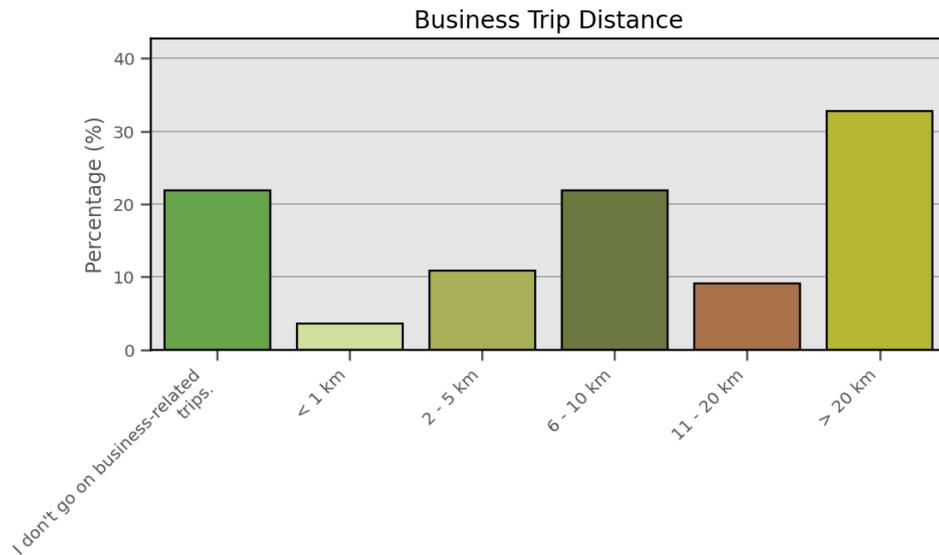


Figure 3.12: Business trip distance distribution

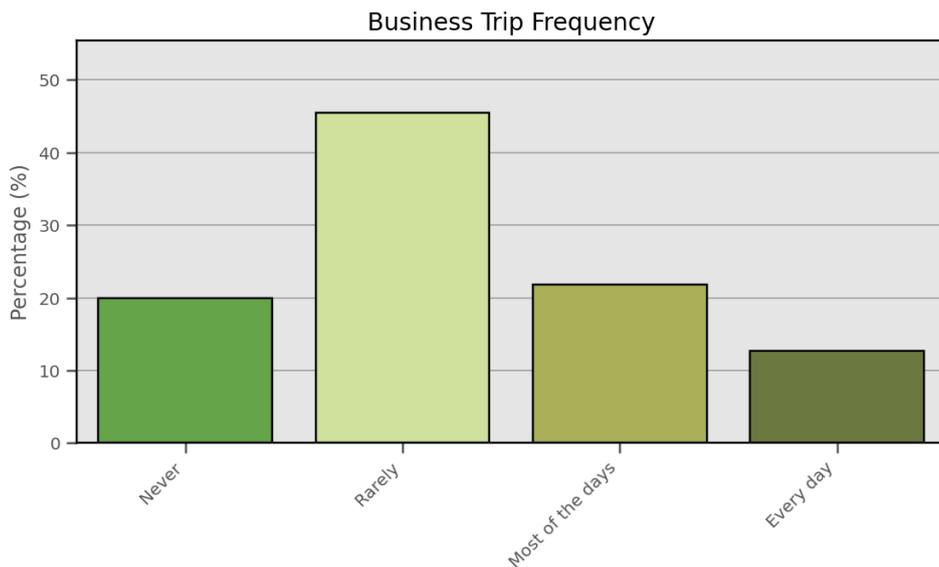


Figure 3.13: Business trip frequency distribution

Further, the psychological questions were answered as follows: about half of the sample population indicated (either moderately or to a high degree) that they consider the effects their transport mode would have on the environment. About 40% of the population showed that they consider their health when making a mode choice. Interestingly, almost the same amount of people indicated that they do not have such considerations, leaving about a fifth of the population neutral. Over 70% of the population showed that weather considerations indeed affect their choice of a transport mode on their way to work. Lastly, about 65% of the employees indicated that a community feeling is an important aspect of their work life. More details can be seen in Figures 3.1 to 3.17.

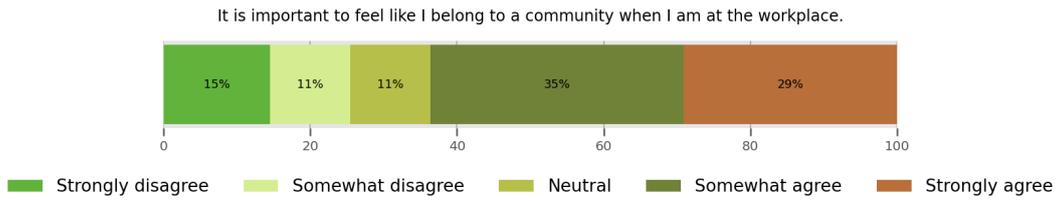


Figure 3.14: The importance of a community at the workplace

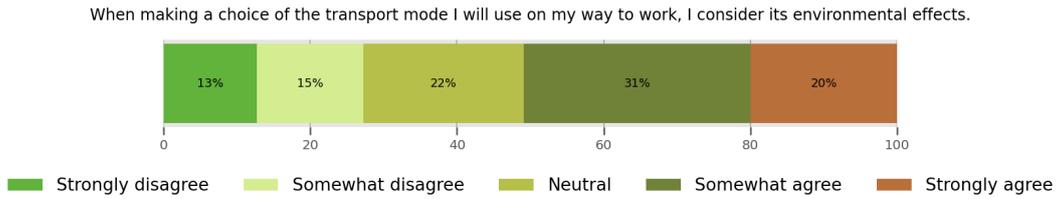


Figure 3.15: Respondents' levels of environmental considerations when choosing a transport mode for commuting between their home and the workplace

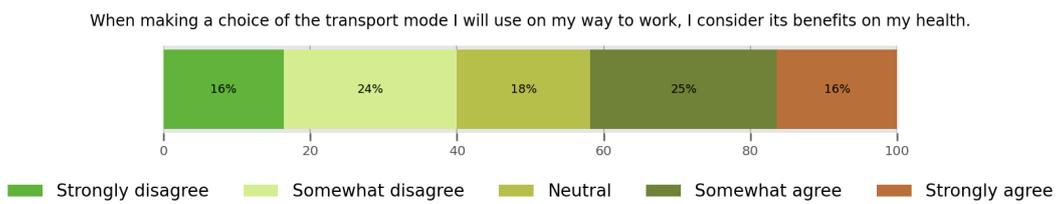


Figure 3.16: Respondents' levels of considerations for their health when choosing a transport mode for commuting between their home and the workplace

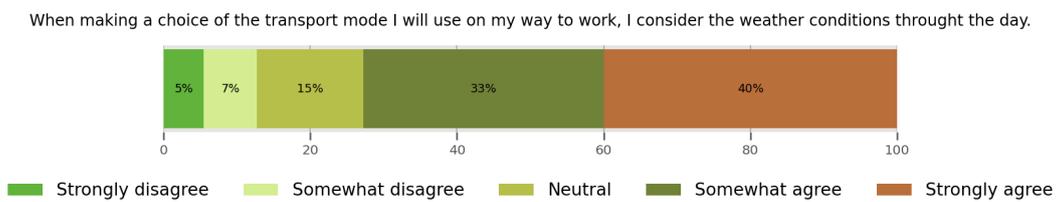


Figure 3.17: Respondents' sensitivity to weather conditions when choosing a transport mode for commuting between their home and the workplace

3.2. Model Outcomes

In this section, the outcomes of the MNL models will be discussed. As aforementioned, the desired Rho-square value must of al least about 0.2 to 0.4 for the model to successfully explain the choices that respondents made. In the case of this research, however, lower values of about 0.1 to 0.2 were achieved, which will be further discussed in Subsections 3.2.1 and 3.2.3. Although lower than the "excellent model fit" threshold, these values are not an indication of poor model performances. On the contrary - they are an expected consequence of the low amount of survey respondents and can still lead to statistical significance (achieved when the p -values are lower than 0.05). [60] Despite this, an attempt was made to improve the model fit by expanding each of the basic models to also include the covariates age, gender and community sensitivity. The reason for including age and gender, instead of other factors mentioned during the expert interviews, was in order to avoid overcomplicating the model. A more complex model would have been more logical when working with more respondents. Thus, an assumption was made that since age and gender are the two most basic individual characteristic, all other factors that affect mobility are directly related to them. [71]

As for including the community values factor in the extended model, this was done in line with one of the goals of this research, which was encapsulated in Subresearch question 2. These covariates were added as main effects, instead of as interaction effects, as for the latter a much larger sample size is necessary. Equations 3.2, 3.3 and 3.4 illustrate how this was incorporated in the utility functions, effectively building upon the base model utility function, which was shown via Equations 2.1, 2.2 and 2.3. The two extended models were also estimated via MNL. The Python programming code, used to estimate the models, can be seen in Appendix E. (Note: only the Python codes for Scenario 1 model 1: base and model 2: extended are provided. The other two models are very similar, the only difference being that anything related to the shared cargo bike alternative is removed.) Table 3.1 provides an overview of how the different alternatives, attributes and attribute levels were presented in the model.

$$V_1 = ASC_{pc} + \beta_{pd}^{pc} \cdot private_car_parking_distance + \beta_{at}^{pc} \cdot private_car_arrival_time \\ + \sum_k \beta_k^{pc} \cdot COMMUNITY_BELONGING_k + \sum_l \beta_l^{pc} \cdot AGE_l + \sum_m \beta_m^{pc} \cdot GENDER_m \quad (3.2)$$

$$V_2 = ASC_{sc} + \beta_{ab}^{sc} \cdot shared_car_advanced_booking + \beta_{at}^{sc} \cdot shared_car_arrival_time \\ + \sum_k \beta_k^{sc} \cdot COMMUNITY_BELONGING_k + \sum_l \beta_l^{sc} \cdot AGE_l + \sum_m \beta_m^{sc} \cdot GENDER_m \quad (3.3)$$

$$V_3 = ASC_{sb} + \beta_{ab}^{sb} \cdot shared_bike_advanced_booking + \beta_{at}^{sb} \cdot shared_bike_arrival_time \\ + \sum_k \beta_k^{sb} \cdot COMMUNITY_BELONGING_k + \sum_l \beta_l^{sb} \cdot AGE_l + \sum_m \beta_m^{sb} \cdot GENDER_m \quad (3.4)$$

In these equations, k , l and m are used to indicate the different community belonging types, age groups and types of genders, respectively.

Factor	Level	Variable and applied coding
Main attributes		
Parking distance (private car)	50 m 200 m 400 m	private_car.parking_distance
Arrival time deviation (all modes)	-10 min 0 min +10 min	arrival_time
Booking time (shared car/van / cargo bike)	0 min 30 min 60 min	advanced_booking
Alternative-specific constants	Private car shared car/van Shared cargo bike	ASC_pc ASC_sc ASC_sb
Socio-demographic covariates		
Age	< 18 (base) 18–24 25–34 35–44 45–54 55–64 > 65	AGE_Under18 AGE_18_24 AGE_25_34 AGE_35_44 AGE_45_54 AGE_55_64 AGE_Over65
Gender	Woman (base) Man Other	GENDER_Woman GENDER_Man GENDER_Other
Community belonging importance	Level 1: Strongly disagree (Answered 1 or 2) Level 2: Disagree (Answered 3 or 4) Level 3: Neutral (Answered 5 or 6) Level 4: Agree (Answered 7 or 8) Level 5: Strongly agree (Answered 9 or 10)	COMMUNITY_BIN_1 COMMUNITY_BIN_2 COMMUNITY_BIN_3 COMMUNITY_BIN_4 COMMUNITY_BIN_5

Table 3.1: Attribute levels and socio-demographic variable coding used in the choice models

3.2.1. Scenario 1: Model 1 Results

The Rho-square of the base model for the first scenario (small amount of cargo) is 0.06, which is relatively low, however also not entirely unexpected, given the low amount of respondents. Table 3.18 shows the parameter estimates.

Figure 3.18: Scenario 1, Model 1: Parameter estimates

Name	Value	Rob. Std err	Rob. t-test	Rob. p-value
ASC_sb	0.506	0.191	2.66	0.00791
ASC_sc	0.254	0.187	1.36	0.174
B_ab_sb	-0.412	0.1	-4.11	4.04e-05
B_ab_sc	-0.2	0.0992	-2.02	0.0434
B_at_pc	-0.0749	0.0567	-1.32	0.187
B_at_sb	-0.241	0.0512	-4.7	2.61e-06
B_at_sc	-0.167	0.0513	-3.25	0.00117
B_pd_pc	-0.15	0.0623	-2.41	0.0159

Based on these estimates, the following insights can be derived:

- Respondents generally have a positive preference for the shared cargo bike over their own car.
- No clear preference has been shown for the shared car/van over the own car alternative.
- The longer in advance people have to make a booking for shared cargo bike, the lower the chance becomes of them picking that alternative.
- The same applies for the shared car/van.
- There is no clear evidence that the estimated arrival time deviation affects respondents' choice for their own car.
- On the contrary, the bigger the deviation between the estimated arrival time and the actual arrival time of a shared cargo bike, the lower the utility of the alternative.
- The same applies for the shared car/van alternative.
- The further people have to walk to a parking, the lower the probability becomes that they will select their own car.

3.2.2. Scenario 1: Model 2 Results

After extending the model with the covariates age, gender and community sensitivity, the model goodness-of-fit improves - the Rho-square is now 0.153, which is an improvement in comparison to the base model. Figure 3.19 shows the parameter estimates.

Figure 3.19: Scenario 1, Model 2: Parameter estimates

Name	Value	Rob. Std err	Rob. t-test	Rob. p-value
ASC_sb	1.95	1.14	1.7	0.0883
ASC_sc	1.49	1.13	1.32	0.188
B_ab_sb	-0.476	0.109	-4.38	1.19e-05
B_ab_sc	-0.214	0.101	-2.11	0.0347
B_at_pc	-0.0865	0.0608	-1.42	0.155
B_at_sb	-0.275	0.0548	-5.02	5.09e-07
B_at_sc	-0.178	0.0538	-3.31	0.000939
B_pc_AGE_18_24	1.52	0.773	1.97	0.0492
B_pc_AGE_25_34	1.49	0.774	1.92	0.055
B_pc_AGE_35_44	2.05	0.778	2.64	0.0084
B_pc_AGE_45_54	1.94	0.79	2.45	0.0142
B_pc_AGE_55_64	0.702	0.79	0.889	0.374
B_pc_AGE_Over65	7.56	0.818	9.25	0
B_pc_GENDER_Man	0.0435	0.136	0.319	0.75
B_pc_GENDER_Other	0.502	0.412	1.22	0.223
B_pc_comm_2	-0.766	0.299	-2.56	0.0104
B_pc_comm_3	-0.582	0.303	-1.92	0.0542
B_pc_comm_4	-1.12	0.255	-4.39	1.15e-05
B_pc_comm_5	-0.982	0.263	-3.73	0.00019
B_pd_pc	-0.17	0.0672	-2.53	0.0113
B_sb_AGE_18_24	-1.45	0.566	-2.55	0.0106
B_sb_AGE_25_34	-1.6	0.551	-2.89	0.00382
B_sb_AGE_35_44	-1.89	0.557	-3.39	0.000686
B_sb_AGE_45_54	-2.58	0.579	-4.45	8.39e-06
B_sb_AGE_55_64	-0.408	0.526	-0.775	0.439
B_sb_AGE_Over65	-4.65	0.587	-7.92	2.44e-15
B_sb_GENDER_Man	-0.1	0.127	-0.786	0.432
B_sb_GENDER_Other	-0.375	0.39	-0.961	0.337
B_sb_comm_2	1.16	0.345	3.37	0.000745
B_sb_comm_3	1.34	0.35	3.82	0.000131
B_sb_comm_4	1.58	0.303	5.23	1.72e-07
B_sb_comm_5	1.39	0.296	4.68	2.81e-06
B_sc_AGE_18_24	-0.0751	0.519	-0.145	0.885
B_sc_AGE_25_34	0.11	0.512	0.215	0.83
B_sc_AGE_35_44	-0.161	0.521	-0.309	0.758
B_sc_AGE_45_54	0.64	0.531	1.21	0.228
B_sc_AGE_55_64	-0.295	0.52	-0.567	0.571
B_sc_AGE_Over65	-2.91	0.546	-5.34	9.23e-08
B_sc_GENDER_Man	0.0566	0.12	0.471	0.637
B_sc_GENDER_Other	-0.128	0.459	-0.278	0.781
B_sc_comm_2	-0.397	0.283	-1.4	0.161
B_sc_comm_3	-0.755	0.296	-2.55	0.0108
B_sc_comm_4	-0.463	0.236	-1.96	0.0499
B_sc_comm_5	-0.404	0.233	-1.73	0.0835

Based on these estimates, the following insights can be derived:

- Respondents show no statistically clear preference for choosing a shared cargo bike or shared car/van over their private car.
- Increased booking time significantly decreases the utility of using a shared cargo bike or shared car/van.
- Arrival time deviations (earlier or later than estimated) do not have a statistically significant effect on the utility of private cars.
- Greater deviation from the expected arrival time significantly reduces the probability of respondents choosing a shared cargo bike or shared car/van.
- The longer people have to walk to a parking, the lower the utility becomes of the private car alternative.
- Respondents aged 25–34, 35–44, 45–54 and 55–64 show a statistically significant preference for private cars. The group 65+ has the strongest preference for using their private car.
- In comparison with the under 18 group, all age groups dislike the idea of using the shared cargo bikes, except for the 55–64 group, where the evidence is inconclusive.
- Respondents aged 18–24, 25–34, 35–44, 45–54 and 55–64 show no meaningful preference for the shared car/van, in comparison with the under 18 group. Respondents over 65, on the other hand, significantly dislike using shared cars/vans.
- There is no evidence that men or people who identify as "other" have a preference for any of the shared alternatives (versus the private car), in comparison with the base group - women.
- Respondents who are moderately insensitive to a community feeling at work have a low probability of choosing their private cars. This group also shows a preference for shared cargo bike, in comparison to the base alternative - own car.
- Respondents who are moderately sensitive to a community feeling at work have a low probability of choosing their private cars. This group also shows a preference for shared cargo bike, in comparison to the base alternative - own car.
- Respondents who are very sensitive to a community feeling at work have a low probability of choosing their private cars. This group also shows a preference for shared cargo bike, in comparison to the base alternative - own car.
- The evidence about the probability of choosing a private car is inconclusive for those who are neutral to a community feeling.
- Respondents who are neutral or moderately sensitive to a community feeling at work have a low probability of choosing the shared car/van over their private car. The evidence is inconclusive for those who are moderately insensitive or very sensitive to a community feeling.

Here, it is important to note that sometimes disliking the base option might simply mean that a respondent has a significant preference for another mode, in comparison with the based mode. This ultimately makes it less likely to choose the base mode. But overall, the model shows that increased booking-in-advance time lowers the likelihood of respondents choosing shared cargo bikes or shared cars/vans. Arrival time deviations reduce the attractiveness of these shared modes but do not significantly affect the utility of private cars. Longer walking distances to parking reduce the appeal of using a private car. Further, compared to respondents under 18, all older age groups show a stronger preference for private cars, particularly those aged 65 and above. Most age groups are less inclined to use shared cargo bikes, except those aged 55–64, for whom the evidence is inconclusive.

Shared cars/vans, in comparison with private cars, are generally not preferred by any age group, with respondents over 65 showing a clear dislike. When it comes to gender, there seems to be no evidence that gender plays a significant role in choosing for shared mobility over the private car. Lastly, there are some mixed signals coming from the community values aspect. According to the parameter estimates, respondents who are moderately insensitive, moderately sensitive, or very sensitive to a sense

of community at work are less likely to choose private cars in general. These same groups, except the neutral one, are more likely to choose shared cargo bikes instead of their own car. Neutral and moderately sensitive respondents are less likely to choose shared cars/vans over their own cars, although the effect is unclear for the other community groups. These results ultimately showed that community orientation is not a stable predictor of shared mobility use.

3.2.3. Scenario 2: Model 1 Results

When estimating the base model for the second scenario (which now encapsulates big amount of cargo and thus no longer has shared cargo bike as an option), the Rho-square has a value of 0.166, which is already closer to a good model fit than in the previous two models. Figure 3.20 shows the parameter estimates.

Figure 3.20: Scenario 2, Model 1: Parameter estimates

Name	Value	Rob. Std err	Rob. t-test	Rob. p-value
ASC_sc	0.498	0.212	2.35	0.0189
B_ab_sc	-0.203	0.127	-1.6	0.109
B_at_pc	-0.15	0.0616	-2.44	0.0145
B_at_sc	-0.198	0.0649	-3.04	0.00234
B_pd_pc	-0.278	0.0731	-3.8	0.000147

Based on these estimates, the following insights can be derived:

- Respondents have a baseline preference for shared car/van, in comparison with the base option - private car.
- The booking-in-advance time has a slight negative effect on the preference of the shared car/van over the private car. This impact, however, is not significant, deeming the effect inconclusive.
- Later-than-expected arrival time affects both the private and the shared car/van, but especially the latter.
- Longer parking distance significantly reduces the attractiveness for the private car.

3.2.4. Scenario 2: Model 2 Results

After extending the base model of the second scenario, an "excellent" goodness-of-fit is achieved with a Rho-square of 0.241. This indicates that the model is better in comparison with the previous models at gaining meaningful insights from the data. Figure 3.21 shows the parameter estimates.

Based on these estimates, the following insights can be derived:

- Respondents show a baseline preference for the shared car/van, but this is not statistically significant.
- There is no clear evidence that the booking time affects negatively the shared car/van utility.
- Arrival time deviations for private car significantly reduce its utility.
- Delays for shared car/van significantly reduce its attractiveness.
- Longer parking distance strongly reduces the appeal of the private car.
- There is no evidence that respondents in all age groups except the 65+ group have a significant preference of private car over shared car/van. This is not the case for the 65+ group, which shows a strong preference for using their private car.
- Men or people who identify as "other" have no significant preference for private car over shared car/van, in comparison with women. This is also the case for the case of choosing a shared car/van over a private car.

- There is no evidence that people who are moderately insensitive, neutral, moderately sensitive or very sensitive to a community feeling at work prefer the private car over the shared car/van. The same applies for the case of preferring the shared car/van over the private car.

To summarize: The only significantly statistical insight that this model provides is that respondents are very sensitive to the parking distance and the later-than-expected arrival time for both shared car/van and private car. The only age group that seems to have a strong preference for private cars in comparison with shared cars/vans is the 65+ age group. Respondents' gender or their sense of community at work, as strong or weak as it is, does not seem to significantly influence their choice of private car versus shared car/van, once more indicating that the community orientation of respondents is not a stable predictor of shared mobility use.

Figure 3.21: Scenario 2, Model 2: Parameter estimates

Name	Value	Rob. Std err	Rob. t-test	Rob. p-value
ASC_sc	0.921	0.692	1.33	0.183
B_ab_sc	-0.225	0.134	-1.67	0.0942
B_at_pc	-0.168	0.0652	-2.58	0.00996
B_at_sc	-0.219	0.0691	-3.18	0.00149
B_pc_AGE_18_24	0.334	0.395	0.845	0.398
B_pc_AGE_25_34	0.384	0.398	0.965	0.335
B_pc_AGE_35_44	0.65	0.405	1.61	0.108
B_pc_AGE_45_54	0.274	0.424	0.645	0.519
B_pc_AGE_55_64	-0.425	0.46	-0.924	0.355
B_pc_AGE_Over65	4.89	0.472	10.4	0
B_pc_GENDER_Man	0.0944	0.117	0.808	0.419
B_pc_GENDER_Other	-0.773	0.497	-1.56	0.12
B_pc_comm_2	0.0427	0.25	0.171	0.864
B_pc_comm_3	-0.196	0.248	-0.791	0.429
B_pc_comm_4	-0.317	0.208	-1.53	0.127
B_pc_comm_5	-0.332	0.221	-1.5	0.133
B_pd_pc	-0.31	0.0768	-4.04	5.38e-05
B_sc_AGE_18_24	-0.334	0.395	-0.845	0.398
B_sc_AGE_25_34	-0.384	0.398	-0.965	0.335
B_sc_AGE_35_44	-0.65	0.405	-1.61	0.108
B_sc_AGE_45_54	-0.274	0.424	-0.645	0.519
B_sc_AGE_55_64	0.425	0.46	0.924	0.355
B_sc_AGE_Over65	-4.89	0.472	-10.4	0
B_sc_GENDER_Man	-0.0944	0.117	-0.808	0.419
B_sc_GENDER_Other	0.773	0.497	1.56	0.12
B_sc_comm_2	-0.0427	0.25	-0.171	0.864
B_sc_comm_3	0.196	0.248	0.791	0.429
B_sc_comm_4	0.317	0.208	1.53	0.127
B_sc_comm_5	0.332	0.221	1.5	0.133



4

Discussion

This chapter reflects on the methodological choices and model outcomes of this research, while placing the findings within a broader scientific and practical context. It begins with a critical assessment of the stated choice experiment design, including the rationale behind key simplifications such as the use of arrival time deviation instead of absolute travel time. The following sections focus on interpreting the outcomes of the MNL models. Here, the influence of booking time, parking distance, and arrival time deviations is discussed in more detail, along with the roles of age, gender, and community orientation. The chapter concludes with a discussion on the scientific contribution of the study and a reflection on the suitability of the chosen methodology, as well as the limitations of the research.

4.1. Reflection on Model Setup Design

One of the more unconventional yet necessary elements in the stated choice experiment design was the use of the “arrival time deviation” attribute levels, ranging from -10, 0, to +10 minutes. This was a simplification designed in order to avoid using absolute travel times or distances, since each employee has different destinations and routes for the different business-related trips they conduct. An alternative approach might have been to describe specific travel distances, for example - “imagine a trip of 15 kilometers”, to make the scenarios more concrete. However, this would have introduced biases in the responses, as cycling 15 kilometers for some might be less favorable than for others, thus eliminating the cargo bike option by default. This issue could have been fixed by introducing distances similarly as the cargo amount aspect. In other words, to have sub-scenarios of the small cargo and big cargo scenarios. These sub-scenarios could have introduced situations such as “imagine you have a small amount of cargo and you need to travel a short distance (for example < 5 kilometers)”.

This distinction between the different travel distances as separate sub-scenarios would have once again faced the issue of having a low amount of respondents. Thus, the more sub-scenarios (each of which is seen as a separate scenario by the Biogeme model) would have not been able to provide meaningful results. Which is why the more abstract arrival times, referring to the general punctuality of a mode, were introduced. This also made the choice tasks more realistic, avoiding causing cognitive overload or survey fatigue, both of which usually lead to the respondent dropping out of the experiment. Lastly, when it comes to the visual elements of the survey, the color schemes used were not deliberately trying to convey a certain underlying meaning behind the symbols. The colors were simply chosen so they could differentiate the elements from one another. However, it could be the case that certain colors could have conveyed subliminal messages, for instance “red is bad” and “green is good”, where red was used for the portrayal of the private car and green - for that of the shared modes. The same considerations can be applied about the AI-generated images, namely - that they create a certain idea of how shared mobility would look in the region. This idea can, in certain cases be misleading, as it could differ from reality. On the other hand, these visualizations were incorporated to create a better survey interface and participation experience, potentially reducing the amount of survey drop-outs.

4.2. Discussion of Model Outcomes

4.2.1. Scenario 1: Outcomes

In the first scenario (small amount of cargo) increasing the booking time consistently lowered the utility of shared modes — particularly shared cargo bikes and shared cars/vans. This suggests that friction related to advanced planning undermines the appeal of shared mobility modes. Respondents appear to place value on spontaneity or immediacy, or simply on avoiding having to plan ahead, which shared modes, especially those requiring advanced reservations, often lack. This was an expected result. What was less expected was that arrival time deviations would prove to significantly reduce the attractiveness only of the shared modes, leaving private car usage more or less unaffected. This reinforced the notion that individuals perceive their private cars as offering greater control and reliability, outbalancing the negative affect of a later-than-expected arrival. On the other hand, the higher sensitivity to the estimated versus actual arrival times of shared modes can be an indication of a general mistrust in shared modes, further indicating towards a hesitation towards these modes.

Demographic covariates showed more distinct patterns. Respondents in all age groups showed statistically significant preference for private cars over shared alternatives, with the strongest car preference being among those aged 65 and older. This aligned with well-documented behavioral patterns of choosing the private car as a default vehicle due to the perceived higher level of autonomy and comfort, especially for older individuals. The only aspect that negatively affected the attractiveness of the private cars, according to the model outcomes, was the parking distance. Increasing the distance between the parking spots and the KeilePand was the only way of decreasing the utility of private cars, which could lead to an increase of the competitiveness of shared modes. In other words - simply providing an alternative does not appear to be enough - private car usage must be discouraged actively. This, however, must be done with caution: shared mobility must not be treated as a one-size-fits-all solution. Especially in the case where efforts are made to de-popularize private cars by removing parking spaces, considerations must be made that by doing so policy-makers might be creating barriers for elderly people, individuals with decreased mobility, or other vulnerable groups.

Regarding shared cargo bikes, most age groups expressed a clear dislike. This could be explained by the fact that if an employee has chosen a given mode to commute to the office, they might prefer to stick to that mode also for their business trips. For instance, if they arrived by private car, it is illogical to switch to cargo bike for business trips. The employees who arrived by bike will continue using their bike during the business trips. And those who arrived by other modes might simply dislike cycling to work, also indicating that they are less likely to pick up the shared cargo bike for a business trip. When it came to the preference for the shared car/van over the other modes, all age groups, except for the 65+ group, appeared to be statistically neutral. This suggested that shared cars/vans are not entirely rejected as an idea, however currently lack strong support, and may struggle to stand out in a mode choice landscape still dominated by private cars. On the brighter side, this neutrality towards shared cars/vans could be indicative that the younger age groups can be persuaded in participating in the shared mobility notion.

This persuasion, or better said - motivation for switching to shared mobility, should be taken into account. Especially given the fact that shared mobility is not an entirely new concept in the KeileCollectief - such an initiative already existed in the area. It began in June 2024 and was driven by one of the roughly 50 companies of the KeilePand, and included the introduction of two shared cars/vans with the idea to gradually increase this number, as more companies joined the movement. Half a year later, however, none of the other companies had adopted this new mobility approach. Moreover, within the company-initiator, only about 15 people had opted for using the shared cars/vans. Many of the employees of the other companies were unaware of certain aspects of the shared cars/vans (such as how the booking of such a vehicle works), or even the existence of these shared cars/vans in the first place. [21] With this information in mind, it is unsurprising that there appears to be a general neutrality or even mistrust towards shared mobility. It becomes difficult to be on board of an initiative without knowing what it entails and what its benefits are.

Besides the age-based preferences, the MNL model also examined whether gender would play a role in the choice towards shared mobility, the initial assumption being that it would indeed have an effect. This was assumed since, according to societal norms, women are usually the primary care-giver, meaning that they are more likely to have to bring or pick up children or elderly people to school or to medical appointments on their way to work. This, presumably, makes women more likely to choose their private cars over completing the aforementioned tasks by less-comfortable modes. This assumption was also made in some of the reviewed literature. Interestingly enough, however, the model concluded that gender does not seem to play a role in the mode choice of the KeileCollectief. This could be a contextual effect, as about 80% of the survey respondents indicated that they do not have children under 13 years old in their household. Children over that age are assumed to be more independent and to thus require less care. Another explanation could be that the survey respondents were insufficient for capturing more nuanced gender-related differences.

The last demographic-based aspect was the community values. Here, the initial assumption was that this aspect would play a very significant role in the mobility patterns of the KeilePand, especially since one of the underlying assumptions of the Municipality was that the KeileCollectief — being a creative and collaborative community — would exhibit stronger openness to shared mobility initiatives due to a heightened sense of workplace belonging and shared values. As aforementioned, this notion was also supported by the reviewed literature, where it was stated that collective identification can foster pro-social behavior, including participation in sustainability efforts. The model outcomes, however, were confusing, showing that people from very different community orientations (not very community-oriented to very community-oriented) can still exhibit what was presumed to be community-based characteristics (such as choosing shared mobility over the private car). Thus, although statistically significant, these model outcomes appear to be less reliable in linking community values with the interest towards shared modes. This could also mean that the assumption that community values play a role in mode choice, might be wrong. This again ties into the notion that the community values aspect might be exaggerated by policy-makers or by the KeilePand, creating a discrepancy between the plans made with these community values in mind and the actual apparent neutrality that survey respondents exhibited when it came to community values.

Together, all of these outcomes paint the following picture: in the situation where a small amount of cargo (such as a backpack) has to be brought to a business meeting, age, gender or community-orientation do not appear to significantly tip the scales in favor of the shared modes. The overwhelming preference is still towards private cars, as the advanced booking time of shared vehicles is a major obstacle. The only way to create a real trade-off between private cars and shared modes is to make the parking spots as far away as possible and to ensure that the shared modes have an advantage over the private car travel time-wise. Lastly, the community values aspect should not be relied upon too much by policy-makers, as it can be misleading - as seen in the results of the two extended models, the community factor did not prove to be a stable indicator of shared mobility.

4.2.2. Scenario 2: Outcomes

In the second scenario (large amount of cargo), the model, thus, estimated the preferences between the private car and shared car/van. The model reached similar conclusions as the previous model - age, gender and community orientation did not play a significant role of choosing shared cars/vans over private cars, and parking distance and travel time indeed negatively affected the choice of private car over the shared car/van. What was interesting in this model is that, unlike in the previous one, the shared car/van booking time appeared to have no significant effect over the utility of the shared cars/vans. This could be because employees who deal with transporting larger cargo are more open to planning ahead. However, the lack of significant position (pro or against) shared cars/vans over private cars, indicated that respondents are still not entirely convinced that shared mobility can be beneficial for them. This could again be explained via the lack of effort to popularize the shared vehicles, demonstrated by the fact that, despite a few shared cars already being present at the KeilePand, barely any of the survey respondents were aware of their existence. Thus, more effort seems to be necessary to inform the employees of the KeilePand about the advantages of the shared cars/vans.

4.3. Reflection on Research Methodology Choice

The decision for choosing stated choice experiments as the main research method was theoretically justified by the existing literature for its appropriateness in similar scenarios. In practice however, especially in the case of the KeileCollectief, the application of the method was constrained by the low amount of employees, as well as survey respondents - an issue, mentioned in the previous chapters. More specifically, these aspects limited the choice of model alternatives, for instance. Thus, instead of having 4 alternatives, namely - own car, shared car, shared van, shared cargo bike, the second and third alternatives had to be combined in one to decrease the number of choice situations. The higher the number of choice situations, the more necessary the method of blocking becomes, in which method survey participants are presented only with one part of the survey, meaning that they have to go through less choice situations. To achieve significant results, however, the number of participants grows with the number of blocks. [72]

Thus, in the case of the KeileCollectief, blocking was not possible, necessitating for multiple decisions to be made in order to avoid having too many choice situations. In the case of this experiment, there were 21, which is generally considered acceptable. If another alternative had been added, they would have increased to 36, necessitating for blocking to be applied. The same considerations were also applied for with the choice of attributes and attribute levels, as well as when building the utility functions for the MNL model. In retrospect, while the sample size limited the complexity of the experimental design, the study still revealed consistent patterns in respondent preferences and allowed for meaningful insights into the influence of key attributes. On the other hand, as mentioned in previous chapter, if this project had received more support from the KeileCollectief, especially in the survey distribution aspect, it would have been possible to have more survey respondents, increasing the value of the stated choice experiment. Nevertheless, despite all of these external obstacles and shortcomings, the research method was applied thoroughly and rigorously throughout the whole process.

4.4. Contribution to Scientific Literature

It is also important to reflect on how the practical outcomes, namely - those of the two models, contribute to the scientific body of knowledge. As discussed in Chapter 1, the reviewed literature painted a fairly optimistic picture of how social aspects, more specifically - socio-demographic factors, could function as enablers or obstacles for the adoption of shared mobility. For instance, factors such as age and gender, among others, were considered as factors significantly affecting the adoption of shared mobility by default. This, however, as shown in this project, is not always the case - in the case of the KeileCollectief these two aspects proved to not be of significant importance. This directly questions the widespread assumption in academic literature that such variables are inherently explanatory across contexts. This highlights a point that was made before - that shared mobility should not be regarded as a one-size-fits all solution, as it was sometimes presented in the literature. It should be tailored, not just to the type of company (big versus small) or type of area (residential versus workspaces), but on a larger scale - maybe regional or national.

A good example here would be the following: in the Netherlands, and in Western Europe for that matter, gender roles are more balanced than in countries in the eastern parts of Europe. This could be the reason why gender did not seem to influence significantly the choice of shared mobility, as seen in this project. Thus, if the same shared mobility project is to be executed in Bulgaria for instance, larger-scale social patterns might play a bigger role and should thus be considered more seriously. This underlines the importance of context-specific modeling, where social or cultural assumptions are not globally applied, but evaluated against the setting in which the study takes place. However, given that the KeileCollectief takes place in the Netherlands, certain assumptions regarding gender as a factor could have been when building the stated choice experiment to treat gender as a non-factor by default, making the model less complex. This would not only simplify the model structure but would also allow more statistical power to be allocated to variables that are contextually meaningful. The idea behind this approach would have been to prioritize empirical relevance over theoretical completeness, which is especially important in smaller-scale studies. This would have been beneficial as certain liter-

ature sources make attempts for creating excessively complex models, which are not always feasible to be realized - as a popular proverb states: "less is more". This project thus supports the idea that simplicity in model design, grounded in empirical justification, can lead to clearer insights than overly detailed models attempting to capture every theoretical nuance. This is just one example that highlights how scientific literature should treat complex topics such as shared mobility - while all factors should be considered initially, assumptions should be made at a later point of time to eliminate a portion of these factors, thus opting for a less complex model, which could achieve much more significant results.



5

Conclusion and Recommendations

In conclusion, this research investigated how employees of small-to-medium-sized enterprises (SMEs) in urban redevelopment areas make transport mode choices for business-related trips, using the KeileCollectief pilot in Rotterdam as a case study. The research was guided by a combination of literature review, expert interviews, and a stated choice experiment (SCE) analyzed through discrete choice modeling. Together, these methods have provided insights into the factors influencing shared mobility adoption, particularly in SMEs in urban redevelopment areas. The KeileCollectief in the Rotterdam's MerweVierHavens (M4H) area was taken as a case study. This is also where the different methods (expert interviews and SCE) were conducted, guided by certain main and sub-research questions. The insights gained from them are provided in the following sections.

5.1. Answering the Formulated Research Questions

5.1.1. Answer to Subresearch Question 1

The first subresearch question was formulated as follows:

Which factors are relevant when it comes to choosing between shared mobility options and private car usage at the KeileCollectief?

This question was necessary to distinguish which of the many socio-demographic, contextual, mode-specific and psychological factors mentioned in the reviewed literature were most applicable for an SME such as the KeileCollectief. The answer to this question was derived from the information given in the three expert interviews that were conducted for the purpose of this research. The findings showed that the most decisive factors are operational in nature, more specifically - advanced booking time for shared modes, parking distance for private car and arrival time deviations for all three modes. Other non-operational factor included the household size and physical limitations that an individual might have, as well as the weather conditions, habits that individuals have built over years of using a given transport mode, and perceived health and environmental considerations associated with different modes. Answering this first subresearch question was a necessary step, as narrowing down the factors to the most important ones for the KeileCollectief later played a crucial role in the set up of the stated choice experiment - the main method used in this research.

5.1.2. Answer to Subresearch Question 2

The second subresearch question was namely:

How do these factors, in combination with the aspect of workplace community values, shape mode choice for the KeileCollectief employees?

Despite the theoretical expectation that strong community values would have a positive effect on the shift towards shared mobility, the model results indicated otherwise. Community orientation, defined as the importance of feeling part of the workplace community, and indicated by respondents themselves via the survey, did not show a statistically strong or consistent effect on mode choice. Coupled with the two chosen socio-demographic factors gender and age, the results showed limited significance in shaping choices in this specific context. One possible explanation is that while communal identity may influence attitudes, it does not automatically translate into behavior, particularly when the practical barriers to using shared mobility, such as the booking-in-advance time and the close proximity of parking spots for private cars, remain high.

5.1.3. Answer to Subresearch Question 3

The third subresearch question was formulated as follows:

What lessons from the KeileCollectief pilot can inform the design of shared mobility policies targeting SMEs ?

This research question was formulated to reflect on the outcomes of the model and how they can be applied to other SMEs. The key policy lesson that followed from the model outcomes was that the transition towards shared mobility would only happen when it becomes practically competitive with private cars. This involves reducing friction in booking, improving vehicle availability, creating obstacles for private cars in terms of parking, and integrating shared modes seamlessly into the daily routines of employees. Other actions should target improving other shared mobility aspects, for instance - creating priority lanes for shared vehicles to ensure they would be faster than private vehicles, even when traveling on the same route. However, these are external actions of motivating SME employees to participate in shared mobility. Lastly, another conclusion that this research reaches is that future policies should avoid assumptions about workplace culture. More specifically - just because a workplace calls itself a "community" does not mean this translates to collective behavior when it comes to transport behavior.

5.1.4. Answering the Main Research Question

The main research question encapsulated the subresearch questions and was as follows:

How do the employees of small-to-medium-sized enterprises (SMEs) make transport mode choices for business-related trips?

The findings of this research show that even the employees of an SME like the KeileCollectief, although presumably more innovative and sustainability-oriented due to their stronger sense of community, struggle with the concept of shifting towards shared mobility. According to the results of the experiment, these employees still tend to lean towards the use of their own private cars for business-related trips, indicating that even in more progressive work environments, practical considerations often outweigh ideological or collective motivations. This aligns well with a notion present in the majority of the literature: convenience is key. This goes both ways - the more convenient private cars are (in terms of parking for instance), the less attractive the shared modes will be. Or vice versa - the more attractive shared modes seem, the more likely it will be that they will be chosen. Thus, if shared mobility is to replace private car use, it has to be at least as seamless and efficient in practice.

This shift towards shared mobility, however, would not happen without a certain amount of additional planning, friction, or uncertainty and the community values aspect, as shown by the results of the experiment, are not enough to outweigh them. This poses a question: if it is difficult to implement shared mobility in a presumably more forward-thinking place like the KeileCollectief, in its capacity of an SME, how much more difficult would that implementation be on a larger scale (e.g. Rotterdam-wide or nationally)? There are undoubtedly many possible answers, however, one to consider is as follows: adoption of shared mobility cannot be expected solely through the provision of infrastructure or availability of services.

Thus, a dual approach is necessary - one that tackles the practical barriers (for example - booking times, vehicle availability, parking distance, service level, and others), and one that focuses on creating a genuine shift in mindset. If shared modes are to be seen as the "community vehicle fleet", then community values need to be nurtured in a way that makes them tangible in daily decision-making, including transport behavior. People must be informed, engaged, and encouraged to join the transition - not only by municipalities, but also by the companies and communities they are part of. This could be achieved via actively involving them to participate in the initiative, not just by merely presenting them with dry technical information, but by demonstrating the possibilities of shared mobility in a practical way. This is the only way that everyone - both policy-makers, as well as the individuals whose daily lives these policies are meant to improve, are on board the same trajectory towards more sustainable mobility choices.

5.2. Recommendations for Future Work

Besides the recommendations given for policy-makers in the previous section, there are other actions that could be taken from an academic standpoint, that could potentially change, confirm or improve the outcomes of this research. Such an action could be to repeat the experiment in another SME, this time aiming for a larger sample size, as well as a higher level of participation among respondents. This would allow for testing for the external validity and generalizability of the findings. Moreover, a larger sample would allow for a more complex model specification, especially the inclusion of a broader range of covariates. While this research focused on age, gender, and community orientation, other potentially relevant socio-demographic, contextual or psychological traits could be included as explanatory variables or interaction effects.

Another important direction for further research would be to expand the scope of the attributes and alternatives in the choice experiment itself. For instance, attributes like reliability, comfort, or digital interface quality could be added in future versions of the experiment to better reflect real-world decision-making. Additionally, incorporating different types of shared modes, such as e-scooters, which was not part of this research, could allow for a broader comparison across the shared mobility spectrum. This could help determine whether the low utility associated with shared cars/vans in this study is specific to the mode, or part of a more general skepticism toward shared services. Lastly, another action that could be undertaken, that was not possible in the scope of this research due to the limited amount of historical data on shared mobility usage at the KeileCollectief, would be to combine stated choice methods with revealed preference data. This method would fall into the third phase (decision) of the innovation process, the first two (knowledge and persuasion) being covered in the context of the performed stated choice experiments. By addressing the decision phase, more insights can be gained into the real-world trade-offs that SME employees must make in their business-related mode choice.

In the next phase of innovation - implementation, it would be possible to examine how people interact with the innovation over time, whether they encounter unforeseen obstacles, and how support structures such as technical help, social encouragement, or leadership visibility influence the rollout. Finally, the last phase - confirmation, could assess whether repeated usage reinforces or weakens SME employees' commitment to shared mobility. Future research could track which factors help consolidate new mobility patterns and which trigger a return to private car use. Understanding these post-decision stages is essential, as initial willingness alone does not automatically lead to sustained adoption.

5.3. Closing Remarks

This section concludes the thesis report. While the outcomes of the research did not indicate towards an immediate or widespread readiness to adopt shared mobility in SME contexts, they nonetheless provide valuable insight into the practical and psychological barriers that currently hinder such a transition. These findings highlight the complexity of behavioral change and the importance of addressing both structural and cultural dimensions. And as societal norms evolve and urban environments continue to transform, the shift towards shared mobility may become an increasingly natural and intuitive action. Until then, what the individuals involved in the driving this change can do is simple: practice what you preach.

Bibliography

- [1] R.J. Orsato and P. Wells. “U-turn: the rise and demise of the automobile industry”. In: *Journal of Cleaner Production* 15.11 (2007). The Automobile Industry & Sustainability, pp. 994–1006.
- [2] Len Holden David Thoms. *The Motor Car and Popular Culture in the Twentieth Century*. [Accessed 07-11-2024]. 1998.
- [3] James Wilson and Alan Mckinlay. “Rethinking the Assembly Line: Organization, Performance and Productivity in Ford Motor Company, c. 1908-27”. In: *Business History* 52 (Aug. 2010), pp. 760–778.
- [4] Joe Kerr Peter Wollen. *Autopia: Cars and Culture*. [Accessed 08-11-2024]. 2002.
- [5] John Meyer. *Automobility and Freedom*. [Accessed 07-11-2024]. 2011.
- [6] Anthony Caruso and Florian Kern. “‘Transition Management’ in Developing a More Sustainable Transportation System”. In: (June 2004).
- [7] *OECD: Cars and Space Consumption - Rethinking the Regulation of Urban Mobility*. <https://www.itf-oecd.org/sites/default/files/docs/cars-space-consumption-regulation-urban-mobility.pdf>. [Accessed 21-10-2024].
- [8] Ruben Verbeeke. *Well-being Indicators for Car-Free Policies | TU Delft Repository — repository.tudelft.nl*. <https://repository.tudelft.nl/record/uuid:27a06549-10eb-40c6-ae78-38a898241194>. [Accessed 28-10-2024].
- [9] Gulsah Dijk and José Marmeleira. *Streets as Social Places*. Jan. 2021.
- [10] William Riggs. *End of the Road: Reimagining the Street as the Heart of the City*. Bristol University Press, 2022.
- [11] Frank van Oort and Gert-Jan Hospers. *Ruimtelijke Economische Verkenning 2024*. Accessed: 2025-06-23. 2024.
- [12] Gemeente Rotterdam. *Aanpak Nul Emissie Mobiliteit: Naar uitstootvrije stedelijke mobiliteit*. [Accessed 06-11-2024], translated from Duchth.
- [13] *Mobiliteitsaanpak*. <https://www.rotterdam.nl/mobiliteitsaanpak>. [Accessed 07-11-2024].
- [14] Rebel Group. *Reclaiming Public Space with Shared Cars*. https://openresearch.amsterdam/image/2024/2/5/reclaiming_public_space_with_shared_cars_wcag.pdf. [Accessed 12-05-2025]. 2023.
- [15] *Merwe-Vierhavens: van Woestijn naar Goudmijn*. <https://drift.eur.nl/app/uploads/2017/02/Gebiedsontwikkeling-Merwe-Vierhavens-Van-Woestijn-tot-Goudmijn.pdf>. [Accessed 23-10-2024].
- [16] *The port that will take you ahead | Port of Rotterdam*. <https://www.portofrotterdam.com/en/why-rotterdam/port-will-take-you-ahead>. [Accessed 22-10-2024].
- [17] Jan Rotmans, René Kemp, and Marjolein van Asselt. “More evolution than revolution: transition management in public policy”. en. In: *Foresight* 3.1 (Feb. 2001), pp. 15–31.
- [18] *KeileCollectief*. <https://www.keilecollectief.nl/>. [Accessed 24-10-2024].
- [19] *Ondernemers — KeileCollectief*. <https://www.keilecollectief.nl/ondernemers>. [Accessed 24-10-2024].
- [20] I. van Gerrevink; V. Joanknecht. *Personal Communication*. Personal communication. Conversation with stakeholders on July 23, 2024. 2024.
- [21] P. Verhoeven. *Personal Communication*. Personal communication. Conversation with stakeholders on October 28, 2024. 2024.

- [22] *Map MerweVierHavens*. <https://groupa.nl/projects/offices-keilepand-m4h-rotterdam-nl/>. [Accessed 09-11-2024].
- [23] Benjamin James Inyang. "Defining the Role Engagement of Small and Medium-Sized Enterprises (SMEs) in Corporate Social Responsibility (CSR)". In: *International Business Research* 6.5 (2013), p. 123.
- [24] *Mkb-verklaring* — *rvo.nl*. <https://www.rvo.nl/onderwerpen/subsidiespelregels/ez/mkb-verklaring>. [Accessed 05-08-2025].
- [25] Nuttawuth Muenjohn et al. "Workplace innovation and work value ethics: The mediating role of leadership in Asian SMEs". In: *Journal of Innovation & Knowledge* 9.3 (2024), p. 100547.
- [26] Everett M. Rogers. *Diffusion of Innovations*. 5th. Free Press, 2003.
- [27] Madiha Shafique Dar, Shakoor Ahmed, and Abdul Raziq. "Small and Medium-Size Enterprises in Pakistan: Definition and Critical Issues". In: *Pakistan Business Review* (Apr. 2017), p. 46.
- [28] Tim Edwards, Rick Delbridge, and Max Munday. "Understanding innovation in small and medium-sized enterprises: a process manifest". In: *Technovation* 25.10 (2005), pp. 1119–1127.
- [29] Eva Ayaragarnchanakul et al. "Choosing a Mode in Bangkok: Room for Shared Mobility?" In: *Sustainability (Switzerland)* 14.15 (2022). Cited by: 3; All Open Access, Gold Open Access.
- [30] Nadine Olipp, Manuel Woschank, and Jacob Kopeinig. "Enablers, Barriers, and Opportunities for the Implementation of Circular Economy Practices in Small and Medium-Sized Enterprises: An Explorative Systematic Literature Review". In: *Latest Advancements in Mechanical Engineering*. Ed. by Franco Concli et al. Cham: Springer Nature Switzerland, 2024, pp. 185–199.
- [31] Nuren Abedin et al. "Travel Behavior of SME Employees in Their Work Commute in Emerging Cities: A Case Study in Dhaka City, Bangladesh". In: *Sustainability* 12.24 (2020).
- [32] Myriam Zakhem and Janille Smith-Colin. "Investigating the Acceptance of Shared Autonomous Micromobility Systems: Evidence from Four Cities in the United States". In: (2023). Available at SSRN.
- [33] L. Kauschke. *The Transition to Smart Mobility: Acceptance and Roles in Future Transportation*. Germany: Springer Fachmedien Wiesbaden, 2023.
- [34] Chinh Q. Ho, Corinne Mulley, and David A. Hensher. "Public preferences for mobility as a service: Insights from stated preference surveys". In: *Transportation Research Part a Policy and Practice* 131 (Sept. 2019), pp. 70–90.
- [35] Dimitrios Efthymiou, Constantinos Antoniou, and Paul Waddell. "Factors affecting the adoption of vehicle sharing systems by young drivers". In: *Transport Policy* 29 (May 2013), pp. 64–73.
- [36] Farzana Mehzabin Tuli, Suman Mitra, and Mariah B. Crews. "Factors influencing the usage of shared E-scooters in Chicago". In: *Transportation Research Part a Policy and Practice* 154 (Oct. 2021), pp. 164–185.
- [37] Jeoung Yul Lee et al. "The impact of the perceived value of the sharing economy on consumer usage behavior: Evidence from shared mobility in China. Asian Business & Management, in press (2023)". In: *Asian Business & Management* 22 (June 2023).
- [38] ELVIRA CICOGNANI et al. "Social Identification and Sense of Community Among Members of a Cooperative Company: The Role of Perceived Organizational Values". In: *Journal of Applied Social Psychology* 42.5 (2012), pp. 1088–1113. eprint: <https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1559-1816.2011.00878.x>.
- [39] Mark Van Vugt. "Averting the tragedy of the commons: Using social psychological science to protect the environment". In: *Current Directions in Psychological Science* 18.3 (2009), pp. 169–173.
- [40] Michael Bamberg. "Narrative Practice and Identity Navigation". In: *Varieties of Narrative Analysis*. Ed. by J. A. Holstein and J. F. Gubrium. London: Sage Publications, 2011, pp. 99–124.
- [41] Henri Tajfel and John C. Turner. "The Social Identity Theory of Intergroup Behavior". In: *Psychology of Intergroup Relations*. Ed. by Stephen Worchel and William G. Austin. Chicago: Hall Publishers, 1986, pp. 7–24.

- [42] Shalom H. Schwartz. *Normative Influences on Altruism*. Ed. by Leonard Berkowitz. 1977.
- [43] Sebastian Bamberg, Marcel Hunecke, and Anke Blobaum. "Social Context, Personal Norms and the Use of Public Transportation: Two Field Studies". In: *Journal of Environmental Psychology* 27.3 (Sept. 2007), pp. 190–203.
- [44] Alexander Bogner, Beate Littig, and Wolfgang Menz. *Interviewing Experts*. Jan. 2009.
- [45] SurveyEngine GmbH. *SurveyEngine*. Accessed: 2023-03-05. 2023.
- [46] ChoiceMetrics. *ChoiceMetrics: Ngene 1.2 User Manual and Reference Guide*. <https://www.choice-metrics.com/NgeneManual140.pdf>. [Accessed 09-05-2025]. 2018.
- [47] Eric Molin. *Lecture 1. Introduction to Experimental Designs*. Course: SEN1221 - part II, Delft University of Technology. 2022.
- [48] Abdulrahman S. Alamri, Stelios Georgiou, and Stella Stylianou. "Discrete choice experiments: An overview on constructing D-optimal and near-optimal choice sets". In: *Heliyon* 9.7 (2023), e18256.
- [49] Peter van der Waerden, Marloes de Bruin-Verhoeven, and Harry Timmermans. *Car drivers' characteristics and the maximum walking distance between parking facility and final destination*. <https://www.jtlu.org/index.php/jtlu/article/view/568/832>. [Accessed 12-05-2025]. 2017.
- [50] E P Kroes and R J Sheldon. "Stated Preference Methods: An Introduction". In: *Journal of Transport Economics and Policy* (1988).
- [51] J J Louviere, D A Hensher, and J D Swait. *Stated Choice Methods: Analysis and Applications*. Cambridge University Press, 2000.
- [52] Microsoft. *Security and Privacy in Microsoft Forms - Microsoft Support* — support.microsoft.com. [Accessed 07-05-2025]. 2018.
- [53] Jolene D. Smyth. *Visual Design, Order Effects, and Respondent Characteristics in a Self-Administered Survey* — digitalcommons.unl.edu. [Accessed 07-05-2025].
- [54] FlatIcons. *FlatIcon*. [Accessed 07-05-2025]. 2025.
- [55] *Diner en Film -What you see is what you eat, Cinema Culinaire* — cinemaculinaire.nl. [Accessed 07-05-2025].
- [56] Gergely Szolnoki and Dieter Hoffmann. "Online, face-to-face and telephone surveys—Comparing different sampling methods in wine consumer research". In: *Wine Economics and Policy* 2.2 (2013), pp. 57–66.
- [57] Pedro Rezende and Satish Ukkusuri. "Social Network Influence on Mode Choice and Carpooling During Special Events: The Case of Purdue Game Day". In: Jan. 2019, pp. 109–126.
- [58] C. Chorus. *Choice behaviour modelling and the logit-model: What and how?* Lecture Slides for the course Statistical Analysis of Choice Behaviour. 2021.
- [59] Michel Bierlaire. *BIOGEME: A free package for the estimation of discrete choice models*. Accessed June 2025. Swiss Association of Transportation Researchers, 2003.
- [60] Daniel McFadden. "Conditional logit analysis of qualitative choice behavior". In: *Frontiers in econometrics*. Ed. by Paul Zarembka. Academic Press, 1974, pp. 105–142.
- [61] Bryan Orme. *Getting Started with Conjoint Analysis: Strategies for Product Design and Pricing Research*. Madison, Wis.: Research Publishers LLC, 2019.
- [62] McKinsey & Company. *The Power of Parity: Advancing Gender Equality in the Dutch Labor Market*. Tech. rep. Accessed on Sunday 17th August, 2025. McKinsey Global Institute, 2018.
- [63] Chartered Institute of Personnel and Development (CIPD). *Age Diversity in SMEs: Reaping the Benefits*. Technical Report tcm18-10835. Accessed on Sunday 17th August, 2025. CIPD, 2014.
- [64] Statistics Netherlands (CBS). *What Is the Level of Education in the Netherlands?* <https://longreads.cbs.nl/the-netherlands-in-numbers-2024/what-is-the-level-of-education-in-the-netherlands/>. Retrieved April 2025. 2024.

- [65] Laura T. McLoughlin, Geertjan Overbeek, and Rutger C.M.E. Engels. "The Development of Autonomy and Independence During Adolescence". In: *Handbook of Adolescent Development Research and Its Impact on Global Policy*. Ed. by Jennifer E. Lansford and Prerna Banati. Accessed June 2025. Springer, 2021, pp. 243–261.
- [66] Statistics Netherlands (CBS). *Households; Size, Composition, Position in the Household, 1 January*. Accessed June 2025. 2024.
- [67] Statistics Netherlands (CBS). *Income Distribution in the Netherlands*. Accessed June 2025. 2024.
- [68] Statistics Netherlands (CBS). *80 percent of adults have a driving licence*. Accessed June 2025. 2019.
- [69] Statistics Netherlands (CBS). *Mobility; travel behaviour of the Dutch population, 2018-2023*. Accessed June 2025. 2024.
- [70] Statista. *Number of Cars per 1,000 Inhabitants in the Netherlands from 1990 to 2022*. Accessed June 2025. 2024.
- [71] Peter Tobbin and Joseph Adjei. "Understanding the Characteristics of Early and Late Adopters of Technology: The Case of Mobile Money". In: *International Journal of E-Services and Mobile Applications* 4 (Aug. 2014).
- [72] Marco Boeri, Riccardo Scarpa, and Caspar Chorus. *Stated choices and benefit estimates in the context of traffic calming schemes: utility maximization, regret minimization, or both? Accepted in January 2014*. Jan. 2014.



A

Survey promotion poster



SHARED MOBILITY AT THE KEILECOLLECTIEF? IT'S HAPPENING!

HELP ME
GRADUATE!

WOULD YOU CONSIDER USING
SHARED MOBILITY?



LIA KONDOVA

Master student @ TU Delft,
doing a thesis on shared mobility
for Gemeente Rotterdam & the
KeileCollectief

PARTICIPATE & WIN!

Participate in my survey & have
the chance to win 1 of the 4
tickets (worth €89,95) to *Cinema
Culinair: What you see is what
you eat!*

The survey takes only 10 minutes!



MORE INFORMATION? EMAIL
LKONDOVA@GMAIL.COM



B

Survey printout

Shared Mobility @ the KeileCollectief

INTRODUCTION

- You are invited to participate in a research study regarding **shared mobility** at the KeileCollectief. This study is being carried out by Lia Kondova, as part of her **Master thesis at TU Delft**, in collaboration with the Municipality of Rotterdam. The purpose of this study is to understand the behavior of the employees of the companies of the KeileCollectief when it comes to using their **own vehicle versus a shared one** when carrying out **business-related trips** during their work day. The survey takes about **10-15 minutes** and by fully completing it **you can win a ticket to Cinema Culinaire** (more about this to follow). The data collected will be used for academic purposes and will not be shared anywhere or be used for promotional purposes. However, as with any online activity the risk of a breach is always possible. To the best of my ability your answers in this study will remain confidential and will be deleted by the end of the calendar year. I will minimize any risks by making the survey anonymous, unless stated by you otherwise - your email address will be collected only if you would like to compete for one of the 4 prizes. Your participation in this study is entirely voluntary and you can withdraw at any time.
- This survey consists of two parts. The first part will present you with different situations with changing characteristics, based on which you will be asked to make a choice for either your own car, a shared car or a shared bike. The second part consists of socio-demographic questions. Once submitted, your answers cannot be changed.
- **The deadline for submission is 27th May 2025**

•

* Required

Consent form

1

I have read the information above and I consent to participating in this survey.

Yes

No

Research background & winnable prize for participants

2

Purpose of research

- This research is part of a pilot study between the Municipality of Rotterdam, BMW, OnzeAuto and the KeilleCollectief regarding the introduction of **shared mobility** in the area.
- The pilot aims to ideally **prevent traffic overload** and **reduce on-street parking** in the area, opening space for the realization of other possibilities for recreational, commercial and residential purposes.
- The following 4 pictures (the bottom two of which have been generated with AI) illustrate how the area could potentially change.

*



I understand

3

- By completing this survey and providing your email below, you get the chance to win 1 of the 4 tickets for **Cinema Culinaire: What you see is what you eat** (worth €89.95).
- The winners will be chosen at random.
- Write "-" if you want to remain anonymous (then however we won't be able to find you and give you a prize)

*



PART 1: Choice situations

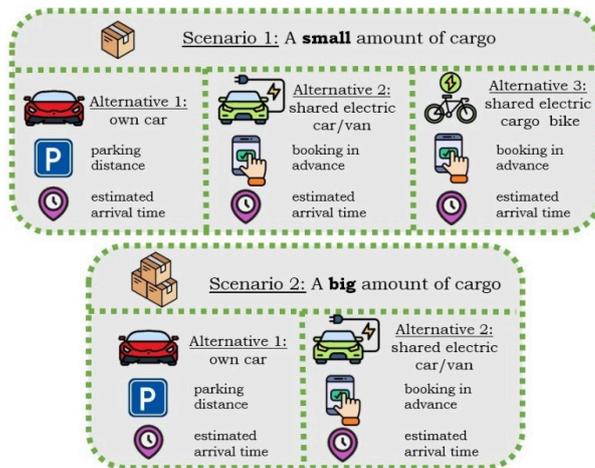
- During your work day it is imaginable that you have to go on **business-related trips** (for example delivering/picking up products, having meetings in an external location, etc.). Based on these trips, you have chosen your **mode of transport from home to work** (for example walking, public transport, your own car or bike, etc.).
- Would you **change your travel behaviour** if you can no longer park your own car close to the KeilePand (in case you come by car)? Would you instead come to work by another mode of transport and take a shared vehicle when necessary for your business-related trips?

4

Choice situations description

- You are presented with **2 scenarios**:
 - one where you have a **small amount of cargo** for your business trips (for example a backpack with a laptop)
 - one where you have a **lot of cargo** (for example you are delivering furniture to a client).
- You have a few **alternatives**:
 - In the **first scenario**, you have **3 alternatives**:
 - coming to work with your **own car**, and using it for your business-related trips during the day
 - coming to work by other modes of transport and using a **shared electric car/van** when you have a business-related trip
 - coming to work by other modes of transport and using a **shared electric cargo bike** when you have a business-related trip
 - In the **second scenario**, you have the first two alternatives only.
- Each alternative has a combination of the following **characteristics** and their levels:
 - **parking distance**: how far away from the KeilePand you can park your own car
 - park "50 meters" away from KeilePand
 - "200 meters"
 - "400 meters"
 - **estimated arrival time**: how much in advance/late/on time you will arrive in comparison with your estimated arrival time to your business trip destination (starting from the KeilePand)
 - "-10 min" - meaning you arrive 10 minutes earlier than you anticipated
 - "0 min" - you arrive around the same time you anticipated
 - "+10 min" - it takes you 10 minutes more than anticipated
 - **booking in advance**: how much in advance you have to book a shared vehicle to ensure it will be available when you need it
 - "0 min" - you walk out of the KeilePand and the shared vehicle is ready for you to take (maybe you need 30 seconds to book it via the app)
 - book "30 min" in advance to ensure the vehicle is available when you need it
 - book "60 min" in advance

*



I understand

5

Important notes for all scenarios and choice situations:

- You can use the shared vehicles **charge-free**. You have to pay for your own car (in case you come to work by car).
- The **shared vehicles are parked right in front of the KeilePand**, thus parking is always within a few meters of the front door.
- After being used, **shared vehicles must be returned back to the KeilePand**.

*

I understand

- **The default scenario is that you come to work with your own car every day.** (In case that you don't, for the sake of this research, please imagine that you do)
- You are presented with different choice situations, where you are asked to assess the presented situation and choose the option that you think makes the most sense to you, depending on the characteristics of the situation. PLEASE CHOOSE THE BEST ALTERNATIVE AS YOU WOULD ACTUALLY CHOOSE IN REAL LIFE, as any other answers would compromise this research.
- For example, the picture below illustrates the following situation. You have to go on a business trip during your work day. You can choose one of the following three alternatives:
 - 1) Go with your **own car**, which is parked 400 meters from the Keilepand and you will arrive about the same time as you expected
 - 2) Go with the **shared car/van** (which is parked right in front of the KeilePand), having to first book the car 60 minutes before you would like to use it, and you will arrive 10 minutes earlier than estimated (maybe in the future there is a priority lane for shared cars, thus making the shared car arrive faster than the personal car)
 - 3) Go with the **shared cargo bike** (which is parked right in front of the KeilePand), having to first book the bike 30 minutes before you would like to use it, and you will arrive 10 minutes later than estimated.
- What would you choose? Which option makes the most sense to you?

*



I understand

SCENARIO 1: Small amount of cargo

7

Situation 1 *

		
 200 m	 0 min	 0 min
 +10 min	 0 min	 0 min

- 1
- 2
- 3

8

Situation 2 *

		
 400 m	 60 min	 0 min
 -10 min	 0 min	 0 min

- 1
- 2
- 3

Situation 3 *

		
 50 m	 0 min	 30 min
 0 min	 -10 min	 +10 min

- 1
- 2
- 3

Situation 4 *

		
 50 m	 30 min	 60 min
 -10 min	 +10 min	 0 min

- 1
- 2
- 3

Situation 5 *

		
 50 m	 60 min	 30 min
 0 min	 +10 min	 +10 min

- 1
- 2
- 3

Situation 6 *

		
 400 m	 60 min	 30 min
 0 min	 -10 min	 +10 min

- 1
- 2
- 3

Situation 7 *

		
 200 m	 60 min	 60 min
 +10 min	 0 min	 -10 min

- 1
- 2
- 3

Situation 8 *

		
 200 m	 30 min	 0 min
 +10 min	 +10 min	 -10 min

- 1
- 2
- 3

Situation 9 *

		
 400 m	 0 min	 60 min
 -10 min	 0 min	 -10 min

- 1
- 2
- 3

Situation 10 *

		
 50 m	 30 min	 0 min
 -10 min	 -10 min	 -10 min

- 1
- 2
- 3

Situation 11 *

		
 400 m	 0 min	 30 min
 0 min	 +10 min	 +10 min

- 1
- 2
- 3

Situation 12 *

		
 200 m	 30 min	 60 min
 +10 min	 -10 min	 0 min

- 1
- 2
- 3

SCENARIO 2: A lot of cargo

19

Situation 1 *

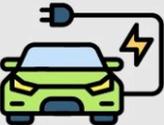
	
 50 m	 0 min
 -10 min	 -10 min

1

2

20

Situation 2 *

	
 400 m	 30 min
 0 min	 -10 min

1

2

Situation 3 *

	
 200 m	 60 min
 +10 min	 -10 min

1

2

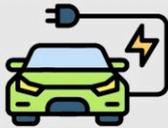
Situation 4 *

	
 200 m	 0 min
 0 min	 0 min

1

2

Situation 5 *

	
 50 m	 30 min
 +10 min	 0 min

1

2

Situation 6 *

	
 400 m	 60 min
 -10 min	 0 min

1

2

Situation 7 *

	
 400 m	 0 min
 +10 min	 +10 min

1

2

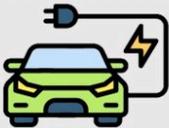
Situation 8 *

	
 200 m	 30 min
 -10 min	 +10 min

1

2

Situation 9 *

	
 50 m	 60 min
 0 min	 +10 min

1

2

PART 2: Demographic questions

In this part you will be asked some personal questions, which will be used for better understanding the reasons for your mode choices. **This data will not be shared publicly!**

28

What is your gender? *

- Woman
- Man
- Other
- Prefer not to say

29

What is your age? *

- < 18
- 18 - 24
- 25 - 34
- 35 - 44
- 45 - 54
- 55 - 64
- > 65

30

What is the highest education level you have attained? *

- Lower than Primary education
- Primary education
- Vocational education (or vmbo, mbo1, havo undergrad, vwo undergrad)
- Intermediate vocational education (or havo, atheneum, gymnasium, mbo2, mbo3, mbo4)
- Bachelor degree
- Master degree
- Higher than Master degree

31

What is your employment type? *

- Part-time (< 35 hours/week)
- Full-time (> 35 hours/week)
- Other

32

What is your yearly income? *

- < 20,000 euro
- 20,000 - 40,000 euro
- 40,001 - 60,000 euro
- 60,001 - 80,000 euro
- > 80,000 euro
- Prefer not to say

33

How far away from your workplace do you live? *

- < 1 km
- 1 - 5 km
- 6 - 10 km
- 10 - 25 km
- > 25 km

34

What is your household situation? *

- Single adult, no child(ren) under 13 years old
- Single adult, with child(ren) under 13 years old
- Multiple adults, no child(ren) under 13 years old
- Multiple adults, with child(ren) under 13 years old

35

Do you have a driver's license? *

- Yes
- No

36

How many cars do you have in your household? *

- 0
- 1
- 2
- 3 or more

Do you have any physical limitations (for example, disabilities or chronic conditions)? *

- Yes
- No
- Prefer not to say

How important is it for you to feel like you belong to a community when you are at your workplace? *(Here community refers to the sense of social belonging and shared identity among the employees of the KeileCollectief, a sense which can foster environmentally responsible behaviors such as the adoption of shared mobility.)* *

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

Not important at all

Extremely important

Travel behaviour questions

This part of the survey aims to understand the mode choice attitude among the employees of the Keilepand.

39

During an average month, how often do you travel with your own car to work (if you have a car)? *

- Never
- Rarely
- Most of the time
- Every day
- I don't have a car

40

If you go on business-related trips during your work day, how far away are they usually from the KeilePand? *

- < 1 km
- 2 - 5 km
- 6 - 10 km
- 11 - 20 km
- > 20 km
- I don't go on business-related trips.

41

During an average month, how often do you need to do business-related trips during work hours? These can be related to picking up or delivering goods somewhere, or having meetings outside of your workplace, during work hours. *

- Never
- Rarely
- Most of the days
- Every day

42

Rate the following statement: "When making a choice of the transport mode I will use on my way to work, **I consider its benefits on my health**". *

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

Completely disagree

Completely agree

43

Rate the following statement: "When making a choice of the transport mode I will use on my way to work, **I consider its environmental effects**". *

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

Completely disagree

Completely agree

Rate the following statement: "When making a choice of the transport mode I will use on my way to work, **I consider the weather conditions through the day**". *

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

Completely disagree

Completely agree

The end!!!

Thank you for participating in this survey! This will not only help the Municipality of Rotterdam and the KeileCollectief with better understanding the attitudes towards shared mobility, but will also help me (Lia) graduate! And you competed for a chance to win a ticket for Cinema Culinair! Best of luck with winning! Have a nice day!

This content is neither created nor endorsed by Microsoft. The data you submit will be sent to the form owner.

 Microsoft Forms



C

Ngene code

Ngene code for scenario 1

Design

```
;alts =  
  private_car,  
  shared_car,  
  shared_bike  
  
;rows = 12  
;orth = sim  
  
;model:  
  
U(private_car) =  
  c_pc +  
  pd_pc * parking_distance [50,200,400] +  
  at_pc * arrival_time [-10,0,10] /  
  
U(shared_car) =  
  c_sc +  
  ab_sc * advanced_booking [0,30,60] +  
  at_sc * arrival_time [-10,0,10] /  
  
U(shared_bike) =  
  ab_sb * advanced_booking [0,30,60] +  
  at_sb * arrival_time [-10,0,10]
```

\$

Ngene code for scenario 2

Design

```
;alts =  
  private_car,  
  shared_car  
  
;rows = 9  
;orth = sim  
  
;model:  
  
U(private_car) =  
  c_pc +  
  pd_pc * parking_distance [50,200,400] +  
  at_pc * arrival_time [-10,0,10] /  
  
U(shared_car) =  
  c_sc +  
  ab_sc * advanced_booking [0,30,60] +  
  at_sc * arrival_time [-10,0,10] /
```

\$



D

Choice tasks

D.1. Choice tasks for scenario 1

Figure D.1: Choice tasks for scenario 1

Design	private_car.parking_distance	private_car.arrival_time	shared_car.advanced_booking	shared_car.arrival_time	shared_bike.advanced_booking	shared_bike.arrival_time
1	200	10	0	0	0	0
2	400	-10	60	0	0	0
3	50	0	0	-10	30	10
4	50	-10	30	10	60	0
5	50	0	60	10	30	10
6	400	0	60	-10	30	10
7	200	10	60	0	60	-10
8	200	10	30	10	0	-10
9	400	-10	0	0	60	-10
10	50	-10	30	-10	0	-10
11	400	0	0	10	30	10
12	200	10	30	-10	60	0

D.2. Choice tasks for scenario 2

Figure D.2: Choice tasks for scenario 2

Design	private_car.parking_distance	private_car.arrival_time	shared_car.advanced_booking	shared_car.arrival_time
1	50	-10	0	-10
2	400	0	30	-10
3	200	10	60	-10
4	200	0	0	0
5	50	10	30	0
6	400	-10	60	0
7	400	10	0	10
8	200	-10	30	10
9	50	0	60	10



E

Python code for the MNL models

E.1. Scenario 1: Small amount of cargo

E.1.1. Model 1.1: Base model

```
# Biogeme
import biogeme.database as db
import biogeme.biogeme as bio
from biogeme.expressions import Beta, Variable, log
from biogeme import models

# General Python packages
import pandas as pd
import numpy as np

pd.set_option('display.max_columns', None)

# -----
# LOAD DATA
# -----

file_path = "[FILE PATH]"

df = pd.read_csv(file_path)

# Ensure CHOICE and alt_id are integers
df['choice'] = df['choice'].astype(int)

# Optional: rescale if needed
df['private_car.parking_distance'] = df['private_car.parking_distance'] / 100
df['private_car.arrival_time'] = df['private_car.arrival_time'] / 5

df['shared_car.advanced_booking'] = df['shared_car.advanced_booking'] / 30
df['shared_car.arrival_time'] = df['shared_car.arrival_time'] / 5

df['shared_bike.advanced_booking'] = df['shared_bike.advanced_booking'] / 30
df['shared_bike.arrival_time'] = df['shared_bike.arrival_time'] / 5

# -----
# BIOGEME SETUP
```

```

# -----

biodata = db.Database("[DATABASE NAME]", df)

# -----
# DEFINE VARIABLES
# -----

choice = Variable('choice')
private_car_parking_distance = Variable('private_car.parking_distance')
private_car_arrival_time = Variable('private_car.arrival_time')
shared_car_advanced_booking = Variable('shared_car.advanced_booking')
shared_car_arrival_time = Variable('shared_car.arrival_time')
shared_bike_advanced_booking = Variable('shared_bike.advanced_booking')
shared_bike_arrival_time = Variable('shared_bike.arrival_time')

# -----
# DEFINE PARAMETERS
# -----

ASC_pc = Beta('ASC_pc', 0, None, None, 1)
B_pd_pc = Beta('B_pd_pc', 0, None, None, 0)
B_at_pc = Beta('B_at_pc', 0, None, None, 0)

ASC_sc = Beta('ASC_sc', 0, None, None, 0)
B_ab_sc = Beta('B_ab_sc', 0, None, None, 0)
B_at_sc = Beta('B_at_sc', 0, None, None, 0)

ASC_sb = Beta('ASC_sb', 0, None, None, 0)
B_ab_sb = Beta('B_ab_sb', 0, None, None, 0)
B_at_sb = Beta('B_at_sb', 0, None, None, 0)

V1 = ASC_pc
    + B_pd_pc * private_car_parking_distance
    + B_at_pc * private_car_arrival_time

V2 = ASC_sc
    + B_ab_sc * shared_car_advanced_booking
    + B_at_sc * shared_car_arrival_time

V3 = ASC_sb
    + B_ab_sb * shared_bike_advanced_booking
    + B_at_sb * shared_bike_arrival_time

V = {1: V1, 2: V2, 3: V3}
av = {1: 1, 2: 1, 3: 1}

# -----
# ESTIMATION
# -----

logprob = models.loglogit(V,av,choice)
biogeme = bio.BIOGEME(biodata,logprob)
biogeme.modelName = "[MODEL NAME]"
biogeme.saveIterations = False

```

```

biogeme.generate_pickle = False
biogeme.generateHtml = True
results = biogeme.estimate()
parameters = results.get_estimated_parameters()
statistics = pd.DataFrame(data=results.get_general_statistics()).transpose()

```

E.1.2. Model 1.2: Extended model

```

# Biogeme
import biogeme.database as db
import biogeme.biogeme as bio
from biogeme.expressions import Beta, Variable, log
from biogeme import models

# General Python packages
import pandas as pd
import numpy as np

pd.set_option('display.max_columns', None)

# -----
# LOAD DATA
# -----

file_path = "[FILE PATH]"
df = pd.read_csv(file_path)

df['choice'] = df['choice'].astype(int)

df['private_car.parking_distance'] = df['private_car.parking_distance'] / 100
df['private_car.arrival_time'] = df['private_car.arrival_time'] / 5
df['shared_car.advanced_booking'] = df['shared_car.advanced_booking'] / 30
df['shared_car.arrival_time'] = df['shared_car.arrival_time'] / 5
df['shared_bike.advanced_booking'] = df['shared_bike.advanced_booking'] / 30
df['shared_bike.arrival_time'] = df['shared_bike.arrival_time'] / 5

# -----
# BIOGEME SETUP
# -----

biodata = db.Database("[DATABASE NAME]", df)

# -----
# DEFINE VARIABLES
# -----

choice = Variable('choice')
private_car_parking_distance = Variable('private_car.parking_distance')
private_car_arrival_time = Variable('private_car.arrival_time')
shared_car_advanced_booking = Variable('shared_car.advanced_booking')
shared_car_arrival_time = Variable('shared_car.arrival_time')
shared_bike_advanced_booking = Variable('shared_bike.advanced_booking')
shared_bike_arrival_time = Variable('shared_bike.arrival_time')

```

```

# DUMMY VARIABLES
COMMUNITY_BIN_1 = Variable("COMMUNITY_BIN_1")
COMMUNITY_BIN_2 = Variable("COMMUNITY_BIN_2")
COMMUNITY_BIN_3 = Variable("COMMUNITY_BIN_3")
COMMUNITY_BIN_4 = Variable("COMMUNITY_BIN_4")
COMMUNITY_BIN_5 = Variable("COMMUNITY_BIN_5")

AGE_Under18 = Variable("AGE_Under18")
AGE_18_24 = Variable("AGE_18-24")
AGE_25_34 = Variable("AGE_25-34")
AGE_35_44 = Variable("AGE_35-44")
AGE_45_54 = Variable("AGE_45-54")
AGE_55_64 = Variable("AGE_55-64")
AGE_Over65 = Variable("AGE_Over65")

GENDER_Woman = Variable("GENDER_Woman")
GENDER_Man = Variable("GENDER_Man")
GENDER_Other = Variable("GENDER_Other")

# -----
# DEFINE PARAMETERS
# -----

ASC_pc = Beta('ASC_pc', 0, None, None, 1)
B_pd_pc = Beta('B_pd_pc', 0, None, None, 0)
B_at_pc = Beta('B_at_pc', 0, None, None, 0)

ASC_sc = Beta('ASC_sc', 0, None, None, 0)
B_ab_sc = Beta('B_ab_sc', 0, None, None, 0)
B_at_sc = Beta('B_at_sc', 0, None, None, 0)

ASC_sb = Beta('ASC_sb', 0, None, None, 0)
B_ab_sb = Beta('B_ab_sb', 0, None, None, 0)
B_at_sb = Beta('B_at_sb', 0, None, None, 0)

# COMMUNITY (base = 1)
B_pc_comm_1 = Beta('B_pc_comm_1', 0, None, None, 1)
B_pc_comm_2 = Beta('B_pc_comm_2', 0, None, None, 0)
B_pc_comm_3 = Beta('B_pc_comm_3', 0, None, None, 0)
B_pc_comm_4 = Beta('B_pc_comm_4', 0, None, None, 0)
B_pc_comm_5 = Beta('B_pc_comm_5', 0, None, None, 0)

B_sc_comm_1 = Beta('B_sc_comm_1', 0, None, None, 1)
B_sc_comm_2 = Beta('B_sc_comm_2', 0, None, None, 0)
B_sc_comm_3 = Beta('B_sc_comm_3', 0, None, None, 0)
B_sc_comm_4 = Beta('B_sc_comm_4', 0, None, None, 0)
B_sc_comm_5 = Beta('B_sc_comm_5', 0, None, None, 0)

B_sb_comm_1 = Beta('B_sb_comm_1', 0, None, None, 1)
B_sb_comm_2 = Beta('B_sb_comm_2', 0, None, None, 0)
B_sb_comm_3 = Beta('B_sb_comm_3', 0, None, None, 0)
B_sb_comm_4 = Beta('B_sb_comm_4', 0, None, None, 0)
B_sb_comm_5 = Beta('B_sb_comm_5', 0, None, None, 0)

# AGE (base = Under18)
B_pc_AGE_Under18 = Beta("B_pc_AGE_Under18", 0, None, None, 1)

```

```

B_pc_AGE_18_24 = Beta('B_pc_AGE_18_24', 0, None, None, 0)
B_pc_AGE_25_34 = Beta('B_pc_AGE_25_34', 0, None, None, 0)
B_pc_AGE_35_44 = Beta('B_pc_AGE_35_44', 0, None, None, 0)
B_pc_AGE_45_54 = Beta('B_pc_AGE_45_54', 0, None, None, 0)
B_pc_AGE_55_64 = Beta('B_pc_AGE_55_64', 0, None, None, 0)
B_pc_AGE_Over65 = Beta('B_pc_AGE_Over65', 0, None, None, 0)

B_sc_AGE_Under18 = Beta('B_sc_AGE_Under18', 0, None, None, 1)
B_sc_AGE_18_24 = Beta('B_sc_AGE_18_24', 0, None, None, 0)
B_sc_AGE_25_34 = Beta('B_sc_AGE_25_34', 0, None, None, 0)
B_sc_AGE_35_44 = Beta('B_sc_AGE_35_44', 0, None, None, 0)
B_sc_AGE_45_54 = Beta('B_sc_AGE_45_54', 0, None, None, 0)
B_sc_AGE_55_64 = Beta('B_sc_AGE_55_64', 0, None, None, 0)
B_sc_AGE_Over65 = Beta('B_sc_AGE_Over65', 0, None, None, 0)

B_sb_AGE_Under18 = Beta('B_sb_AGE_Under18', 0, None, None, 1)
B_sb_AGE_18_24 = Beta('B_sb_AGE_18_24', 0, None, None, 0)
B_sb_AGE_25_34 = Beta('B_sb_AGE_25_34', 0, None, None, 0)
B_sb_AGE_35_44 = Beta('B_sb_AGE_35_44', 0, None, None, 0)
B_sb_AGE_45_54 = Beta('B_sb_AGE_45_54', 0, None, None, 0)
B_sb_AGE_55_64 = Beta('B_sb_AGE_55_64', 0, None, None, 0)
B_sb_AGE_Over65 = Beta('B_sb_AGE_Over65', 0, None, None, 0)

# GENDER (base = Woman)
B_pc_GENDER_Woman = Beta('B_pc_GENDER_Woman', 0, None, None, 1)
B_pc_GENDER_Man = Beta('B_pc_GENDER_Man', 0, None, None, 0)
B_pc_GENDER_Other = Beta('B_pc_GENDER_Other', 0, None, None, 0)

B_sc_GENDER_Woman = Beta('B_sc_GENDER_Woman', 0, None, None, 1)
B_sc_GENDER_Man = Beta('B_sc_GENDER_Man', 0, None, None, 0)
B_sc_GENDER_Other = Beta('B_sc_GENDER_Other', 0, None, None, 0)

B_sb_GENDER_Woman = Beta('B_sb_GENDER_Woman', 0, None, None, 1)
B_sb_GENDER_Man = Beta('B_sb_GENDER_Man', 0, None, None, 0)
B_sb_GENDER_Other = Beta('B_sb_GENDER_Other', 0, None, None, 0)

# -----
# DEFINE UTILITY FUNCTIONS
# -----

V1 = ASC_pc
    + B_pd_pc * private_car_parking_distance
    + B_at_pc * private_car_arrival_time
    + B_pc_comm_2 * COMMUNITY_BIN_2
    + B_pc_comm_3 * COMMUNITY_BIN_3
    + B_pc_comm_4 * COMMUNITY_BIN_4
    + B_pc_comm_5 * COMMUNITY_BIN_5
    + B_pc_AGE_18_24 * AGE_18_24
    + B_pc_AGE_25_34 * AGE_25_34
    + B_pc_AGE_35_44 * AGE_35_44
    + B_pc_AGE_45_54 * AGE_45_54
    + B_pc_AGE_55_64 * AGE_55_64
    + B_pc_AGE_Over65 * AGE_Over65
    + B_pc_GENDER_Man * GENDER_Man
    + B_pc_GENDER_Other * GENDER_Other

```

```

V2 = ASC_sc
+ B_ab_sc * shared_car_advanced_booking
+ B_at_sc * shared_car_arrival_time
+ B_sc_comm_2 * COMMUNITY_BIN_2
+ B_sc_comm_3 * COMMUNITY_BIN_3
+ B_sc_comm_4 * COMMUNITY_BIN_4
+ B_sc_comm_5 * COMMUNITY_BIN_5
+ B_sc_AGE_18_24 * AGE_18_24
+ B_sc_AGE_25_34 * AGE_25_34
+ B_sc_AGE_35_44 * AGE_35_44
+ B_sc_AGE_45_54 * AGE_45_54
+ B_sc_AGE_55_64 * AGE_55_64
+ B_sc_AGE_Over65 * AGE_Over65
+ B_sc_GENDER_Man * GENDER_Man
+ B_sc_GENDER_Other * GENDER_Other

V3 = ASC_sb
+ B_ab_sb * shared_bike_advanced_booking
+ B_at_sb * shared_bike_arrival_time
+ B_sb_comm_2 * COMMUNITY_BIN_2
+ B_sb_comm_3 * COMMUNITY_BIN_3
+ B_sb_comm_4 * COMMUNITY_BIN_4
+ B_sb_comm_5 * COMMUNITY_BIN_5
+ B_sb_AGE_18_24 * AGE_18_24
+ B_sb_AGE_25_34 * AGE_25_34
+ B_sb_AGE_35_44 * AGE_35_44
+ B_sb_AGE_45_54 * AGE_45_54
+ B_sb_AGE_55_64 * AGE_55_64
+ B_sb_AGE_Over65 * AGE_Over65
+ B_sb_GENDER_Man * GENDER_Man
+ B_sb_GENDER_Other * GENDER_Other

V = {1: V1, 2: V2, 3: V3}
av = {1: 1, 2: 1, 3: 1}

# -----
# ESTIMATION
# -----

logprob = models.loglogit(V, av, choice)
biogeme = bio.BIOGEME(biodata, logprob)
biogeme.modelName = "[MODEL NAME]"
biogeme.saveIterations = False
biogeme.generate_pickle = False
biogeme.generateHtml = True

results = biogeme.estimate()
parameters = results.get_estimated_parameters()
statistics = pd.DataFrame(data=results.get_general_statistics()).transpose()

```



F

Scientific Paper

Understanding Transport Mode Choice for Business-Related Trips Among SME Employees: A Stated Choice Experiment at the KeileCollectief

L.D. (Lia) Kondova

Delft University of Technology, the Netherlands

August 17, 2025

Abstract

This research investigates how employees of small-to-medium-sized enterprises (SMEs) in urban redevelopment areas make transport mode choices for business-related trips, using the KeileCollectief pilot in Rotterdam as a case study. Drawing on a literature review, expert interviews, and a stated choice experiment (SCE) analyzed through discrete choice modeling, the study identifies the influence of both operational and socio-demographic factors on shared mobility adoption. Key attributes examined include parking distance, booking time, and arrival time deviation, alongside variables such as age, gender, and community belonging. Results reveal that shorter booking times, reduced parking distances, and minimal arrival time deviations increase the likelihood of selecting shared mobility modes over private cars. However, socio-demographic effects were less consistent, challenging common assumptions about their role in mode choice. The findings provide actionable recommendations for municipalities and mobility providers, including tailoring shared mobility solutions to context-specific needs and improving usability to encourage adoption. This research contributes to the shared mobility literature by focusing on SME contexts while also offering methodological insights for stated choice experiment design in localized urban mobility studies.

1 INTRODUCTION

Throughout the 20th century, the automobile played a key role in societal development - technologically, economically, environmentally, socially, culturally, and politically [26]. As cars became abundant in cities, congestion and environmental issues emerged [37]. Today, cities like Rotterdam face increasing space demand from economic growth, population expansion, and sustainability transitions [36]. The Municipality's Environmental Vision and Mobility Approach aim to reduce private car use, promote walking, cycling, and public transport, and introduce shared mobility [29, 4].

While residential areas and large companies have targeted shared mobility policies, SMEs remain overlooked. The KeileCollectief pilot aims to fill this gap by understanding SME employees' attitudes towards shared mobility. The KeileCollectief is located in the redeveloping MerweVierHavens area ("M4H") - a hub for sustainable innovation and cultural regeneration [3, 5, 28]. The pilot, initiated with the Municipality of Rotterdam and BMW, tests how shared mobility affects behavior in a closed SME community [2, 35, 38]. The goal is to identify factors influencing transport mode choice for business-related trips, supported

by a literature review. The literature highlights socio-demographic, mode-specific, contextual, and psychological factors influencing mode choice (Figure 1) [7, 24, 6, 39, 18, 17, 12, 16, 14, 33, 13]. In order to address the practical and the scientific research gaps, the following main and sub-research questions have been formulated:

How do the employees of small-to-medium-sized enterprises (SMEs) make transport mode choices for business-related trips?

- *Which factors are relevant when it comes to choosing between shared mobility options and private car usage at the KeileCollectief?*
- *How do these factors, in combination with the aspect of workplace community values, shape mode choice for the KeileCollectief employees?*
- *What lessons from the KeileCollectief pilot can inform the design of shared mobility policies targeting SMEs?*

2 METHODOLOGY

2.1 Expert Interviews

To make these factors more relevant for SMEs in Rotterdam, the case of the KeileCollectief became an integral part of this project. In order to gain some initial insights into the mobility patterns of the KeileCollectief employees, expert interviews were conducted. The interviews revealed that travel time, parking availability, and ease of use were key factors when making a choice for the business-related trips of the employees. Household situation and physical limitations were important socio-demographic aspects. Contextual and psychological factors included weather conditions, health benefits, environmental effects, and individual habits. Unique factors mentioned were cargo amount and home-work distance. A visualization of the interplay between these factors, as well as the ones found in scientific literature is provided in Figure 2.

2.2 Stated Choice Experiments

By narrowing down the factors affecting the employees of the KeileCollectief when making a mode choice, the expert interviews and literature review formed the foundation for constructing stated choice experiments (SCE) [10]. The aim of such experiments is to explore the trade-offs between factors, which is particularly useful in situations where no historical data is available [23]. In this context, the target audience is presented with hypothetical choice scenarios, each described by attributes and their levels, encapsulated in so-called scenarios [31]. Alternatives can be labeled, as with different modes of transportation, or unlabeled, as with generic service plans [10].

For this research, three labeled alternatives were considered: the employees' own private car, a shared electric car/van, and a shared electric cargo bike, as defined in the Municipality's KeileCollectief Pilot Brief. The car and van were combined into a single alternative to reduce the number of tasks, a necessary step to maintain feasibility with the smaller expected SME sample. The distinction between a bigger shared mode (car/van) and a smaller one (cargo bike) became relevant when considering the amount of cargo. Therefore, two scenarios were created: "small amount of cargo," feasible for a cargo bike, and "big amount of cargo," which required a car or van.

The attributes chosen were "parking distance," "arrival time deviation," and "booking in advance". Parking distance was aligned with the Municipality's strategy to relocate private parking further away, with levels at 50 m, 200 m, and 400 m [34]. Arrival time deviation was chosen instead of absolute travel time to avoid inconsistencies between respondents with different trip destinations, with levels at -10, 0, and +10 minutes. The threshold of 10 minutes was justified by walking distances of up to 400 m, which typically take about 5-10 minutes [34]. Booking in advance reflected the trade-off between vehicle availability and ease of use, with levels of 0, 30, and 60 minutes.

Mode-specific factors	Socio-demographic factors	Contextual factors	Psychological factors
Vehicle purchase price	Age	Temperature	Driving pleasure
Fuel cost	Gender	Precipitation	Habit
Maximum range of the vehicle	Income level	Wind speed	Innovation attitude
Fuel consumption	Education level	Weather conditions	Privacy concerns
Travel time	Employment status	Urban design	Health benefits
Commuting expense	Vehicle ownership		Perceived safety
Vehicle availability	Number of cars in the household		Environmental responsibility
Parking availability	Household type		
Parking rate	Household size		
Ease of use	Marital status		
	Family situation		
	Health		
	Physical limitations		

Figure 1: Factors from the reviewed literature

The construction of choice tasks was carried out using Ngenex [31]. A decision was made to estimate only main effects, since these allow for fewer tasks, are better suited for small sample sizes, and are easier to interpret [10, 19, 20]. Interaction effects, by contrast, often provide marginal improvements while increasing risks of multicollinearity in transport contexts. In terms of design, a fractional factorial orthogonal design was chosen, ensuring zero correlation between attributes while reducing the number of tasks [10, 23]. The labeled nature of the alternatives required simultaneous construction of choice sets. In total, 21 tasks were generated: 12 for the small cargo scenario and 9 for the big cargo scenario. These were later embedded into the survey instrument to capture respondents’ preferences.

2.3 Survey

The survey design began with platform selection, where Microsoft Forms was chosen for its GDPR compliance and integration within the TU Delft environment [22]. Special attention was paid to language clarity and accessibility, avoiding jargon to ensure respondents with diverse profiles could easily participate. For example, the attribute was framed as “ease of booking” instead of “booking difficulty” to avoid bias. Visual presentation was equally important, relying on consistent heuristics, copyright-free symbols [15], and AI-generated images of the KeilePand to contextualize scenarios [30]. These visuals helped employees relate to the hypothetical situations, as suggested in the expert interviews.

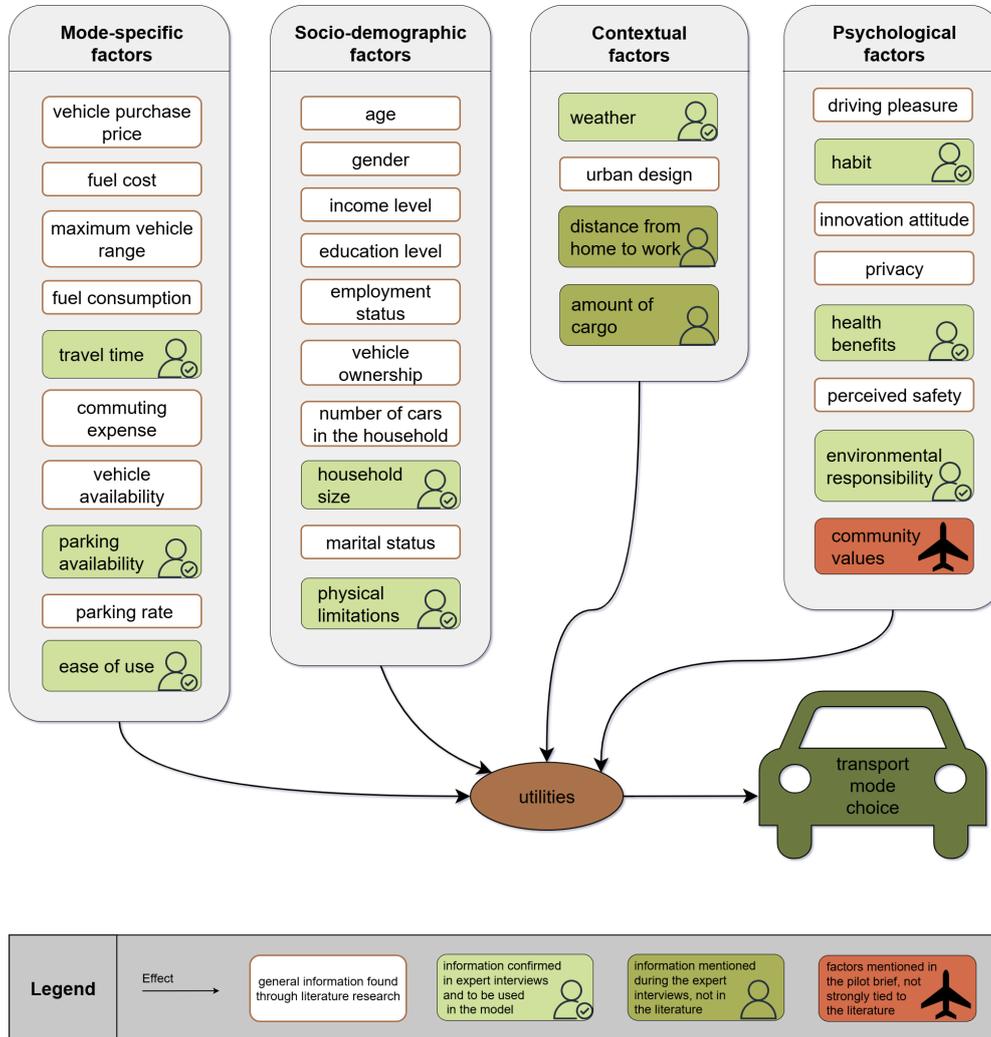


Figure 2: Factors affecting the choice of shared modes among SME employees

The survey consisted of five main parts. The first introduced the project, included a participation incentive (“Cinema Culinaire” tickets) [1], and obtained consent. The second explained the two cargo scenarios and three alternatives, along with their attributes. The third contained the 21 choice situations, designed to capture trade-offs between key factors identified in interviews. The fourth

part collected socio-demographic data such as age, gender, and income, reflecting the literature and expert feedback on influential covariates. The fifth part addressed current travel behavior, including primary mode, trip frequency, and environmental considerations, providing context for interpreting results. The survey concluded with a gratitude statement.

After design, a pilot version was distributed to academic and non-academic contacts, whose feedback improved clarity [30]. The final distribution strategy prioritized face-to-face contact at the KeilePand in May 2025, where employees received posters with QR codes linking to the survey. Posters used bright colors and creative visuals to align with the community’s spirit. While this method generated responses, it was challenging to reach all employees due to irregular attendance and limited institutional support. Consequently, an office newsletter was used to complement face-to-face efforts, contributing about 20% of the total responses [32].

2.4 Data Analysis

The analysis of discrete choices collected at the KeilePand was conducted using the Multinomial Logit (MNL) Model, which estimates which factors influence mode choice by assuming each alternative has an observable utility and a random error term [27, 11]. To prepare the data, Biogeme [8] was used, requiring the dataset to be transformed into long format, where each row represented a choice situation per respondent, including respondent ID, choice ID, chosen alternative, attribute levels, and socio-demographic dummies. This structure enabled the estimation of utility functions linking attributes and covariates to mode choice.

Because the experiment included two scenarios (small and big cargo), two separate base models were constructed with only the main effects of attributes: parking distance, arrival time, and booking in advance. Utility functions were specified for private car, shared car/van, and shared cargo bike, with the latter excluded from the big cargo scenario. Equations 1, 2 and 3 illustrate how the utility functions were constructed. Each base model was estimated using the MNL framework, with Rho-square values between 0.2 and 0.4 generally considered excellent [21].

$$\begin{aligned}
 V_1 = ASC_{pc} & \\
 & + \beta_{pd}^{pc} \cdot private_car_parking_distance \\
 & + \beta_{at}^{pc} \cdot private_car_arrival_time
 \end{aligned} \tag{1}$$

$$\begin{aligned}
 V_2 = ASC_{sc} & \\
 & + \beta_{ab}^{sc} \cdot shared_car_advanced_booking \\
 & + \beta_{at}^{sc} \cdot shared_car_arrival_time
 \end{aligned} \tag{2}$$

$$\begin{aligned}
 V_3 = ASC_{sb} & \\
 & + \beta_{ab}^{sb} \cdot shared_bike_advanced_booking \\
 & + \beta_{at}^{sb} \cdot shared_bike_arrival_time
 \end{aligned} \tag{3}$$

Before interpreting results, the required number of respondents was addressed. To ensure statistical validity, the minimum sample size was calculated, via incorporating the number of tasks, alternatives, and maximum attribute levels [25]. This ensured that enough responses were collected to make the models reliable and robust.

3 RESULTS

3.1 Sample Specifications

The survey sample consisted of 55 valid respondents, surpassing the minimum of 24 required. Gender distribution was almost equal, reflecting the Dutch workforce, while the largest age group was 25-34 years old, followed by 35-44 and 45-54, aligning broadly with SME demographics. Most employees had higher education (over 75%), which is above the Dutch workforce average, suggesting a more highly educated sample. About 80% lived in households without children under 13, and 10% reported a physical limitation. Income levels largely matched national patterns, with most employees earning €20K-€40K, but part-time versus full-time distributions diverged from the national average.

Around 80% of respondents held a driver's license, and about half regularly used a car for commuting, even though nearly half lived within 5 km of their workplace. Over half of households owned at least one car, though overall car ownership was lower than the national average. Regarding business travel, the largest group reported trips over 20 km, though such trips were generally infrequent, with one-fifth never making them. Environmental awareness influenced about half of the respondents' travel decisions, while 40% considered health in mode choice. Weather conditions had a stronger impact, influencing over 70% of the employees. Finally, about 65% highlighted the importance of community feeling in their work life. Together, these socio-demographic, mobility, and psychological factors form the baseline context for understanding SME employees' transport mode choices in the KeileCollectief.

3.2 Model outcomes

In the case of this research, lower Rho-square values of about 0.1 to 0.2 were achieved, which was an expected consequence of the low amount of survey respondents. An attempt was made to improve the model fit by expanding each of the basic models to also include the covariates age, gender and community sensitivity. Equations 4, 5 and 6 illustrate how this was the extended models built upon the base model utility function. Here, it is important to note that k , l and m are used to indicate the different community belonging types, age groups and types of genders, respectively.

$$\begin{aligned}
V_1 = ASC_{pc} & \\
& + \beta_{pd}^{pc} \cdot private_car_parking_distance \\
& + \beta_{at}^{pc} \cdot private_car_arrival_time \\
& + \sum_k \beta_k^{pc} \cdot COMMUNITY_BELONGING_k \\
& + \sum_l \beta_l^{pc} \cdot AGE_l \\
& + \sum_m \beta_m^{pc} \cdot GENDER_m
\end{aligned} \quad (4)$$

$$\begin{aligned}
V_2 = ASC_{sc} & \\
& + \beta_{ab}^{sc} \cdot shared_car_advanced_booking \\
& + \beta_{at}^{sc} \cdot shared_car_arrival_time \\
& + \sum_k \beta_k^{sc} \cdot COMMUNITY_BELONGING_k \\
& + \sum_l \beta_l^{sc} \cdot AGE_l \\
& + \sum_m \beta_m^{sc} \cdot GENDER_m
\end{aligned} \quad (5)$$

$$\begin{aligned}
V_3 = ASC_{sb} & \\
& + \beta_{ab}^{sb} \cdot shared_bike_advanced_booking \\
& + \beta_{at}^{sb} \cdot shared_bike_arrival_time \\
& + \sum_k \beta_k^{sb} \cdot COMMUNITY_BELONGING_k \\
& + \sum_l \beta_l^{sb} \cdot AGE_l \\
& + \sum_m \beta_m^{sb} \cdot GENDER_m
\end{aligned} \quad (6)$$

The Rho-square of the base model for the first scenario (small amount of cargo) is 0.06. Based on these estimates, the following insights can be derived:

- Respondents generally have a positive preference for the shared cargo bike over their own car.
- The longer in advance people have to make a booking for the shared cargo bike, the lower the chance becomes of them picking that alternative.
- The same applies for the shared car/van.
- The bigger the deviation between the estimated arrival time and the actual arrival time of a shared cargo bike, the lower the utility of the alternative.
- The same applies for the shared car/van alternative.
- The further people have to walk to a parking, the lower the probability becomes that they will select their own car.

After extending the model with the covariates age, gender and community sensitivity, the model goodness-of-fit improves - the Rho-square is now 0.153. Based on these estimates, the following insights can be derived:

- Increased booking time significantly decreases the utility of using a shared cargo bike or shared car/van.
- Greater deviation from the expected arrival time significantly reduces the probability of respondents choosing a shared cargo bike or shared car/van.
- The longer people have to walk to a parking, the lower the utility becomes of the private car alternative.
- Respondents aged 25-34, 35-44, 45-54 and 55-64 show a statistically significant preference for private cars. The group 65+ has the strongest preference for using their private car.
- In comparison with the under 18 group, all age groups dislike the idea of using the shared cargo bikes, except for the 55-64 group, where the evidence is inconclusive.
- Respondents over 65 significantly dislike using shared cars/vans.
- Respondents who are moderately insensitive, moderately sensitive, or very sensitive to a community feeling at work are less likely to choose private cars and more likely to choose shared cargo bikes.
- Neutral and moderately sensitive respondents are less likely to choose shared cars/vans over their own cars.

When estimating the base model for the second scenario (big amount of cargo), the Rho-square has a value of 0.166. Based on these estimates, the following insights can be derived:

- Respondents have a baseline preference for shared car/van, in comparison with private car.

- Later-than-expected arrival time affects both the private and the shared car/van, but especially the latter.
- Longer parking distance significantly reduces the attractiveness for the private car.

After extending the base model of the second scenario, an "excellent" goodness-of-fit is achieved with a Rho-square of 0.241. Based on these estimates, the following insights can be derived:

- Arrival time deviations for private car significantly reduce its utility.
- Delays for shared car/van significantly reduce its attractiveness.
- Longer parking distance strongly reduces the appeal of the private car.
- The 65+ group shows a strong preference for using their private car.
- Gender does not significantly affect mode choice.
- Community belonging does not significantly influence the choice between private and shared cars/vans.

4 DISCUSSION

4.1 Reflection on Model Setup Design

A key element in the experiment design was the use of "arrival time deviation" levels (-10, 0, +10 minutes). This abstraction was chosen over absolute travel times or distances, since employees have highly varied destinations. Using distances (e.g., "15 kilometers") would have biased results, as certain modes would be excluded by default (e.g., cycling long distances). While sub-scenarios combining cargo size and travel distance could have addressed this, the small sample size would not have supported such complexity. Thus, the punctuality-based framing was introduced, making tasks more realistic and avoiding survey fatigue. Lastly, the color schemes in the survey visuals carried no deliberate symbolic meaning.

4.2 Discussion of Model Outcomes

For the small cargo scenario, longer booking times consistently lowered the utility of shared modes, particularly cargo bikes and shared cars/vans. Arrival deviations reduced the attractiveness of shared modes but had little effect on private cars, which are perceived as more reliable. This reflects a general mistrust in shared modes compared to the control offered by private cars.

Demographic effects were modest. All age groups showed a preference for private cars, strongest among those 65+. Parking distance was the only factor reducing private car utility, suggesting that discouraging car use is necessary for shared modes to compete. Shared cargo bikes were broadly disliked, while shared cars/vans were met with neutrality - indicating potential to persuade younger groups with the right incentives. Gender showed no effect, likely influenced by contextual factors such as few respondents with young children. Community values produced ambiguous outcomes. While literature and policy assumptions linked community orientation with pro-social mobility choices, the results showed weak and inconsistent correlations. Strong or weak community orientation did not clearly predict shared mode use. This indicates that policy reliance on community values as a driver for shared mobility may be overstated.

Taken together, when transporting small cargo, socio-demographics and community values did not meaningfully shift preferences. Private cars remained dominant, with booking time as the main barrier to shared modes. Only increasing parking distance or ensuring time advantages for shared modes creates real trade-offs. For large cargo, results were similar: socio-demographic and community variables had little influence. Parking distance and travel time negatively affected private car utility, but booking time did not affect shared cars/vans—likely because larger-cargo users accept planning ahead. Nonetheless, respondents remained unconvinced of the benefits of shared mobility.

4.3 Reflection on Research Methodology Choice

The choice of stated choice experiments was supported by literature, but application at the KeileCollectief was constrained by the small respondent pool. This limited the number of scenarios and made blocking impossible [9]. With 21 scenarios, the design was still acceptable, and patterns in preferences emerged. Greater survey support from the KeileCollectief would have allowed a richer design and stronger results. Despite these constraints, the method was applied rigorously and yielded valuable insights.

4.4 Contribution to Scientific Literature

This study contributes by challenging assumptions in existing literature. Age and gender, often regarded as key determinants of shared mobility adoption, were not influential in this context. This suggests that socio-demographics are not universally explanatory and should not be treated as default predictors. Shared mobility research must account for local and cultural contexts rather than applying one-size-fits-all assumptions. For example, in the Netherlands, where gender roles are relatively balanced, gender did not shape mobility choices. In contrast, in Eastern European contexts, gender could play a larger role. This highlights the importance of context-specific modeling: theoretical completeness should not outweigh empirical relevance. Simplifying models by excluding irrelevant factors can yield clearer insights, especially in smaller-scale studies. Thus, this research supports the view that shared mobility modeling benefits from contextual tailoring and parsimonious design over unnecessary complexity.

5 CONCLUSION AND RECOMMENDATIONS

In conclusion, this research examined how employees of small-to-medium-sized enterprises (SMEs) in urban redevelopment areas choose transport modes for business-related trips, using the KeileCollectief pilot in Rotterdam as a case study. Guided by literature review, expert interviews, and a stated choice experiment (SCE) analyzed through discrete choice modeling, the study provided insights into the factors influencing shared mobility adoption in SME contexts.

Expert interviews identified operational factors as most decisive: advance booking for shared modes, parking distance for private cars, and arrival time deviations across all modes. Other influences included household size, physical limitations, weather, long-term habits, and perceived health or environmental benefits. These insights guided the SCE design by narrowing down the most relevant attributes. Despite expectations, community orientation showed no consistent or strong effect on mode choice. Together with age and gender, it played a limited role compared to operational barriers. This suggests that while communal identity may shape attitudes, it does not automatically translate into behavior when booking requirements or car convenience remain dominant. The main lesson is that shared mobility adoption depends on practical competitiveness with private cars. Reducing booking friction, improving vehicle availability, and discouraging car use through parking management are essential. Measures such as priority lanes could further increase the relative attractiveness of shared modes. At the same time, workplace “community” should not be assumed to automatically encourage collective transport choices.

Thus, the findings of this research show that even in a setting like the KeileCollectief, where innovation and community are emphasized, private cars remain dominant. Practical considerations—booking time, vehicle access, parking—outweigh ideological or collective motivations. Convenience remains the

deciding factor: when private cars are easy, shared modes struggle; when shared modes become easier, they gain traction. Community values alone do not overcome practical barriers. This raises a broader implication: if shared mobility adoption is challenging in a relatively progressive SME, it will likely be even harder at larger scales. Infrastructure and service provision alone are insufficient—policies must combine structural changes with efforts to shift mindsets. Employees should be actively involved and shown, in practical terms, the benefits of shared mobility, rather than being expected to adopt it based solely on community ideals.

Future research should build on these findings by:

- Repeating the experiment in other SMEs with larger sample sizes to test external validity and enable more complex model specifications.
- Expanding choice attributes to include reliability, comfort, or app interface quality, and comparing across more shared modes (e.g., e-scooters).
- Combining stated choice data with revealed preferences to capture real-world trade-offs.

Linking this to innovation theory, the current study mainly covered the knowledge and persuasion stages. Future work should explore the decision, implementation, and confirmation phases: how employees experience shared mobility in practice, what support structures help adoption, and which factors sustain or undermine long-term usage. Such insights would clarify how experimental willingness translates into durable behavioral change.

Lastly, while the results did not indicate widespread readiness for shared mobility in SMEs, they highlight the key operational and cultural barriers. Understanding these obstacles is a necessary step toward designing effective policies and workplace strategies. As cities evolve, shared mobility may gradually become more intuitive, but for now, progress depends on aligning rhetoric with practice - ensuring that both policy-makers and communities actively model the sustainable behaviors they seek to promote.

References

- [1] Diner en film — what you see is what you eat, cinema culinair. [Accessed 07-05-2025].
- [2] Keilecollectief. [Accessed 24-10-2024].
- [3] Merwe-vierhavens: van woestijn naar goudmijn'. <https://drift.eur.nl/app/uploads/2017/02/Gebiedsontwikkeling-Merwe-Vierhavens-Van-Woestijn-tot-Goudmijn.pdf>. [Accessed 23-10-2024].
- [4] Mobiliteitsaanpak. <https://www.rotterdam.nl/mobiliteitsaanpak>. [Accessed 07-11-2024].
- [5] The port that will take you ahead — Port of Rotterdam. <https://www.portofrotterdam.com/en/why-rotterdam/port-will-take-you-ahead>. [Accessed 22-10-2024].
- [6] Nuren Abedin, Md Mahmudur Rahman, Muhammad Ismail Hossain, Kenji Hisazumi, and Ashir Ahmed. Travel behavior of sme employees in their work commute in emerging cities: A case study in dhaka city, bangladesh. *Sustainability*, 12(24), 2020.
- [7] Eva Ayaragarnchanakul, Felix Creutzig, Aneeqe Javaid, and Nattapong Puttanapong. Choosing a mode in bangkok: Room for shared mobility? *Sustainability (Switzerland)*, 14(15), 2022. Cited by: 3; All Open Access, Gold Open Access.
- [8] Michel Bierlaire. *BIOGEME: A free package for the estimation of discrete choice models*. Swiss Association of Transportation Researchers, 2003. Accessed June 2025.
- [9] Marco Boeri, Riccardo Scarpa, and Caspar Chorus. Stated choices and benefit estimates in the context of traffic calming schemes: utility maximization, regret minimization, or both? accepted in january 2014, 01 2014.
- [10] ChoiceMetrics. Choicemetrics: Ngene 1.2 user manual and reference guide, 2018. [Accessed 09-05-2025].
- [11] C. Chorus. Choice behaviour modelling and the logit-model: What and how? Lecture Slides for the course Statistical Analysis of Choice Behaviour, 2021.
- [12] Madiha Shafique Dar, Shakoora Ahmed, and Abdul Raziq. Small and medium-size enterprises in pakistan: Definition and critical issues. *Pakistan Business Review*, page 46, April 2017.
- [13] Tim Edwards, Rick Delbridge, and Max Munday. Understanding innovation in small and medium-sized enterprises: a process manifest. *Technovation*, 25(10):1119–1127, 2005.
- [14] Dimitrios Efthymiou, Constantinos Antoniou, and Paul Waddell. Factors affecting the adoption of vehicle sharing systems by young drivers. *Transport Policy*, 29:64–73, May 2013.
- [15] FlatIcons. Flaticon, 2025. [Accessed 07-05-2025].
- [16] Chinh Q. Ho, Corinne Mulley, and David A. Hensher. Public preferences for mobility as a service: Insights from stated preference surveys. *Transportation Research Part A Policy and Practice*, 131:70–90, September 2019.
- [17] Benjamin James Inyang. Defining the role engagement of small and medium-sized enterprises (sme) in corporate social responsibility (csr). *International Business Research*, 6(5):123, 2013.
- [18] L. Kauschke. *The Transition to Smart Mobility: Acceptance and Roles in Future Transportation*. Springer Fachmedien Wiesbaden, Germany, 2023.
- [19] E P Kroes and R J Sheldon. Stated preference methods: An introduction. *Journal of Transport Economics and Policy*, 1988.
- [20] J J Louviere, D A Hensher, and J D Swait. *Stated Choice Methods: Analysis and Applications*. Cambridge University Press, 2000.
- [21] Daniel McFadden. Conditional logit analysis of qualitative choice behavior. In Paul Zarembka, editor, *Frontiers in econometrics*, pages 105–142. Academic Press, 1974.

- [22] Microsoft. Security and privacy in microsoft forms - microsoft support, 2018. [Accessed 07-05-2025].
- [23] Eric Molin. Lecture 1. introduction to experimental designs, 2022. Course: SEN1221 - part II, Delft University of Technology.
- [24] Nadine Olipp, Manuel Woschank, and Jacob Kopeinig. Enablers, barriers, and opportunities for the implementation of circular economy practices in small and medium-sized enterprises: An explorative systematic literature review. In Franco Concli, Lorenzo Maccioni, Renato Vidoni, and Dominik T. Matt, editors, *Latest Advancements in Mechanical Engineering*, pages 185–199, Cham, 2024. Springer Nature Switzerland.
- [25] Bryan Orme. *Getting Started with Conjoint Analysis: Strategies for Product Design and Pricing Research*. Research Publishers LLC, Madison, Wis., 2019.
- [26] R.J. Orsato and P. Wells. U-turn: the rise and demise of the automobile industry. *Journal of Cleaner Production*, 15(11):994–1006, 2007. The Automobile Industry & Sustainability.
- [27] Pedro Rezende and Satish Ukkusuri. *Social Network Influence on Mode Choice and Carpooling During Special Events: The Case of Purdue Game Day*, pages 109–126. 01 2019.
- [28] Jan Rotmans, René Kemp, and Marjolein van Asselt. More evolution than revolution: transition management in public policy. *Foresight*, 3(1):15–31, February 2001.
- [29] Gemeente Rotterdam. Aanpak Nul Emissie Mobiliteit: Naar uitstootvrije stedelijke mobiliteit. [Accessed 06-11-2024], translated from Dutch.
- [30] Jolene D. Smyth. Visual design, order effects, and respondent characteristics in a self-administered survey. [Accessed 07-05-2025].
- [31] SurveyEngine GmbH. Surveyengine, 2023. Accessed: 2025-03-05.
- [32] Gergely Szolnoki and Dieter Hoffmann. Online, face-to-face and telephone surveys—comparing different sampling methods in wine consumer research. *Wine Economics and Policy*, 2(2):57–66, 2013.
- [33] Farzana Mehzabin Tuli, Suman Mitra, and Mariah B. Crews. Factors influencing the usage of shared e-scooters in chicago. *Transportation Research Part a Policy and Practice*, 154:164–185, October 2021.
- [34] Peter van der Waerden, Marloes de Bruin-Verhoeven, and Harry Timmermans. Car drivers’ characteristics and the maximum walking distance between parking facility and final destination, 2017. [Accessed 12-05-2025].
- [35] I. van Gerrevink; V. Joanknecht. Personal communication. Personal communication, 2024. Conversation with stakeholders on July 23, 2024.
- [36] Frank van Oort and Gert-Jan Hospers. Ruimtelijke economische verkenning 2024, 2024. Accessed: 2025-06-23.
- [37] Ruben Verbeeke. Well-being Indicators for Car-Free Policies — TU Delft Repository — repository.tudelft.nl. <https://repository.tudelft.nl/reCORD/uuid:27a06549-10eb-40c6-ae78-38a898241194>. [Accessed 28-10-2024].
- [38] P. Verhoeven. Personal communication. Personal communication, 2024. Conversation with stakeholders on October 28, 2024.
- [39] Myriam Zakhem and Janille Smith-Colin. Investigating the acceptance of shared autonomous micromobility systems: Evidence from four cities in the united states. 2023. Available at SSRN.