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Can Bus On-demand be Attractive in Suburban Areas: A Case Study in Gothenburg

Master's thesis in Master Program Infrastructure and Environmental Engineering

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Cover: An illustration of bus on-demand.

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Abstract

This master thesis has investigated in how to reduce the use of private cars to travel more sustainably during everyday traveling. The study has focused on bus on-demand services to see if it can be a suitable substitute for private cars in suburban areas of Gothenburg. Compared to a normal bus, a bus on-demand is a minibus that can pick up passengers at either a bus stop or a virtual bus stop close to the passenger's home. Bus on-demand costs the same as a normal bus ticket and ensures that passengers in the same area are picked up with the same minibus. The master thesis has investigated the attitude towards bus on-demand, travel mode choice behavior, and the potential for using bus on-demand in Gothenburg's suburban areas. This has been done by creating a survey and sending it out to various respondents. In the survey, respondents had to answer which mode of transport they had chosen where time and cost differed. There were four different travel modes, bus on-demand, public transport, shared bicycle/e-scooter, and private car with two different weather scenarios. The results of the survey were applied in Python to obtain coefficients which were then used in probability calculations. The results indicated that individuals are more willing to choose a private car over bus on-demand. This preference can be attributed to the perceived cost-effectiveness and time efficiency of cars. Additionally, respondents' attitude towards adopting a new travel mode and their existing travel habits significantly influenced their preferences. Several other factors also contributed to this trend. However, bus on-demand have the potential to transform public transportation by providing enhanced flexibility, efficiency, accessibility, and sustainability. Implementation of bus on-demand services is expected to decrease the number of cars in urban areas. Thereby reducing carbon dioxide emissions and contributing to the development of more sustainable urban environments for future generations.

Keywords: Bus on-demand, Gothenburg, Habits, Mode choice behavior, Suburban areas, Sustainable travel, Travel mode.

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Natalie Smilevsk & Vera Wallin, Gothenburg, June 2024

Contents

List of Abbreviations

bod	bus on-demand
pt	public transport
shared	shared bicycle/e-scooter
car	private car
at	access time
wt	waiting time
tt	travel time
et	egress time

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Introduction

Gothenburg has over 600,000 inhabitants and the population is growing every year (Göteborgs Stad, 2020). In the last 4 years, the population has increased by 33,000 people. This leads to increasing traffic and congestion, meanwhile city of Gothenburg has a program with a vision to transition into an ecologically sustainable city by 2030. This involves reducing the environmental impact of transportation, ensuring good air quality, and creating a healthy sound environment. The goal is to decrease Gothenburg's carbon footprint annually, aiming for a rapid transition to a net-zero footprint. Emissions within Gothenburg's geographical area are targeted to decrease by at least 10.3 % per year, with consumption-based emissions decreasing by at least 7.6 % annually until 2030. Achieving the sub-goal of reducing the climate impact of transportation requires a shift from car travel to walking, cycling, and public transportation.

In Gothenburg, road traffic is one of the largest contributors to increased air pollution and noise levels (Göteborgs Stad, 2020). To accomplish the environmental goal of 2030, people must reduce road traffic and prioritize walking, cycling, and public transportation when traveling to school or work. Air pollution increases the risk of cardiovascular diseases, respiratory illnesses, and cancer. The road traffic also contributes to queues. If more people would travel by public transport instead of cars the congestion would decrease since one bus can replace 40 cars (Zicla, 2020).

According to the City of Gothenburg there must be a change in the city to achieve the goal of 2030 (Göteborgs Stad, 2020). The travel time with public transport can be decreased with fewer bus stops and smarter routes. Fewer bus stops could result in longer walking distances, potentially leading to extended travel times. The City of Gothenburg has done calculations of various future scenarios for public transportation. The result has indicated that significant adjustments to the public transport system are necessary to achieve an average 10% reduction in travel time in Gothenburg. This requires investment far beyond the current planning scope to achieve this goal (Göteborgs Stad, 2014).

The overall accessibility of public transport in suburban areas is lower than in the city (Larsson, 2022). This is mainly due to the demand, and limited range of available bus lines and services, combined with the large distance to the nearest bus stations. The proximity of these bus stations often varies, from one to five kilometers. Because of these challenges, the dominant mode of transport remains private vehicles (Protect our winters, n.d.). This makes residents choose their car for their

daily commuting needs. A public transport system that is not optimal contributes to a situation where individuals feel forced to rely on private cars to commute to Gothenburg (Larsson, 2022). This thesis will investigate if the use of cars can be replaced with bus on-demand in suburban areas outside Gothenburg's central city. Research will be made on whether there is a demand to apply bus on-demand and the attitudes towards bus on-demand services. Bus on-demand is a minibus that can pick up passengers at either a bus stop or a virtual bus stop (Västtrafik, n.d.). There are virtual bus stops at a distance of 50-300 meters from the passenger's home. It arrives within about 10-20 minutes, but can also be ordered 30 days in advance, and costs the same as a bus ticket. The trips are booked in an app, ensuring that several passengers booked in the same area are picked up with the same minibus. At the moment, Västtrafik has been testing for a couple of months whether bus on-demand could be an option in Ulricehamn, Skene, Kinna, and Örby.

Bus on-demand can contribute to reduced congestion on the roads (Vansteenwegen et al., 2022). It has significant potential to enhance the option of this kind of public transportation instead of choosing the private car. Bus on-demand has proved effective when traditional public bus services face challenges. This is especially obvious in instances of low transportation demand, such as in suburban areas, or when demand differs a lot between peak hours and off-peak hours. In these circumstances where there is fixed routes and timetables, buses can result in either near-empty or overcrowded conditions. None of the scenarios are profitable because underutilized buses result in inefficiencies for the bus company, while overcrowded buses lead to passenger frustration and sometimes the passengers cannot fit into the bus. In this case, bus on-demand can consider real-time demand on an individual and short-term basis by adjusting bus routes and timetables within significantly shorter time frames compared to conventional public bus systems.

1.1 Aim and Research Questions

This master thesis will investigate how to reduce the use of private cars to travel more sustainably during everyday traveling. The study will focus on bus on-demand services to see if it can be a suitable substitute for private cars in suburban areas of Gothenburg. The investigation will cover travel behavior for on-demand bus use, based on surveys and a calibrated travel behavior model.

The research questions are:

- What are the attitudes of different individuals towards bus on-demand services?
- What is the mode choice behavior of bus on-demand services in different contents?
- What is the potential demand for using bus on-demand in Gothenburg's suburban areas?

2

Literature Review

In the following sections travel behavior, case studies, challenges, and the discrete choice model are presented.

2.1 Travel Behavior

The choice of transport mode is highly dependent on habits and habits significantly affect travel patterns (Forward, 2023). It's important to identify motivating factors, such as attitudes and norms, to understand what facilitates or hinders travel. This section will present different parameters that affect people's travel behavior.

2.1.1 Distance and Time

Distance plays a critical role in selecting transportation modes (Forward, 2023). If the distance does not exceed the thresholds of three km for walking and five km for bicycling, individuals are likely to choose walking or bicycling, even if they own a car. For example in cities where trips tend to be shorter, it offers the most potential for travel by foot or bicycle. However, the decision is not only based on distance; subjective perception also plays a crucial role. It's the individual's perception of distance rather than the actual distance that determines whether they choose to walk. Studies indicate that regular bicyclists are less frightened by longer distances than those who don't bicycle on an everyday basis (Pisoni et al., 2022).

Subjective perception of distance is closely tied to the element of time (Forward, 2023). How individuals understand the passage of time and the experiences associated with it, greatly influences their attitudes towards distance and transportation choices. For instance, travelers perceive 'experiential time' when they enjoy a journey, and 'dead time' when they do not. It's only in the latter scenario that travelers focus on the duration of the journey. This suggests that the perception of time is heavily influenced by the quality of the experiences during that time, rather than the actual clock time. When the experience is positive, time may not be perceived as wasted, explaining why some individuals willingly undertake long journeys (Lyons et al., 2013). For instance, regular bus commuters may perceive their journeys as faster than those who cycle or drive, as they value the relaxation opportunity during transit, paying less attention to journey speed.

2.1.2 Convenience

Convenience, flexibility, and perceived control are key factors influencing travelers' decisions on transportation modes (Forward, 2023). These factors also lead many people to choose the car because it is perceived as convenient and flexible. However, this preference for cars can undermine the use of public transportation, especially if bus services are infrequent or inconvenient (Eriksson & Forward, 2010). Regardless of the chosen mode of transportation, travelers tend to prioritize what they perceive as the most pleasant option. Convenience plays a significant role in people's decision to drive even for short distances. Hence, it's crucial to explore how alternative modes of transportation can be made more convenient. Improving the convenience of public transportation involves minimizing obstacles and choosing the most direct routes (Forward, 2023). Additionally, enhancing utilities like well-designed bicycle paths can boost the appeal of bicycling. While convenience and accessibility are closely related, they are not interchangeable. For instance, a comfortable bus journey might outweigh the importance of taking the most direct route. Socioeconomic factors indicate that men are more inclined to travel by car, while there is a greater likelihood for women to use public transportation. Green behavior is often associated with femininity, which may lead men to avoid such behavior if they wish to maintain their masculine identity.

2.1.3 Cost

Many individuals prioritize economic factors when opting for public transport, bicycling, or walking over driving, although it might not be their primary consideration (Forward, 2023). Three different groups were identified with an increased likelihood of utilizing public transportation despite also owning a private car: educated individuals, older adults, and individuals residing in single-person households (Kuhnimof et al., 2006). However, despite the assumption that increased fuel prices would lead to a reduction in the use of cars, research indicates otherwise (Forward, 2023). It appears that those who drive are not significantly affected by price changes. This could be because car owners perceive car usage as a marginal cost or feel a lack of attractive alternatives. Moreover, the fixed cost of owning a car remains regardless of its usage, while public transport costs are seen as additional costs. Implementing parking fees at workplaces could help reduce car usage, particularly when combined with other measures such as fuel and taxes. Another research indicates that a bus on-demand system could rival private car usage concerning both costs and travel time, provided that the demand is significant. (Vansteenwegen et al., 2022). It also suggests that a shared on-demand transport system is favored over a private taxi system because of the cost.

2.1.4 Environment and Personal Health

The interaction between environmental consciousness and personal well-being is crucial in transportation decisions. Although it is known that driving is harmful to the environment, it is still uncertain how environmental awareness influences people's choice of transportation mode (Forward, 2023). Some studies suggest that individ-

uals with heightened environmental consciousness tend to choose environmentally friendly modes of transport, which correlates with reduced car use. Individuals who possess a private car and are knowledgeable about public transportation often choose public transport as an option, as it proves to be a superior choice over the car in certain circumstances (Kuhnimof et al., 2006). However, despite awareness of climate change, many travelers, particularly frequent car users, do not connect their travel behavior with carbon emissions (Forward, 2023). Furthermore, arguments highlighting the health risks of driving have little influence over this group, as they acknowledge that cars do not contribute to their physical well-being. Unlike cyclists who often prioritize health benefits, drivers view their mode of transport as a way to access spare time activities. Therefore, the decision to drive the car is largely influenced by short-term conveniences such as speed and ease of travel, rather than environmental or health considerations.

2.1.5 Social Norms and Habits

Social norms play a significant role in shaping behavior, including transportation choices (Forward, 2023). When individuals are uncertain about how to act, they often observe the behavior of others and may adopt similar practices. Particularly if they seek acceptance from those individuals. Conversely, behaviors that deviate from social norms are often avoided, as they may threaten personal and group identities. One group notably influenced by social behavior is bus travelers, as studies have shown that individuals who use buses are more likely to have friends and family members who also use this mode of transportation.

The formation of new behaviors typically involves a conscious process over time. These behaviors can become habits, performed almost automatically. Individuals tend to stick to habitual modes of transport, particularly for their regular journeys, despite the potential benefits of exploring different options (Forward, 2023). Although habits largely explain behavior, attitudes and norms should not be disregarded, as they still play a role in shaping travelers' attitudes toward transport modes. However, individuals may not consciously consider why they choose certain transportation modes, underlying causes can be brought to consciousness through questioning themselves. The likelihood of each adult in a household driving increases when children are present (Kuhnimof et al., 2006). Moreover, individuals who drive and reside in households with two or more household members are less willing to use public transport alongside their car. Studying habits can create challenges, as they are not consistently measured. Habits develop through repeated actions and are performed without much thought (Forward, 2023). Individuals with strong habits are less receptive to information about alternative transportation modes, while those with weaker habitual patterns may be more open to trying new options. Researchers suggest that habits reach a point when it is automatized, typically after about 66 days (Gardner et al., 2012). Therefore, interventions aimed at changing habits require sustained support over an extended period to succeed.

2.2 Case Studies

In this section, similar case studies will be performed in the cities Säffle, Sundsvall, Guangzhou, and Melbourne.

2.2.1 Bus on-demand in Säffle

Säffle is a suburban area in Sweden with 15,242 inhabitants (SCB, 2022a). Säffle has flexible bus on-demand services as a regular service in their public transport. It was launched as a pilot test in 2021, after positive feedback it became part of the public transport system a year later and is called the X-line (Värmlandstrafiken, 2024). The trip is booked through an app and the user enters the address they want to travel from and the destination that they want to go to. If several people in the same area have booked in the same direction, the route will be adapted to where the other people are picked up and dropped off. The customer travels with the same ticket as other public transport. It is possible to book journeys between 06:00-19:00 on weekdays, and 10:30-14:30 on Saturdays but the X-line does not operate on Sundays.

The X-line has contributed to a significant increase in public transport usage in the suburban Säffle. In October, 3023 trips were booked and this can be compared with the previous regular bus line that had about 320 trips per month and drove according to a timetable (Säffle kommun, 2023). A company called Swedish Public Transport conducts an annual survey on national quality-, attitude-, and travel satisfaction for the public transport industry. The target group for the public transport barometer is the general public aged 15-85 and the survey is commissioned by regional public transport authorities and county transport companies (Svensk Kollektivtrafik, 2023). In 2023, region Värmland, i.e. where Säffle is located, was in first place with a satisfaction rate of 86 %.

2.2.2 Bus on-demand in Sundsvall

Another area in Sweden with around 100,000 inhabitants is Sundsvall (SCB, 2022b). After the pandemic, there was a change in travel patterns and needs among travelers (Nobina, 2023). Therefore, Sundsvall launched a new mode of travel called Paxa in 2023. The minibus runs within a defined area in the center of the city and is only on the road if a customer has booked a trip in the app within specified opening hours. This saves both emissions and money (Nobina, 2023). The new type of public transport will complement the existing scheduled services to enable more people to want and be able to travel without a car. One month after the launch of Paxa, statistics show that travel with the minibus is increasing by 20 % every week and over 1000 passengers in one month (Sundsvall kommun, 2023). Despite the rapid increase, waiting times between ordering and collection have remained low. It takes an average of ten minutes for the bus to arrive from the time it is ordered. Paxa has around 300 virtual stops that are strategically located (Nobina, 2023). Nine out of ten passengers book the minibus through the app, while about one in ten people

use the customer center (Sundsvall kommun, 2023).

2.2.3 Case Study in Guangzhou

In a study carried out in China in the city of Guangzhou, the travel time was analyzed by comparing the performance of the transport system with a fixed route and with a flexible route (Pei et al., 2019). Then a corresponding simulation program was designed in MATLAB.

The results showed that at low to normal demand levels, the proposed on-demand route system tends to have the shortest travel time (Pei et al., 2019). This was because the on-demand system can meet passengers' travel needs with decreased travel time and reduce the number of unnecessary stops without boarding or disembarking activities. The on-demand system resulted in a reduction of total travel times by over 10 %. The study also included a sensitivity analysis of vehicle number and passenger flow density. The result showed that the on-demand system was more beneficial than the fixed route services. Especially when the fixed route frequency is less frequent than every 16 minutes and the demand is less than 40 passengers per hour. The comparative analysis of the study showed that the on-demand system is best suited for situations involving a limited number of buses, longer departure intervals, and low passenger demand. This means that an on-demand system has the most benefits in areas with low population density since it reduces passengers' overall waiting time and travel time.

2.2.4 Case Study in Melbourne

In the inner city of Melbourne in Australia a simulation model was developed to compare on-demand public transportation with the existing fixed route. (Liyanage & Dia, 2020). The study included quality of service, waiting time, travel time, number of trips, hourly vehicle utilization, and passenger kilometers traveled.

The data indicated a significant benefit of on-demand use compared to the scheduled bus (Liyanage & Dia, 2020). When comparing the scheduled buses with on-demand buses in the morning peak hour, the waiting time for on-demand bus service was reduced by 78 %, and in the afternoon peak, the reduction was 81 %. In total the average waiting time decreased by 89 %. The result showed that the scheduled bus service had a utilization rate of 16 % in the peak hour and the on-demand services had a 70 % vehicle utilization rate. The data also indicated that the vehicle occupation during the off-peak hour was twice more for on-demand service compared to scheduled bus. This means that it benefits the operator to have on-demand service in Melbourne since it attracts people to use public transportation. The number of trips also increased by 18 % with on-demand service. When comparing the total travel time, the on-demand service was 55 % shorter which indicates that travelers save more travel time by taking on-demand service. From this result, it could be concluded that average emissions were reduced by 48 % in CO2 per trip with on-demand service. Overall the on-demand service had a lot of advantages in Melbourne.

2.3 Challenges with Bus on-demand for Västra Götalandsregionen

Västtrafik is responsible for public transport in Västra Götalandsregionen in Sweden. According to N. Olsson (interview, 2 February 2024), an employee at Västtrafik, Västtrafik is in a phase where they are investigating in which areas they can adopt bus on-demand. Three parameters are analyzed: the impact of bus on demand for travel behavior, economic aspects, and customer demand. Västtrafik wants to reduce congestion and the number of vehicles in the city center. Therefore, it is not appropriate for the bus on-demand to travel from the suburban area to the inner city. One of the challenges with bus on-demand is to make it attractive for travelers and change people's behavior from car use. Another is that it should be financially sustainable for Västtrafik, which is the biggest challenge according to N. Olsson. Furthermore, N. Olsson believes that bus on-demand will be most beneficial when self-driving buses are introduced since it is the driver that is one of the biggest costs. The bus on-demand responds to real-time instructions from passengers, but in the future, the routes should be optimized even more (Pei et al., 2019).

2.4 Discrete Choice Model

A discrete choice model aims to investigate the behavior of transportation users regarding their transportation mode selection (Aloulou, 2018). It also seeks to predict the modifications resulting from changes in the characteristics of transportation modes or socioeconomic variables of the decision-maker. Using this model, researchers can analyze and predict the travel behavior of individuals and simulate decision-making processes accurately. The random utility model serves as the foundation for discrete choice models (Ben-Akiva et al., 1997). Individuals have one option to choose from different alternatives of mode travel and typically select the alternative associated with the highest utility. The alternative with the most utility can vary between individuals since people value different aspects. For example, some value availability, cost, weather, travel time, or waiting time. The subjective factors also have an impact on the choices the individuals make, for instance, age, income, environmental awareness, and personal beliefs. The utility can be calculated by Equation 2.1.

$$U_{in} = V_{in} + \varepsilon_{in} \tag{2.1}$$

Where Vin represents the deterministic aspect of the utility function and Vin is expressed as Vin = $\alpha + \beta$ * Xin. Where α and β are the coefficients of the different attributes Xin (Balakrishnan & Ramanujam, 2011).

2.4.1 Multinomial Logit (MNL) Model

Ngene is a software tool utilized in decision science research to create and analyze experimental designs (Ngene, 2018). The software enables the creation of orthogonal, optimal orthogonal, and efficient stated choice designs. With Ngene it is also possible to calculate the Multinonimal logit model to analyze discrete choices in

decision science and the probability of an individual choosing one particular transport mode. The advantage of the model is that you can analyze a large amount of data containing different alternatives and the model then generates a utility function. The disadvantage of the model is the distribution between the different options cannot be too uneven as this leads to an unreliable answer and in turn one cannot analyze the result.

3
Methods

This chapter presents the methodology for this master thesis. The first step was a literature search about different travel modes and suitable areas around Gothenburg. This was followed by one interview with an involved employee at Västtrafik. The next step involved designing a survey for citizens in suburban areas. One focus was to investigate the acceptance and subjective opinions of people with different living contexts and socioeconomic backgrounds. The results of the survey were the basis for the estimated model. The third step was to create a mode choice model using Python. This master thesis was also focused on conducting an empirical case study in a suburban area outside Gothenburg to estimate usage demand. After that, the probability calculations were made. The last step was to analyze the result and determine if bus on-demand could substitute private cars in suburban areas outside Gothenburg. The process of the methodology is presented in Figure 3.1.

Figure 3.1: The schematic diagram of the methodology steps.

3.1 Study Area

The study focuses on the suburban areas of Gothenburg. Gothenburg is located in southwestern Sweden and has a population of 604 367 citizens, in large-Gothenburg there is a population of 1 080 051 citizens (Göteborgs Stad, 2023). Gothenburg has buses and trams covering the central parts of the city. The red lines are for trams and the purple are for trunk buses, see Figure 3.2. For some suburban areas, Gothenburg has express buses and commuter trains. Pink lines are for express buses and orange lines are for commuter trains, see Figure 3.3. Areas located outside the tram- and trunk bus network and inside the express- and commuter network have been chosen as the focus of the study. The suburban areas outside of the city center are notably distant from the nearest public transportation station that takes them to the center of Gothenburg. This increases the travel time from the suburban to the city center with public transport. Therefore, residents of these areas commonly rely on private cars for commuting to Gothenburg (Vansteenwegen et al., 2022). To mitigate the reliance on cars the introduction of an alternative transportation mode becomes imperative. Bus on-demand could serve as a viable solution by facilitating residents' transit from their homes to the nearest connection point for express buses

or commuter trains. This provides convenient access to public transport into the city center and would contribute to a reduction in private car use. Consequently limiting urban traffic congestion, lowers emissions, and attenuates noise pollution levels within the city.

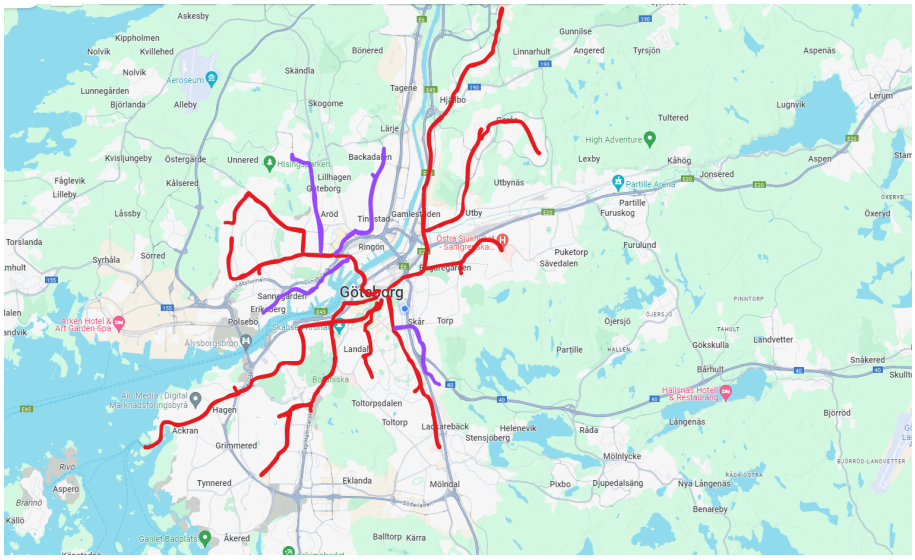


Figure 3.2: The figure shows Gothenburg's terminal stations, red are trams and purple are trunk buses. (Google Maps, 2024a). Edited.

Figure 3.3: The figure shows Gothenburg's express buses in pink, and commuter trains in orange. (Google Maps, 2024a). Edited.

3.2 Survey Design

For this thesis, surveys were chosen as the method. Surveys can provide a robust, flexible, and efficient method for collecting the data needed to address the research questions about bus on-demand. The survey for this thesis was made in Google Forms, see Appendix. Google Forms is a tool that can handle a large amount of answers. The answers are also easy to convert into Excel sheets that were needed for programming. It also has a variety of question types, including multiple-choice, check-boxes, short answers, and more. The questions were formulated with the help of supervisors at Chalmers University of Technology and Ramboll. The survey was tested by a few people before it was sent out on a larger scale, to evaluate the questions and answers. There were 24 multiple-choice questions and one short-answer question. The first section of the survey was questions regarding the respondent's travel behavior at the moment, the second section consisted of questions regarding different scenarios and the last section was socioeconomic questions. There were a total of twelve scenarios where time and cost differed. The first six scenarios were in good weather, sun, and 18 degrees Celsius. The last six scenarios were in bad weather, wind, and zero degrees Celsius. The table design of the scenarios is presented below in Chapter 3.2.3. It was important to get answers from people who live in suburban areas outside Gothenburg. Therefore, the survey was sent out to six different Facebook groups in these areas outside Gothenburg. The Facebook groups served as a platform for people to communicate with each other within the neighborhood. Those areas were Torslanda, Utby, Lerum, Härryda, Partille, and Mölndal, see Figure 3.4. The Facebook groups had members between 3,400-18,400 people. The survey was also sent out on the social media Instagram, Facebook, and to the employees at Ramboll.

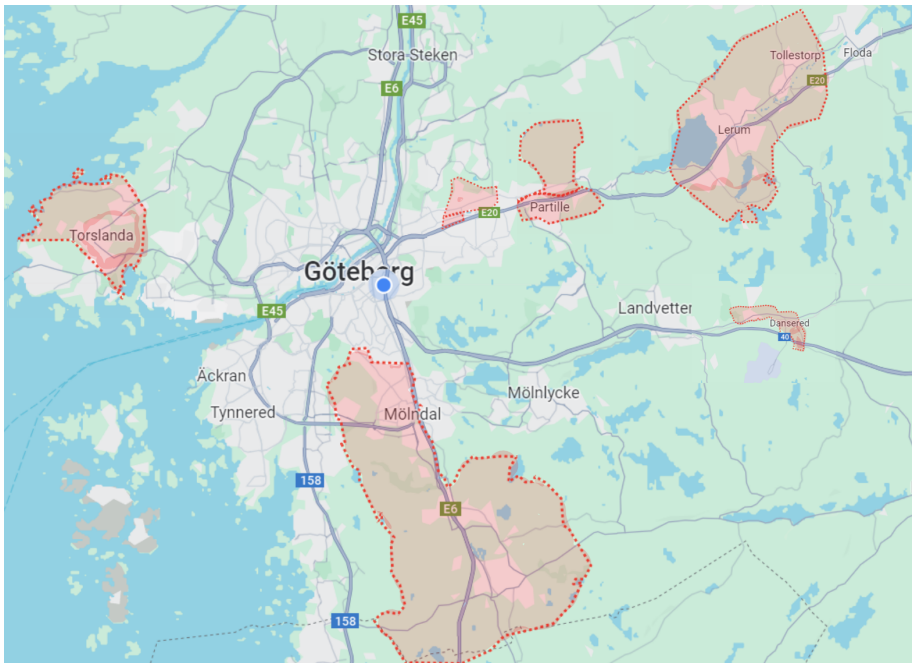


Figure 3.4: The figure shows the suburban areas of Torslanda, Utby, Lerum, Härryda, Partille, and Mölndal. (Google Maps, 2024c). Edited.

3.2.1 Alternatives and Attributes

In the survey, the choices of travel modes were bus on-demand, public transport, shared bicycle/e-scooter, and private car. When choosing between different options, respondents use certain criteria to evaluate the advantages and disadvantages of each option. These criteria, called attributes, were considered by the respondent when answering the survey. The attributes were access time, waiting time, travel time, egress time, total time, and cost. Egress time is the time it takes to walk from the bus to the destination. The values of the travel time varied depending on the mode, see Table 3.1. There were two travel situations to be assumed:

- A three km trip when the weather was sunny and 18 degrees Celsius.
- A three km trip when the weather was windy and 0 degrees Celsius.

The assumption of a three km trip was made because it can be equated with the distance for people in suburban areas to their closest station that takes them to the city of Gothenburg.

The modeling of the cost for the attributes of private cars depended on the parking fee and fuel, see Table 3.1. The parking fee can vary depending on where you park and for how long. The cost of public transportation and bus on-demand represent a range of ticket prices, encompassing individual fares for adult passengers, period tickets, and reduced fares for younger travelers, see Table 3.1. For shared bicycles and e-scooters, the cost depended on the cost of having a monthly membership, the starting fee, and how long it was used.

Table 3.1: The attributes for different transport modes.

Alternatives	**Attributes**	**Levels of Attributes**
Bus on-demand	Waiting time	(1, 3, 5) min
	Travel time in vehicle	(10, 15, 25) min
	Cost	(10, 35, 55) kr
Public transport	Access time	(2, 5, 8) min
	Travel time in vehicle	(10, 20, 30) min
	Egress time	(1, 3, 5) min
	Cost	(10, 30, 40) kr
Shared bicycles or e-scooters	Access time	(2, 4, 6) min
	Travel time	(8, 14, 20) min
	Cost	(20, 35, 50) kr
Private car	Waiting time	(0) min
	Travel time in vehicle	(5, 10, 15) min
	Cost	(10, 70, 90) kr

3.2.2 Orthogonal Design and Scenario Creation

The orthogonal design capitalizes on orthogonality to produce every conceivable scenario that meets the criteria of attribute-level equilibrium. This method enables the separate estimation of all parameters, assuming no correlation among attribute levels. For this study, Ngene software was utilized to generate scenarios, as it offers a range of experimental designs, including the orthogonal design. This part of the master thesis provides the most suitable scenarios for the respondents in the survey. The number of combinations of four alternatives each having three/four attributes is too high and impractical to present to a single respondent. Therefore these twelve scenarios were selected, see Figure 3.5.

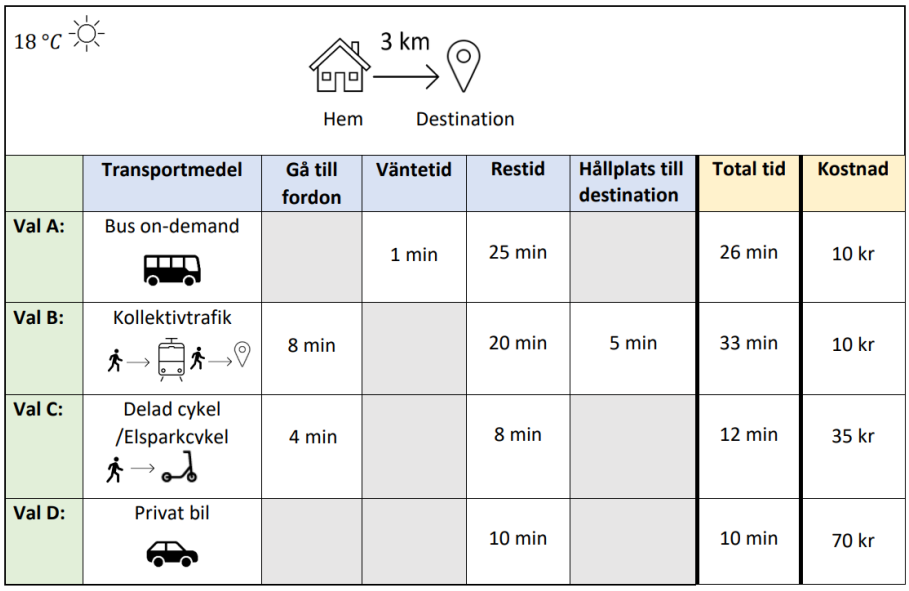
In Figure 3.5, twelve scenarios generated by Ngene were selected since they were comparable with each other. These scenarios were then applied to two different blocks, 'Block 1' and 'Block 2' see to the left in Figure 3.5. The blocks were then applied with two different weather conditions, resulting in 24 distinct scenarios, see Appendix. The scenarios were divided into two surveys because it was decided that twelve scenarios were enough for one respondent. It was exactly the same survey, except that the scenarios differed. Survey A had Block 1 with good weather and Block 2 with bad weather. Survey B had Block 1 with bad weather and Block 2 with good weather.

Block	bod_wt	bod_tt	bod_ cost	pt_at	pt_tt	pt_et	pt_cost	shared_ at	shared_ tt	shared_ cost	car_tt	car_ cost
1	1	25	10	8	20	5	10	4	8	35	10	70
1	1	10	55	2	10	1	40	2	14	50	5	90
1	5	15	35	5	10	5	30	6	8	20	15	10
1	3	15	55	8	30	5	30	2	20	50	10	70
1	3	25	35	2	20	3	10	6	20	20	15	40
1	5	10	10	5	20	1	40	4	20	35	5	70
2	1	25	10	2	20	3	40	2	14	50	5	90
2	1	10	55	2	10	1	40	2	20	50	5	90
2	3	25	35	8	10	5	10	6	8	20	10	40
2	5	15	35	5	30	3	30	4	14	35	15	10
2	5	10	10	8	30	1	10	4	8	35	10	40
2	3	15	55	5	30	3	30	6	14	20	15	10

Figure 3.5: The figure shows the twelve scenarios generated by the software Ngene. See the abbreviation explanation in the List of abbreviations.

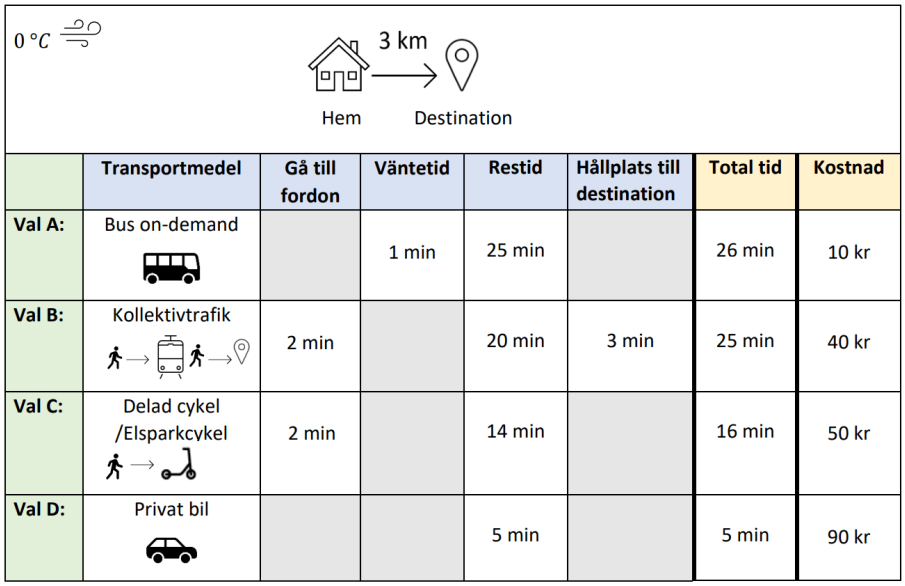
3.2.3 Table Design of Scenarios

In the two surveys, the scenarios were visually presented as a table with both symbols and text. An illustration from a scenario in good weather is shown in Figure 3.6 and an illustration from a scenario in bad weather is shown in Figure 3.7. Symbols were used in the table to make it easier for the respondents to understand which vehicle was involved. As it is most common to read from left to right, it was decided to set up the table in the same way. Colors were chosen to make it even clearer to the eye, as was the choice of bold lines in certain places. The total travel time column was made to make it easier for the respondent. The scenarios were made in Swedish since the respondents live in Sweden.



	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		1 min	25 min		26 min	10 kr
Val B:	Kollektivtrafik	8 min		20 min	5 min	33 min	10 kr
Val C:	Delad cykel /Elsparkcykel	4 min		8 min		12 min	35 kr
Val D:	Privat bil			10 min		10 min	70 kr

Figure 3.6: The figure shows the table in the survey for one scenario Block 1 with good weather.



	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		1 min	25 min		26 min	10 kr
Val B:	Kollektivtrafik	2 min		20 min	3 min	25 min	40 kr
Val C:	Delad cykel /Elsparkcykel	2 min		14 min		16 min	50 kr
Val D:	Privat bil			5 min		5 min	90 kr

Figure 3.7: The figure shows the table in the survey for one scenario of Block 2 with bad weather.

3.3 Model Estimation

The model estimation includes the discrete choice model, multinomial logit model, and estimation process of the model's parameters.

3.3.1 Discrete Choice Model

In this survey the discrete choice model was based on the following:

- The decision-making was made by the respondents.
- The travel mode choices were bus on-demand, public transport, shared bicycle and e-scooter, and private car.
- The attributes were access time, waiting time, travel time, egress time, total time, and cost.
- The decision-making principle relies on utility theory, assuming that the respondents act rationally and select the option with the greatest utility for the individual.

The utility was calculated with the Equation 3.1 where V is an observed component, in this case, the travel mode and ϵ is an unobserved component, for example, access time, waiting time, travel time, and egress time (Balakrishnan & Ramanujam, 2011).

$$U_{in} = V_{in} + \varepsilon_{in\_accesstime} + \varepsilon_{in\_waitingtime} + \varepsilon_{in\_traveltime} + \varepsilon_{in\_egresstime} \tag{3.1}$$

3.3.2 Utility Functions

According to utility theory, individuals are assumed to be rational decision-makers who aim to maximize their overall satisfaction or utility (Ben-Akiva et al., 1997).

When faced with multiple travel mode options, individuals will evaluate the utility associated with each mode, considering cost, travel time, comfort, and personal preferences. The following utility functions have been used in Python.

$$U_{bod} = ASC_{bod} + B_{tt-bod} * bod_{tt} + B_{cost} * bod_{cost} \tag{3.2}$$

$$U_{pt} = ASC_{pt} + B_{at-pt} * pt_{at} + B_{tt-pt} * pt_{tt} + B_{et-pt} * pt_{et} + B_{cost} * pt_{cost} \tag{3.3}$$

$$U_{shared} = ASC_{shared} + B_{at-shared} * shared_{at} + B_{tt-shared} * shared_{tt} + B_{cost} * shared_{cost} \tag{3.4}$$

$$U_{car} = ASC_{car} + B_{tt-car} * car_{tt} + B_{cost} * car_{cost} \tag{3.5}$$

U stands for the utilities of the different travel modes bus on-demand, public transport, shared bicycle/e-scooter, and private car.

ASC_travelmode, stands for Alternative Specific Constant. It represents a parameter in a discrete choice model that captures the constant or baseline utility associated with each alternative in the choice set.

B_attribute_travelmode stands for the attribute of each travel mode for example access time, waiting time, travel time, and agrees time.

Travelmode_attribute stands for the variables that present each travel mode for each attribute.

B_cost stands for the parameter of the estimated cost for all travel.

Travelmode_cost stands for the variables that present the cost attributes for each travel mode.

3.3.3 Estimation Process of Model's Parameters

The Biogeme software package was used to determine the parameters of the utility functions. This package was used in Python to estimate the parameters of the discrete choice model through maximum likelihood estimation for bad and good weather. See the Python code in the Appendix. The values were collected from the responses to the surveys in Excel. The scripts were executed using a programming editor called Visual Studio Code. Maximum likelihood estimation is based on optimization algorithms for problem-solving and estimation processes (Bierlaire, 2020). The maximum likelihood estimation is a nonlinear method and observes the

individual choices independently, see Equation 3.6 (Balakrishnan & Ramanujam, 2011).

$$L(\alpha, \beta) = N \prod_{i=1}^{n} P(c_i|C_i) \tag{3.6}$$

The software Biogeme was also used when analyzing the personal data from the surveys like income, gender, household members, and age. The different kinds of levels of personal data were divided in the Excel file that was connected to Biogeme, see the following Tables 3.2, 3.3, 3.4, and 3.5 below. One of the levels is set equal to zero when there are only two levels because there must be a benchmark in the programming to get the difference from the other value, see Tables 3.4, and 3.5.

Table 3.2: The level that was divided for income.

Level	**Income**
1	0 kr – 23,200 kr
2	23,200 kr – 40,000 kr
3	40,000 kr – 61,900 kr
4	61,900 kr +

Table 3.3: The level that was divided for age.

Level	**Age**
1	0 – 25 years
2	26 – 35 years
3	36 – 55 years
4	56 + years

Table 3.4: The level that was divided for gender.

Level	**Gender**
0	Women
1	Men

Table 3.5: The level that was divided for the household members.

Level	Household members
0	1 – 2
1	3 +

3.4 Case Study

The result from the model estimation was then applied to the case study in Lerum. Lerum is a suburban area located 20 km from Gothenburg and has around 43,500 residents (Lerums kommun, 2024). The case study was performed in Lerum in a residential area called Häcksjöbäck. Häcksjöbäck is located three kilometers from Lerum's station and this could be equated with the scenarios in the survey, see Figure 3.8. Google Maps was used to produce the different routes for bus on-demand, public transport, shared bicycle/e-scooter, and private cars. The waiting time and travel time for the bus on-demand was two minutes and 15 minutes, see Table 3.6. The access time, travel time, and egress time for public transport were six minutes, 17 minutes, and one minute. The access time and travel time for shared bicycle/e-scooter was three minutes and nine minutes. For a private car, the travel time was six minutes. The cost was assumed differently depending on the vehicle and travel time. In this case study, the costs of using bus on-demand and public transport were 36 kr, a shared bicycle/e-scooter 33 kr, and a private car 24 kr.

Table 3.6: The time and cost for the case study in Lerum.

Travel mode	at	wt	tt	et	cost
Bus on-demand	0 min	2 min	15 min	0 min	36 kr
Public transport	6 min	0 min	17 min	1 min	36 kr
Shared bicycle/e-scooter	3 min	0 min	9 min	0 min	33 kr
Private car	0 min	0 min	6 min	0 min	24 kr

Then the utility of the different travel modes for good and bad weather was calculated with the utility function, see Chapter 3.3.2 above. After that, the probability was calculated with a Multinomial logit model for each mode with the following Equation 3.7 (Balakrishnan & Ramanujam, 2011).

$$P(c_i|C_n) = \frac{e^{V_{in}}}{\sum_{j:c_j \in C_n} e^{V_{jn}}} \tag{3.7}$$

where $P(c_i|C_n)$ is the probability of choosing the travel mode c_i given the choice set C_n. V_{in} is the systematic utility associated with alternative c_i for individual n. $\sum_{j:c_j \in C_n}$ denotes the summation over all alternatives c_j that belong to the choice set C_n.

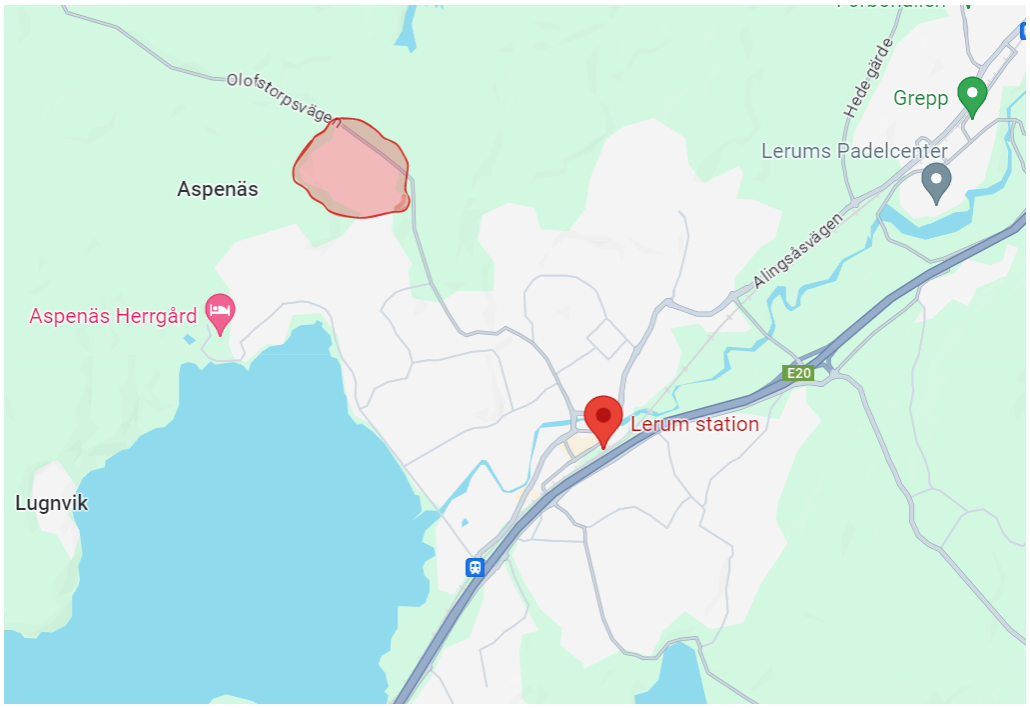


Figure 3.8: The figure shows Lerum station and the area of Häcksjöbäck. (Google Maps, 2024b). Edited.

4
Results & Discussion

The following chapter will present the results and discussion of the results. It contains results from the survey, Biogeme, and the case study.

4.1 Outcome of Survey

Two surveys with exactly the same questions but with different scenarios were sent out. Survey A received 175 responses and survey B received 183 responses. The result is based on the fact that the surveys are summarized, i.e. a total of 358 people participated in the survey. The outcome of the survey is presented in Table 4.1. There was an overrepresentation of women among the respondents, see Table 4.1. Of these participants, there was an even age distribution. The respondents' monthly income is evenly distributed across three ranges: 0-15,000 SEK, 23,200 - 40,000 SEK, and 40,000 - 61,900 SEK, representing 26%, 25.7%, and 26.3% respectively. The participants' educational backgrounds vary widely, ranging from completion of high school to several years of university education, see Table 4.1. When it comes to the number of members in the household, two people are predominant at 37.7%. Single-person households was 23.2% and of three, four, or five household members, the answers are distributed 17.3%, 17.6%, and 4.2% respectively. This gives a total of 38.8%, which assumes that 38.8% have children in the household. The majority of respondents, 70.9 %, had 0-1 km to the nearest bus/train station.

Table 4.1: The sample distribution of socioeconomic questions in the survey.

Characteristic	**Category**	**Sample distrubution**
Gender	Female	243 (68.0 %)
	Male	111 (31.0 %)
	Non-binary	2 (0.5 %)
	Prefer not to say	2 (0.5 %)
Age	0-15	0 (0.0 %)
	16-25 years	123 (34.4 %)
	26-35 years	80 (22.3 %)
	36-55 years	95 (26.5 %)
	56-75 years	55 (15.4 %)
	75 + years	5 (1.4 %)
Monthly income	0 kr	5 (1.4 %)
	0 - 15,000 kr	93 (26.0 %)
	15,500 - 23,200 kr	28 (7.8 %)
	23,200 - 40,000 kr	92 (25.7 %)
	40,000 - 61,900 kr	94 (26.3 %)
	61,900 + kr	25 (7.0 %)
	Prefer not to tell	21 (5.8 %)
Highest completed education	Primary school	6 (1.7 %)
	High school	102 (28.5 %)
	University 1-3 years	96 (26.8 %)
	University 1-5 years	117 (32.7 %)
	Higher education	30 (8.4 %)
	Prefer not to say	7 (1.9 %)
Household members	1	83 (23.2 %)
	2	135 (37.7 %)
	3	62 (17.3 %)
	4	63 (17.6 %)
	5+	15 (4.2 %)
Distance to nearest bus/train station	0-1 km	254 (70.9 %)
	1-2 km	49 (13.7 %)
	2-3 km	21 (5.9 %)
	3-5 km	8 (2.2 %)
	5 + km	21 (5.9 %)
	Don't know	5 (1.4 %)

Figure 4.1 presents which three options people prioritize the most when choosing a travel mode. The three most prioritized options are time-efficient, price-worthy, and comfortable. In the surveys, respondents could also write a comment about why they did not choose public transport as a travel mode. The majority of the answers were about time, price, and/or comfort, see Appendix. Figure 4.2 presents the result of how people currently get back and forth to work/school. 'Bus/Tram/Train' and 'Private car' are the most common travel modes.

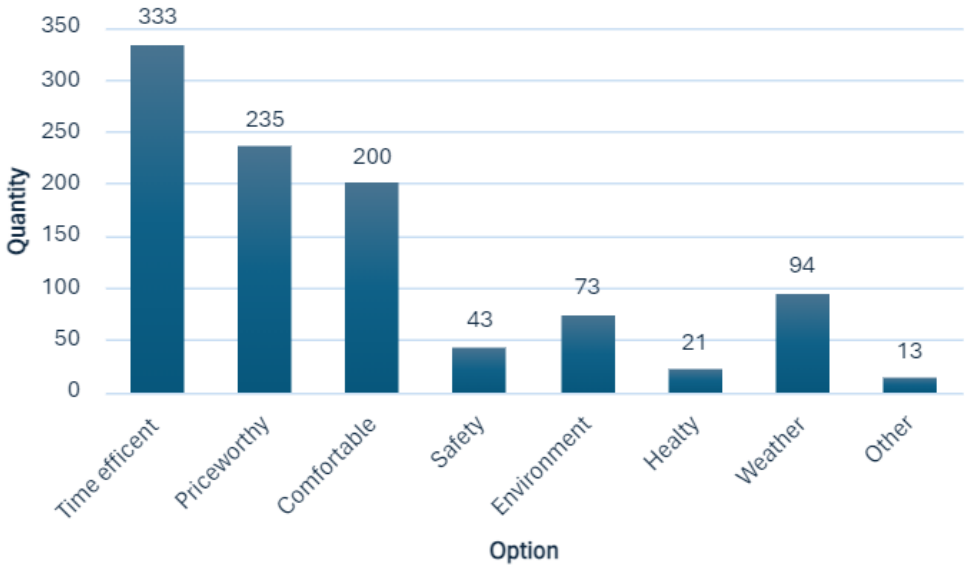


Figure 4.1: The result of which 3 options people prioritize the most when choosing a mode of transport.

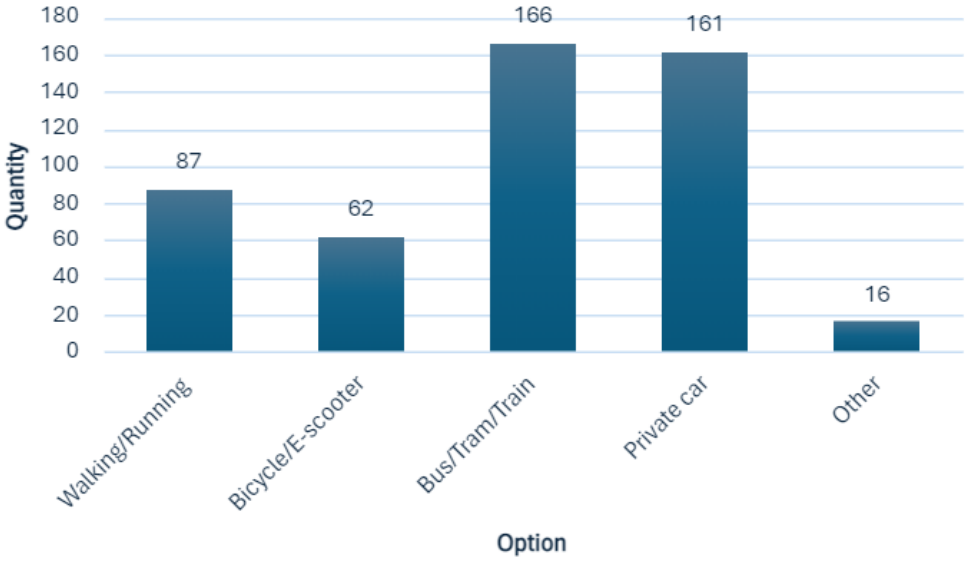


Figure 4.2: The result of how people currently getting back and forth to work/school. Multiple options were available.

Figure 4.3 shows how often people use public transport, only one option was available. Out of 358 respondents, the most common answer was 'Almost never' with 100 responses, followed by 'Every day' as the second most common response. Figure 4.4 indicates that 71 percent of all respondents have access to a private car. After a comparison, it turns out that most respondents who answered that they use public transport 'Every day' or 'Several times a week' do not have access to a car. While those who answered that they use public transport 'A few times a year' or 'Almost never', have access to a car. This was true for over half of all respondents, more precisely 53%.

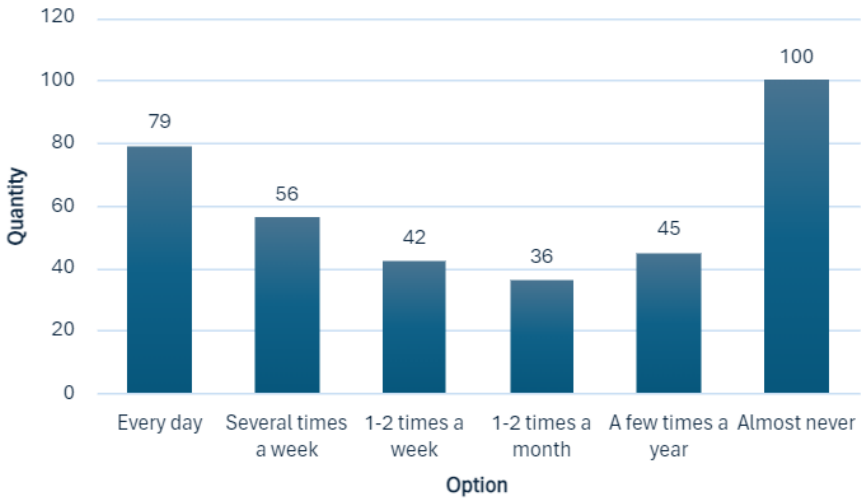


Figure 4.3: The result of how often people use public transport when going back and forth to work/school.

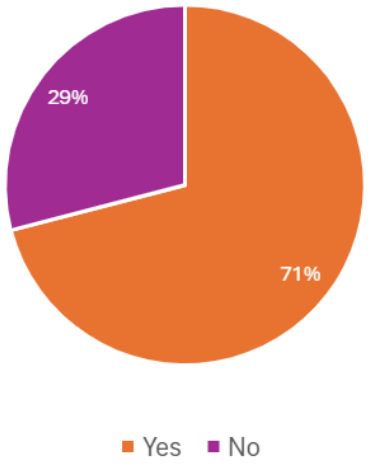


Figure 4.4: The result of how many respondents had access to a private car.

Of 358 respondents, 60% were very positive or positive about introducing bus on-demand, see Figure 4.5. For 20% of the respondents, it did not matter and 19% were

partly positive. This result may indicate that people would appreciate a change in public transport, perhaps an implementation of bus on-demand. But at the same time, the results show that many people would not care if bus on-demand was implemented. This may be because 70.9% of the respondents already have good communication facilities to access public transport, see Figure 4.1. They may live close to a bus or train station, which means they are not dependent on bus on-demand services and would not use them as there are existing working alternatives. The result could also depend on people's habit of travel behavior. As mentioned in chapter 2.1.5, social norms and habits, individuals tend to stick to habitual modes of transport. Habits develop through repeated actions and are executed almost unconsciously. Individuals may not even reflect on why they choose a particular travel mode, especially for routine journeys like commuting to work or school, as they become almost automatic.

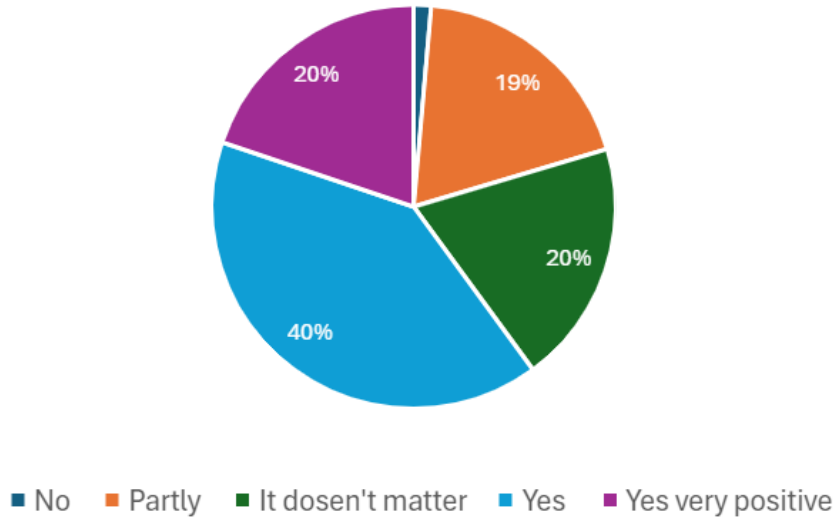


Figure 4.5: The result of how supportive people are of introducing bus on-demand.

4.2 Genreal Outcome of Biogeme

The result of the outcomes produced by Biogeme is shown in Table 4.2 and 4.3. The result includes Attributes, Value, Rob Std err, Rob. t-test, Rob p.value, and Cost per minute for good and bad weather. The value of the result is the estimated coefficient for an attribute variable indicating how much that variable influences the choice of a mode of transportation. The higher the value, of 'Value', the greater the expected effect of that specific parameter. The standard error is a measure of the uncertainty for an estimated parameter in a statistical model. The higher the value of Rob. Std err, the greater the uncertainty surrounding the estimated parameter. Robust t-test measures whether there is enough evidence to conclude that the parameter has a real effect on the outcome of the model. A result of less than an absolute value of 1.5 is unreliable and has not been focused on in this report. Robust t-test

also depends on the Rob. value. The lower the value of the Rob. p-value, the more significant the result and the less likely the null hypothesis is correct. The 'kr/min' means how willing a person is to pay to reduce the time by one minute for a specific attribute. It was calculated by dividing different attribute_travel modes with cost, see Table 4.2 and 4.3. The reason for $ASC\_public - transport$ is not shown in the tables is because it is set to zero as a benchmark. This means that the other values are related to public transport.

Table 4.2: The result of Biogeme for good weather, see explanation of abbreviations in List of Abbreviations.

	Value	**Rob.Std err**	**Rob. t-test**	**Rob. p-value**	**kr/min**
ASC_bod	-0.386011	0.243206	-1.587178	1.124723e-01	-
ASC_car	1.417860	0.315928	4.487925	7.192032e-06	-
ASC_shared	-1.034933	0.370978	-2.789744	5.274975e-03	-
Cost	-0.054050	0.002808	-19.249962	0.000000e+00	-
Access time_pt	-0.048841	0.031293	-1.560788	1.185739e-01	0.9
Access time_shared	-0.149782	0.049975	-2.997118	2.725448e-03	3.1
Egress time_pt	-0.223995	0.057986	-3.862894	1.120516e-04	4.1
Travel time_bod	-0.113864	0.012395	-9.186037	0.000000e+00	2.1
Travel time_car	-0.249123	0.027071	-9.202456	0.000000e+00	4.6
Travel time_pt	-0.113982	0.010538	-10.815917	0.000000e+00	2.1
Travel time_shared	-0.099708	0.015283	-6.524239	6.834755e-11	1.8

Table 4.3: The result of Biogeme for bad weather, see explanation of abbreviations in List of Abbreviations.

	Value	**Rob.Std err**	**Rob. t-test**	**Rob. p-value**	**kr/min**
ASC_bod	-0.488360	0.227581	-2.145874	3.188299e-02	-
ASC_car	0.897541	0.300451	2.987315	2.814395e-03	-
ASC_shared	-3.490084	0.596064	-5.855212	4.764033e-09	-
Cost	-0.044247	0.002540	-17.422345	0.000000e+00	-
Access time_pt	-0.092921	0.031671	-2.934000	3.346239e-03	2.1
Access time_shared	0.036043	0.085423	0.421940	6.730688e-01	0.8
Egress time_pt	-0.250065	0.060678	-4.121182	3.769327e-05	5.7
Travel time_bod	-0.095934	0.011968	-8.015678	1.110223e-15	2.2
Travel time_car	-0.207577	0.025712	-8.073082	6.661338e-16	4.7
Travel time_pt	-0.097297	0.010463	-9.298731	0.000000e+00	2.2
Travel time_shared	-0.089529	0.025056	-3.573100	3.527798e-04	2.0

To determine which alternative is most beneficial to choose based on the given values in Biogeme, one can look at the Alternative Specific Constants (ASC), see Table 4.2 and 4.3. *ASC_car* has the highest value and is therefore the most advantageous choice, indicating a higher utility function for choosing the car than the other alternatives. Then public transport is the second most beneficial, followed by the bus on-demand, and the least beneficial is shared bicycle/e-scooter. In bad weather conditions, the usage of *ASC_shared* varies significantly, as it is uncommon for individuals to choose shared bicycles/e-scooters as travel modes.

The result for good weather shows that people are willing to pay 4.6 kr to reduce one minute of the travel time of a car and 2.1 kr for a bus on-demand, see Table 4.2. This means that people would pay more to minimize the travel time in the car than bus on-demand. This may be because when driving a car, one must focus on driving, unlike when using public transportation, where passengers can relax. People would also pay 2.1 kr per minute for public transport to reduce travel time, 0.9 kr for access time, and 4.1 kr for egress time. Individuals' attitudes towards distance and time change, whether the experience is positive or not, this is explained more in Chapter 2.1.1 Distance and Time. The price difference that people are willing to pay for travel time, access time, and egress time of public transport differs since people rather travel with public transport than walk to their destination after getting off the public transport. This means that the time from the bus/train station to the destination matters more than the travel with the public transport. For shared bicycle/e-scooter the price individuals would have been willing to pay to reduce the travel time is 1.8 kr and for access time 3.1 kr, see Table 4.2. This could be because

it may be more pleasant to travel with a bicycle/e-shooter than to walk.

The result of bad weather shows that people would pay more to minimize the travel time in the car compared to public transport, which was the case for good weather as well. The travel behavior is similar in good and bad weather when comparing the values. In bad weather, people are willing to pay 2.1 kr for access time, 2.2 kr for travel time, and 5.7 kr for the egress time of public transport, see Table 4.3. It is reasonable that people are willing to pay more for the access time and egress time of public transport in bad weather since you are not protected from the weather. For bus on-demand people are willing to pay 2.2 kr in bad weather which is a higher price than in good weather. This could indicate that bus on-demand is more popular during the winter. People are also willing to pay more in bad weather to reduce one minute of travel time in a car, which could depend on the higher risk of traffic accidents in bad weather.

4.3 Personal Data of Biogeme

The personal data has also been processed in Biogeme in the same way as the general outcome of Biogeme. The personal data includes age, gender, household members and income. All data is collected from the responses from the survey. The results for the personal data in good weather are presented in Table 4.4 and for bad weather in Table 4.5. Age and income are divided into four levels where level one is set to zero, the benchmark. For gender, the woman is set as the benchmark, and one and two household members are set as the benchmark for household members. This means 'B_V_household1_bod' is three or more household members.

Table 4.4: The result of Biogeme for personal data in good weather.

	Value	**Rob.Std err**	**Rob. t-test**	**Rob. p-value**
B_V_age2_bod	0.275473	0.144810	1.902308	5.713091e-02
B_V_age3_bod	-0.079591	0.152590	-0.521598	6.019503e-01
B_V_age4_bod	0.146428	0.166556	0.879147	3.793215e-01
B_V_gender1_bod	-0.288213	0.116471	-2.474534	1.334101e-02
B_V_household1_bod	0.015240	0.117131	0.130115	8.964752e-01
B_V_income2_bod	-0.329417	0.134069	-2.457076	1.400731e-02
B_V_income3_bod	-0.352044	0.143167	-2.458979	1.393328e-02
B_V_income4_bod	-0.342619	0.217004	-1.578855	1.143693e-01

Table 4.5: The result of Biogeme for personal data in bad weather.

	Value	**Rob.Std err**	**Rob. t-test**	**Rob. p-value**
B_V_age2_bod	0.356440	0.138621	2.571326	1.013099e-02
B_V_age3_bod	-0.157460	0.146690	-1.073425	2.830807e-01
B_V_age4_bod	-0.214965	0.164712	-1.305099	1.918592e-01
B_V_gender1_bod	-0.299324	0.110008	-2.720920	6.510058e-03
B_V_household1_bod	-0.158754	0.112781	-1.407628	1.592412e-01
B_V_income2_bod	-0.423843	0.129896	-3.262943	1.102619e-03
B_V_income3_bod	-0.285482	0.136607	-2.089800	3.663578e-02
B_V_income4_bod	-0.425388	0.212438	-2.002408	4.524091e-02

Bus on-demand is the chosen travel mode to analyze how it is affected by personal data. Table 4.4 and Table 4.5 show the results for good respectively bad weather. Age level two (26-35 years) is more likely to use the bus on-demand than the youngest people, i.e. age level one. See the column 'Value' in 4.4. Age levels three and four i.e. 36 years and more, have a t-test under 1.5, which means that the values for B_V_age3_bod and B_V_age4_bod are unreliable and no firm conclusions can be drawn.

The results on how gender impacts travel behavior indicate that women are more likely to choose bus on-demand than men, regardless of the weather. This can be linked to Chapter Two Literature Review, which discusses the socioeconomic factor indicating a higher likelihood for women to choose public transport than men. This may be due to the association between femininity and environmentally friendly behavior, and men want to avoid being associated with feminine traits. The result from the survey indicates the same thing. Women would be more likely to choose bus on-demand compared to men.

Table 4.4 shows that households with three or more members are marginally more willing to travel by bus on-demand than households with one or two members. In Table 4.5, when the weather is bad, the opposite is observed. However, both of these have a low t-test so the values are unreliable.

The results of income show that despite the weather, income level one (0 kr - 23,200 kr) is always more willing to choose bus on-demand over all other income levels, see Table 4.4 and Table 4.5. What differentiates is that for bad weather, income level three (40,000 kr - 61,900 kr) would be more willing to choose bus on-demand than income levels two and four (23,200 kr - 40,000 and 61,900 kr +). However, the result is the opposite for good weather. The fact that those who earn the least are most willing to use bus on-demand probably indicates that people with high incomes could have access to a private car. People who already own a car often see

public transport as an added cost. They already pay for the car, so they might as well use it. As mentioned in Chapter 2.1.3 Cost.

4.4 Implemented Case Study in Lerum

A case study from Lerum station to the residential area Häcksjöbäck with all four travel modes was made. The result for good weather is presented in Table 4.6 and for bad weather in Table 4.7. The result clearly shows that a private car has the highest probability of being chosen. For good weather, the travel mode bus on-demand is the least conceivable option, closely followed by public transport. For bad weather, shared bike/e-scooter is the least likely option, followed by bus on-demand. That shared bicycle/e-scooter has the lowest probability in windy and cold weather, is very logical. The fact that the car became travel mode with the highest probability means that it is cheap and fast compared to the other options. Driving for three km was assumed to cost 24 kr, which was cheaper than all the other three travel mode options. The price did not include the cost of buying a car, only the fuel and parking costs. In addition, the car is also the fastest travel mode, and thereby the car has the highest probability of being chosen.

Table 4.6: The result of the case study for good weather.

Travel mode	**Probability**
Bus on-demand	4.6%
Public transport	5.9%
Shared bike/e-scooter	6.9%
Private car	82.6%

Table 4.7: The result of the case study for bad weather.

Travel mode	**Probability**
Bus on-demand	8.1%
Public transport	9.4%
Shared bike/e-scooter	1.1%
Private car	81.4%

If the goal is to get more people to use public transport/bus on-demand, the prices must be reduced. According to the survey, 29% of the people's main reason why they don't use public transport is because it is too expensive, see Appendix. People

won't choose it unless it's cheaper, especially if it takes a longer time. Otherwise, the car has to be more expensive to use. For example, if parking lot tickets increase in suburban areas the probability of using private cars would decrease. This will then result in that the probability for bus on-demand and public transport will increase. The second prevailing reason was that the accessibility to the bus station and the frequency of departures were too limited to opt for public transportation. Thus, bus on-demand would have been a solution to these concerns, as it relies on virtual bus stops that are located closer than existing ones. However, even if bus on-demand would be a solution to reduce car usage, the majority don't see themselves choosing that travel mode. This could be due to uncertainty about what bus on-demand entails, as well as the difficulty in changing the behavior that one is accustomed to. Prioritizing public transport and cycle paths in urban design could reduce travel time significantly for those travel modes (Trafikverket, 2017). At the same time, the travel time for a car will probably increase when it is not prioritized on the roads. This could result in a different outcome in the case study. Because if public transportation is prioritized and bus on-demand services in urban areas, individuals may become less reliant on owning a private car. In the survey, 71% of respondents reported having access to a car. For a trip of just 3 km, taking the car is cheaper compared to public transportation if one already owns a vehicle. This is because individuals have fixed costs such as insurance and ownership expenses, making them more likely to choose the car for that trip.

5
General Discussion

This chapter will discuss the general results of the master thesis, what factors may have influenced the results, and how bus on-demand works in reality when it was tested in Kinna. It will also go through how urban planning can change people's travel behavior and what the future of travel may look like.

5.1 Factors Influencing Results

The prioritization of factors such as time efficiency, cost, and comfort when choosing a travel mode was evident among respondents. Some examples of respondents' answers to why they do not choose public transport were: "Too expensive and takes too much time", "Expensive and sometimes unreliable", and "Few departures or long transfer times". See the Appendix for more examples. Notably, public transport and private cars emerged as the most commonly used modes of commuting to work or school. The likelihood of selecting a bus on-demand was lower compared to private cars and public transport. This could be attributed to its new way of traveling, leading to uncertainty among potential users regarding its functionality, benefits, and profitability. This is understandable, as studies show that individuals often choose familiar options (Forward, 2023). Västtrafik, Gothenburg's public transport company, is testing bus on-demand in Kinna which is located 61 km from Gothenburg. Feedback from both bus drivers and residents was overwhelmingly positive. The bus driver indicated significant demand since sometimes the driver operates non-stop for four hours due to high numbers of passengers. If the survey was available for areas that already use bus on-demand services, responses may have differed. In addition, the lower likelihood of choosing bus on-demand may be linked to the respondents' distance to a bus/train station that takes them to the city of Gothenburg. It was 70.9% that answered that they had 0-1 km to the bus station which means that the need for bus on-demand services is not huge since they have other alternatives. Unlike in Kinna, where the fixed route bus services are limited. It would be interesting to see if the result changes with more respondents that have three km or more to the close bus station that takes them to the city of Gothenburg.

5.2 Bus on-demand Tested in Reality

Bus on-demand in Kinna is a pilot project in the spring of 2024, and we were there one day to test it. The associated app was easy to understand and overall it felt smooth. Two buses were driving around the community and citizens seemed to use

the minibuses frequently. It picked up other travelers both times we tested it. The driver believes that bus on-demand will be implemented after this project as it is very appreciated in the area. Many people think it's luxurious to be picked up and dropped off so close to home, even though you live in the countryside. At the travel center in Kinna, there were clear signs informing about bus on-demand. This will probably be an important factor in the future, that a new travel mode must be marketed in a good way. Promoting it in a good and simple way leads to people being willing to try new modes of travel, which in long turns can lead to changing people's travel behavior.

5.3 Influence of Urban Planning

To reduce the environmental impact of traffic, ensure good air quality, and create a healthy sound environment, priority must be given to environmentally friendly travel modes. It requires a shift from cars to environmentally friendly alternatives instead. Such as walking, cycling, and public transport, where bus on-demand is part of public transport. For this shift to happen, public transport must be more attractive than cars. The results of the survey showed that time, price, and comfort are what people prioritize the most when traveling. Therefore, it means that public transport must be more time-efficient, affordable, and/or comfortable than cars for people to use. This can be done by prioritizing public transport in society. If public transport is for example prioritized in terms of road design, then both cost and time will be reduced. By giving public transportation priority, delays can be reduced, and punctuality can be improved. This leads to increased efficiency and decreased operating costs for public transportation. By prioritizing buses and trams over cars, travel time for public transport can be reduced and frequency increased. This can be done through public transport lanes and signal priority (Trafikverket, 2017). Prioritizing public transport over car traffic creates a fast and reliable service and raises the status of public transport. This in turn will make more people choose public transport over cars. Public transport systems can carry a large number of people in a relatively small space, making them much more efficient than individual cars. By encouraging more people to use public transport instead of driving, cities can significantly reduce traffic congestion on their roads, leading to shorter travel times, improved road safety, and reduced prices. Compared to individual cars, public transport produces fewer emissions per passenger, leading to improved air quality and reduced greenhouse gas emissions. This is particularly important in climate change, as reducing emissions from transportation is essential for mitigating its impacts and building more sustainable cities. Especially for Gothenburg to reach its goal of being an ecologically sustainable city by 2030, bus on-demand can be a helping hand.

5.4 Future Implication

Overall, bus on-demand services have the potential to revolutionize public transportation by offering greater flexibility, efficiency, accessibility, and sustainability.

As technology continues to improve and more cities embrace innovative transportation solutions, bus on-demand services are likely to play an important role in the future of travel in suburban areas.

Bus on-demand offers a flexible and convenient alternative to traditional fixed-route bus services. Passengers can request a ride using a mobile app and be picked up and dropped off at locations of their choice. By using algorithms to optimize routes and match passengers with vehicles, bus on-demand services can operate more efficiently, reducing wait times, travel times, and congestion, while also maximizing the use of available vehicles and resources. In suburban areas today, a common issue is the tendency for buses to run empty during off-peak hours (Jonmyren, 2023). With bus on-demand services, buses operate only when there is a travel demand, thereby maximizing efficiency and reducing unnecessary trips.

The future indicates an increase in population density, with many choosing to move into urban areas. This will lead to more congestion, poor air quality, and increased carbon dioxide emissions. Therefore, it is crucial to find a solution for everyday travel in the future. Cars are not a sustainable solution for a society living in congestion, whether they run on diesel or electricity. It will not be viable in the long run if the population continues to increase in the same direction. Therefore, we believe that bus on-demand is a solution to encourage people living in suburban areas to choose public transport instead of driving into the city center by car. They can take a bus on-demand to the nearest station and then continue their journey into the city center by public transport. For this to happen, the suburban area needs to have the right conditions and people need to be willing to change their travel habits. This will reduce the number of cars in the city, which in turn decreases carbon dioxide emissions, which finally will create more sustainable urban environments for future generations.

6
Conclusion

What are the attitudes of different individuals towards bus on-demand services?

Regarding the respondents' results, 60% of people's attitude toward implementing bus on-demand was positive. While the rest didn't care, some were partly positive and a small amount didn't want it to be implemented. This may be because some individuals already have good access to public transport. Living close to a bus or train station ensures that they are not dependent on bus on-demand services. The attitudes towards bus on-demand in Kinna were overwhelmingly positive from residents since it contributed to a flexible and accessible way of travel. One factor could be because the demand in Kinna is high since the fixed bus route doesn't cover the needs. There must be a need among the residents for people to choose bus on-demand. The need is higher for individuals living in suburban areas, like Kinna. Compared to individuals who live close to a bus or train station.

What is the mode choice behavior of bus on-demand services in different contents?

To understand people's mode choice behavior, it is necessary to investigate what people prioritize when choosing a mode of travel. According to the survey, the three main things people prioritize are time efficiency, price-worthy, and comfort. When the personal data was analyzed in Biogeme, it was found that people between ages 26-35 are more likely to choose bus on-demand compared to people between ages 0-25. In addition, women are more likely to choose bus on-demand than men. This finding is in line with research showing that women tend to use public transport more often due to its association with femininity and environmentally friendly practices. Moreover, regardless of weather conditions, individuals with an income between 0 kr and 23,200 kr show a consistently higher willingness to choose bus on-demand compared to other income groups. This preference among low-income individuals suggests that individuals with higher incomes may have access to a private car, which influences their choice of transportation mode.

What is the potential demand for using bus on-demand in Gothenburg's suburban areas?

The case study shows that the probability of using a bus on-demand in Lerum was lower compared to public transport and private cars. One factor could be the price, as it was one of the most expensive options for that specific trip if the cost of owning a car is not included. If bus on-demand was cheaper, the potential demand could

be higher. However, for bus on-demand to effectively replace people's dependency on private cars, it would need to be so successful in suburban areas that choosing it over owning a car. If the aim is to reduce car dependency, bus on-demand services must prioritize comfort, time, and cost. Furthermore, studies and analyses are necessary to determine where the need for bus on-demand services exists. For instance, it cannot be in densely populated areas where larger buses are preferred, nor can it be in too sparsely populated areas. Since it may not be financially viable for the bus on-demand company. A practical method is to conduct pilot tests in different suburban areas to identify the optimal conditions for introducing bus on-demand services. The test pilot can then investigate whether current travel behavior can be changed with the introduction of bus on-demand services. This will also provide insights into residents' willingness to use it and the perceived benefits compared to existing transportation options.

In conclusion, bus on-demand services offer a flexible, efficient, and sustainable alternative to traditional fixed-route bus services and have the potential to revolutionize public transportation in the future. As cities continue to grow and evolve, bus on-demand services will play an increasingly important role in providing accessible, and environmentally friendly transportation options for residents.

7
Limitations

While this study has provided valuable insights into travel behaviors and bus on-demand, it is important to acknowledge several limitations that may have impacted the findings and conclusions presented in this thesis. These limitations are addressed to provide a transparent assessment of the strengths and weaknesses of the research, as well as to offer guidance for future studies in this area.

Limitations in the study:

- One of the primary limitations of this study is the relatively narrow scope of respondents. Only 358 answers were collected, with more female respondents than males. These factors may have affected and limited the result.

- Another limitation of this study relates to the methods employed in the research process. All responses were made online on a computer or phone. This might initiate some bias in the results since older people may have difficulty understanding how the technology works. But, also the uncertainty that comes with the respondents interpreting the questions in the survey.

- It is not possible to know with certainty that respondents answer truthfully. Furthermore, there is also a risk that some do not have such good self-awareness of their real actions.

- Only four travel modes were included in the study. Walking and cycling with a private bike were not taken into account. These options may have influenced the results if they had been available.

- Human factors may have affected some single data when the data was compiled from the survey into Excel sheets.

- In Level of Attributes, bus on-demand, and public transport had different costs. There was a difference of five respectively 15 kr. But in reality, these two modes of transport have the same cost.

Future research in this area should include a comparison of more different travel modes. It could also include a focus on the frequency of public transport departures and not just the distance to the station. It is also important to investigate which geographical areas would be suitable for bus on-demand. In areas with too many people, regular buses should be used instead and in areas with too little population, bus-on-demand will not be suitable either. This is therefore an important factor

for the future in which suburban areas of Gothenburg bus on-demand should be implemented. This was a comprehensive study, future research could investigate in one specific suburban. Future research should also take into account what it takes to change an individual's travel behavior. This needs to be solved before a new transportation mode is implemented.

In conclusion, this study has provided valuable information. This study aims to contribute to the ongoing dialogue in this field by addressing these limitations and providing suggestions for future research.

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A
Appendix

Buss on-demand A

Denna undersökning är till för att hjälpa kollektivtrafiken i Göteborgsområdet. Ditt deltagande i denna studie är frivilligt, men mycket viktigt. Det är viktigt att du svarar så ärligt som möjligt. Undersökningen är helt anonym och tar ca 5-8 minuter att genomföra. Tack på förhand!

(This survey is to help public transports systems in areas around Gothenburg. Your participation in this study is voluntary, but very important. It is important that you answer as truthfully. The survey is totally anonymous and takes about 5-8 minutes to finish. Thank you in advance!)

* Anger obligatorisk fråga

1. Har du tillgång till bil i hushållet? *
(Do you have access to a private car?)

Markera endast en oval.

- ◯ Ja (Yes)
- ◯ Nej (No)

2. Hur långt har du från ditt hem till en hållplats/tågstation som tar dig in till Göteborgs centrum? *
(What is the distance between your home and nearest bus/train station that takes you into the Gothenburg centre?)

Markera endast en oval.

- ◯ 0-1 km
- ◯ 1-2 km
- ◯ 2-3 km
- ◯ 3-5 km
- ◯ 5+ km
- ◯ Vet ej (Don't know)

3. Hur ofta åker du kollektiv trafik till och från jobb/skola? *
(How often do you use public transport back and forth to work/school?)

Markera endast en oval.

- ◯ Varje dag (Every day)
- ◯ Flera gånger i veckan (Several times a week)
- ◯ 1-2 gånger i veckan (1-2 times a week)
- ◯ 1-2 gånger i månaden (1-2 times a month)
- ◯ Några gånger per år (A few times a year)
- ◯ Nästan aldrig (Almost never)

4. Hur tar du dig just nu till och från jobb/skola? Flera alternativ går att välja. *
(How are you currently getting back and forth to work/school? Multiple options are available)

Markera alla som gäller.

- ☐ Går/Springer (Walking/Running)
- ☐ Cyklar/El-sparkcykel (Bicycle/E-scooter)
- ☐ Buss/Spårvagn/Tåg (Bus/Tram/Train)
- ☐ Bil (Private car)
- ☐ Annat (Other)

5. Vilka 3 alternativ prioriterar du högst när du väljer transportsätt? *
(Which 3 options do you prioritize most when choosing a mode of transport?)

Markera alla som gäller.

- ☐ Tidseffektivt (Time efficient)
- ☐ Prisvärt (Priceworthy)
- ☐ Bekvämt (Comfortable)
- ☐ Säkerhet (Safety)
- ☐ Miljövänligt (Environmentally friendly)
- ☐ Hälsosamt (Healthy)
- ☐ Vädret (Weather)
- ☐ Annat (Other)

6. Vad får dig att INTE välja kollektivtrafik:
(What makes you NOT use public transport)

Buss on-demand 2 av 4

Bus on-demand är en minibuss som hämtar upp dig någonstans utanför ditt hem och som du kan beställa i en app. Minibussen hämtar även upp andra personer i samma område och kör sedan till slutdestinationen. Nedan kommer vi att utgå från 12 olika scenarier. Vänligen svara så ärligt som möjligt.

(Bus on-demand is a minibus that picks you up around your home that you can order in an app. The minubus will also pick up other people in the same area and then go to the final destination. Below we will assume 12 different scenarios. Please answer as honestly as possible.)

7. **I del 1** antar vi att vädret är soligt och att temperaturen är 18 grader. 6 olika scenarier med olika transportsätt antas. Välj ditt föredragna transportsätt i varje antaget scenario på ett ärligt sätt. *

Scenario 1.1, tänk dig att du behöver åka från hemmet till närmaste destination som tar dig till jobbet/skolan i bra väder (sol och 18 grader). Anta att du har de fyra alternativen i figuren nedan, och att du känner till restiden och kostnaden för varje alternativ, **vilket transportmedel föredrar du?**

(In Section 1, we assume the weather is sunny and temperature is 18 degrees. 6 different scenarios with different transport modes are assumed. Please choose your preferred transport mode in each assumed scenario honestly.

Scenario 1.1, imagine you need to go from home to the nearest destination that takes you to work/school in good weather (sunny and 18 degrees). Assume you have the four options in the below figure, and you know the travel time and cost of each option, which transport mode do you prefer?)

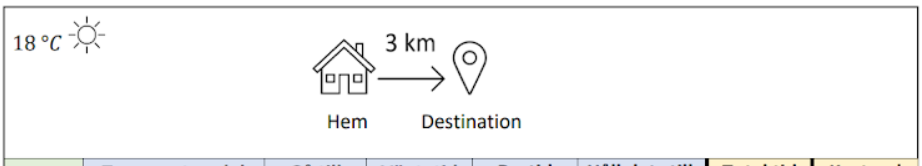
	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		1 min	25 min		26 min	10 kr
Val B:	Kollektivtrafik	8 min		20 min	5 min	33 min	10 kr
Val C:	Delad cykel /Elsparkcykel	4 min		8 min		12 min	35 kr
Val D:	Privat bil			10 min		10 min	70 kr

Markera endast en oval.

- Val A
- Val B
- Val C
- Val D

8. Det nya scenariot 1.2 skiljer sig från tidigare scenarier. Restiden och kostnaden för olika transportsätt har förändrats, vilket visas i figuren nedan. Vilket transportsätt föredrar du? *

(*In the new scenario 1.2 different from previous scenarios. The travel time and cost of different transport modes has changed shown in below figure. Which transport mode do you prefer?*)



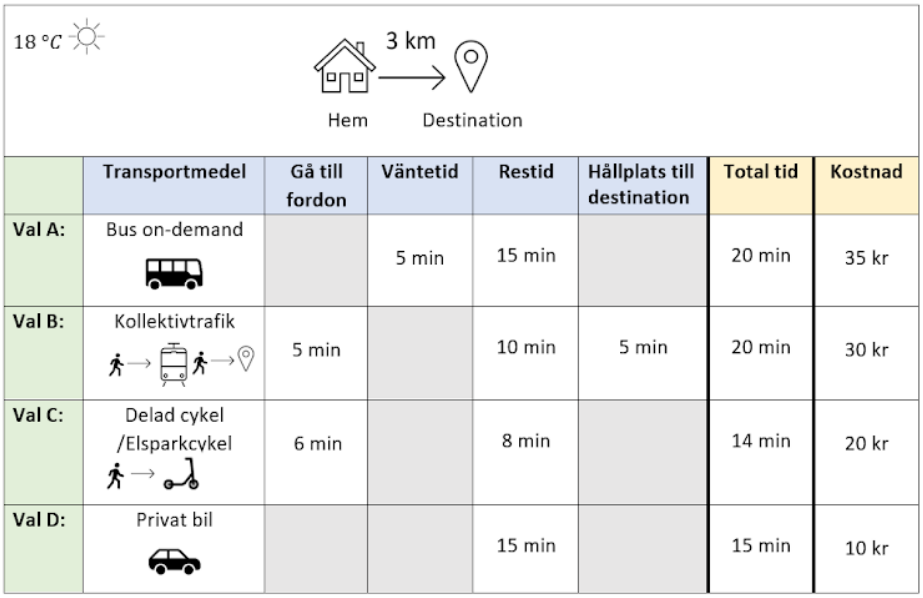
	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		1 min	10 min		11 min	55 kr
Val B:	Kollektivtrafik	2 min		10 min	1 min	13 min	40 kr
Val C:	Delad cykel /Elsparkcykel	2 min		14 min		16 min	50 kr
Val D:	Privat bil			5 min		5 min	90 kr

Markera endast en oval.

- ◯ Val A
- ◯ Val B
- ◯ Val C
- ◯ Val D

9. Det nya scenariot 1.3 skiljer sig från tidigare scenarier. Restiden och kostnaden för olika transportsätt har förändrats, vilket visas i figuren nedan. Vilket transportsätt föredrar du? *

(*In the new scenario 1.3 different from previous scenarios. The travel time and cost of different transport modes has changed shown in below figure. Which transport mode do you prefer?*)



	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		5 min	15 min		20 min	35 kr
Val B:	Kollektivtrafik	5 min		10 min	5 min	20 min	30 kr
Val C:	Delad cykel /Elsparkcykel	6 min		8 min		14 min	20 kr
Val D:	Privat bil			15 min		15 min	10 kr

Markera endast en oval.

- ◯ Val A
- ◯ Val B
- ◯ Val C
- ◯ Val D

10. Det nya scenariot 1.4 skiljer sig från tidigare scenarier. Restiden och kostnaden för olika transportsätt har förändrats, vilket visas i figuren nedan. Vilket transportsätt föredrar du? *

(*In the new scenario 1.4 different from previous scenarios. The travel time and cost of different transport modes has changed shown in below figure. Which transport mode do you prefer?*)

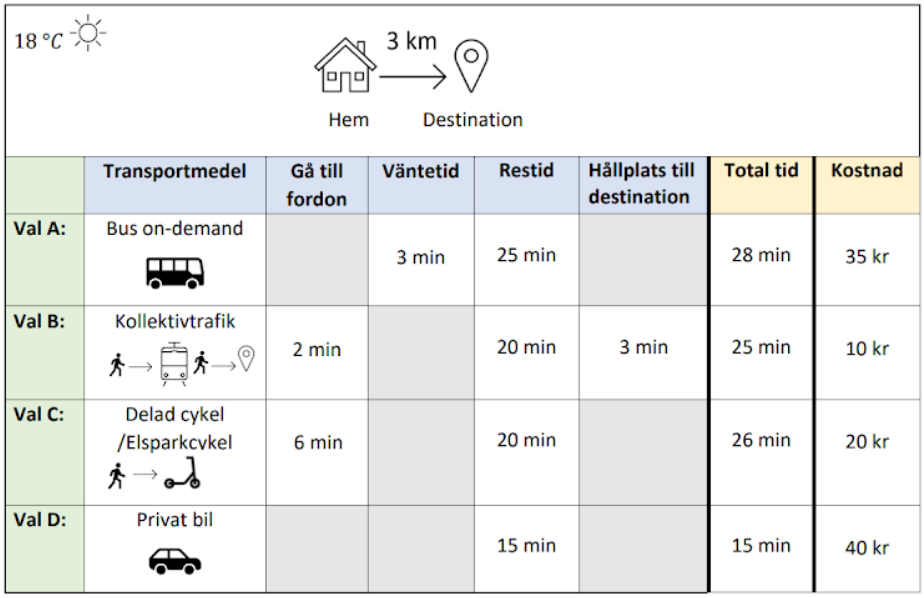
	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		3 min	15 min		18 min	55 kr
Val B:	Kollektivtrafik	8 min		30 min	5 min	43 min	30 kr
Val C:	Delad cykel /Elsparkcykel	2 min		20 min		22 min	50 kr
Val D:	Privat bil			10 min		10 min	70 kr

Markera endast en oval.

- ◯ Val A
- ◯ Val B
- ◯ Val C
- ◯ Val D

11. Det nya scenariot 1.5 skiljer sig från tidigare scenarier. Restiden och kostnaden för olika transportsätt har förändrats, vilket visas i figuren nedan. Vilket transportsätt föredrar du? *

(*In the new scenario 1.5 different from previous scenarios. The travel time and cost of different transport modes has changed shown in below figure. Which transport mode do you prefer?*)



	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		3 min	25 min		28 min	35 kr
Val B:	Kollektivtrafik	2 min		20 min	3 min	25 min	10 kr
Val C:	Delad cykel /Elsparkcykel	6 min		20 min		26 min	20 kr
Val D:	Privat bil			15 min		15 min	40 kr

Markera endast en oval.

- ◯ Val A
- ◯ Val B
- ◯ Val C
- ◯ Val D

12. Det nya scenariot 1.6 skiljer sig från tidigare scenarier. Restiden och kostnaden för olika transportsätt har förändrats, vilket visas i figuren nedan. Vilket transportsätt föredrar du? *

(*In the new scenario 1.6 different from previous scenarios. The travel time and cost of different transport modes has changed shown in below figure. Which transport mode do you prefer?*)

	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		5 min	10 min		15 min	10 kr
Val B:	Kollektivtrafik	5 min		20 min	1 min	26 min	40 kr
Val C:	Delad cykel /Elsparkcykel	4 min		20 min		24 min	35 kr
Val D:	Privat bil			5 min		5 min	70 kr

Markera endast en oval.

- ◯ Val A
- ◯ Val B
- ◯ Val C
- ◯ Val D

Del 2, dåligt väder (Section 2, bad weather) 3 av 4

13. **I del 2** antar vi att vädret är blåsigt och att temperaturen är 0 grader. 6 olika scenarier med olika transportsätt antas. Välj ditt föredragna transportsätt i varje antaget scenario på ett ärligt sätt. *

Scenario 2.1, tänk dig att du behöver åka från hemmet till närmaste destination som tar dig till jobbet/skolan i dåligt väder (blåsigt och 0 grader). Anta att du har de fyra alternativen i figuren nedan, och att du känner till restiden och kostnaden för varje alternativ, **vilket transportmedel föredrar du?**

(In Section 2, we assume new case: the weather is windy and temperature is 0 degrees. 6 different scenarios with different transport modes are assumed. Please choose your preferred transport mode in each assumed scenario honestly.

Scenario 2.1, imagine you need to go from home to the nearest destination that takes you to work/school in bad weather (windy and 0 degrees). Assume you have the four options in the below figure, and you know the travel time and cost of each option, which transport mode do you prefer?)

	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		1 min	25 min		26 min	10 kr
Val B:	Kollektivtrafik	2 min		20 min	3 min	25 min	40 kr
Val C:	Delad cykel /Elsparkcykel	2 min		14 min		16 min	50 kr
Val D:	Privat bil			5 min		5 min	90 kr

Markera endast en oval.

- Val A
- Val B
- Val C
- Val D

14. Det nya scenariot 2.2 skiljer sig från tidigare scenarier. Restiden och kostnaden för olika transportsätt har förändrats, vilket visas i figuren nedan. Vilket transportsätt föredrar du i dåligt väder (blåsigt och 0 grader)? *

(*In the new scenario 2.2 different from previous scenarios. The travel time and cost of different transport modes has changed shown in below figure. Which transport mode do you prefer in bad weather (windy and 0 degrees)?*)

	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		1 min	10 min		11 min	55 kr
Val B:	Kollektivtrafik	2 min		10 min	1 min	13 min	40 kr
Val C:	Delad cykel /Elsparkcykel	2 min		20 min		22 min	50 kr
Val D:	Privat bil			5 min		5 min	90 kr

Markera endast en oval.

- Val A
- Val B
- Val C
- Val D

15. Det nya scenariot 2.3 skiljer sig från tidigare scenarier. Restiden och kostnaden för olika transportsätt har förändrats, vilket visas i figuren nedan. Vilket transportsätt föredrar du i dåligt väder (blåsigt och 0 grader)? *

(*In the new scenario 2.3 different from previous scenarios. The travel time and cost of different transport modes has changed shown in below figure. Which transport mode do you prefer in bad weather (windy and 0 degrees)?*)

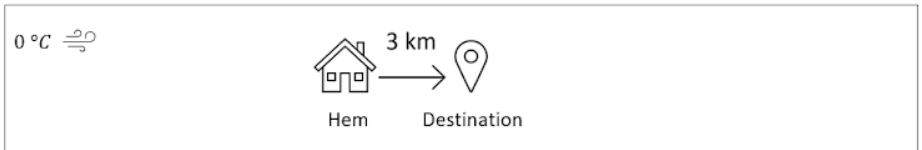
	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		3 min	25 min		28 min	35 kr
Val B:	Kollektivtrafik	8 min		10 min	5 min	23 min	10 kr
Val C:	Delad cykel /Elsparkcykel	6 min		8 min		14 min	20 kr
Val D:	Privat bil			10 min		10 min	40 kr

Markera endast en oval.

- Val A
- Val B
- Val C
- Val D

16. Det nya scenariot 2.4 skiljer sig från tidigare scenarier. Restiden och kostnaden för olika transportsätt har förändrats, vilket visas i figuren nedan. Vilket transportsätt föredrar du i dåligt väder (blåsigt och 0 grader)? *

(*In the new scenario 2.4 different from previous scenarios. The travel time and cost of different transport modes has changed shown in below figure. Which transport mode do you prefer in bad weather (windy and 0 degrees)?*)



	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		5 min	15 min		20 min	35 kr
Val B:	Kollektivtrafik	5 min		30 min	3 min	38 min	30 kr
Val C:	Delad cykel /Elsparkcykel	4 min		14 min		18 min	35 kr
Val D:	Privat bil			15 min		15 min	10 kr

Markera endast en oval.

- Val A
- Val B
- Val C
- Val D

17. Det nya scenariot 2.5 skiljer sig från tidigare scenarier. Restiden och kostnaden för olika transportsätt har förändrats, vilket visas i figuren nedan. Vilket transportsätt föredrar du i dåligt väder (blåsigt och 0 grader)? *

(*In the new scenario 2.5 different from previous scenarios. The travel time and cost of different transport modes has changed shown in below figure. Which transport mode do you prefer in bad weather (windy and 0 degrees)?*)

	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		5 min	10 min		15 min	10 kr
Val B:	Kollektivtrafik	8 min		30 min	1 min	39 min	10 kr
Val C:	Delad cykel /Elsparkcykel	4 min		8 min		12 min	35 kr
Val D:	Privat bil			10 min		10 min	40 kr

Markera endast en oval.

- ◯ Val A
- ◯ Val B
- ◯ Val C
- ◯ Val D

18. Det nya scenariot 2.6 skiljer sig från tidigare scenarier. Restiden och kostnaden för olika transportsätt har förändrats, vilket visas i figuren nedan. Vilket transportsätt föredrar du i dåligt väder (blåsigt och 0 grader)? *

(*In the new scenario 2.6 different from previous scenarios. The travel time and cost of different transport modes has changed shown in below figure. Which transport mode do you prefer in bad weather (windy and 0 degrees)?*)

	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		3 min	15 min		18 min	55 kr
Val B:	Kollektivtrafik	5 min		30 min	3 min	38 min	30 kr
Val C:	Delad cykel /Elsparkcykel	6 min		14 min		20 min	20 kr
Val D:	Privat bil			15 min		15 min	10 kr

Markera endast en oval.

- Val A
- Val B
- Val C
- Val D

Allmänt (Generally) 4 av 4

19. Ser du positivt på att införa buss on-demand?
(Are you supportive of introducing bus on-demand?)

Markera endast en oval.

- 1 - Nej (No)
- 2 - Delvis (Partly)
- 3 - Spelar ingen roll (It dosen't matter)
- 4 - Ja (Yes)
- 5 - Ja väldigt positiv (Yes very positive)

20. Kön (Gender)

Markera endast en oval.

- Kvinna (Female)
- Man (Male)
- Icke binär (Non-binary)
- Vill inte ange (Prefer not to say)

21. Ålder? (Age?)

Markera endast en oval.

- 0-15
- 16-25
- 26-35
- 36-55
- 56-75
- 75+

22. Vad är din månadsinkomst innan skatt?
(Monthly income, pre-tax)

Markera endast en oval.

- ◯ 0 kr
- ◯ 0-15 500 kr
- ◯ 15 500 - 23 200 kr
- ◯ 23 200 - 40 000 kr
- ◯ 40 000 - 61 900 kr
- ◯ 61 900 + kr
- ◯ Vill ej ange (Prefer not to tell)

23. Vad har du för avklarad utbildning?
(Highest completed education?)

Markera endast en oval.

- ◯ Grundskola (Primary school)
- ◯ Gymnasiet (High school)
- ◯ Högskola 1-3 år (University 1-3 years)
- ◯ Högskola 3-5 år (University 3-5 years)
- ◯ Högre utbildning (Higher education)
- ◯ Vill ej ange (Prefer not to say)

24. Hur många bor i ditt hushållet?
(How many households people live in your home?)

Markera endast en oval.

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5 +

25. Har du månads- eller årskort för kollektivtrafiken?
(Do you have monthly or yearly public transit ticket?)

Markera endast en oval.

- ◯ Ja månadskort (Yes monthly)
- ◯ Ja årskort (Yes yearly)
- ◯ Nej (No)

Buss on-demand B

Denna undersökning är till för att hjälpa kollektivtrafiken i Göteborgsområdet. Ditt deltagande i denna studie är frivilligt, men mycket viktigt. Det är viktigt att du svarar så ärligt som möjligt. Undersökningen är helt anonym och tar ca 5-8 minuter att genomföra. Tack på förhand!

(This survey is to help public transports systems in areas around Gothenburg. Your participation in this study is voluntary, but very important. It is important that you answer as truthfully. The survey is totally anonymous and takes about 5-8 minutes to finish. Thank you in advance!)

* Anger obligatorisk fråga

1. Har du tillgång till bil i hushållet? *
(Do you have access to a private car?)

Markera endast en oval.

- ◯ Ja (Yes)
- ◯ Nej (No)

2. Hur långt har du från ditt hem till en hållplats/tågstation som tar dig in till Göteborgs centrum? *
(What is the distance between your home and the nearest bus/train station that takes you into Gothenburg centre?)

Markera endast en oval.

- ◯ 0-1 km
- ◯ 1-2 km
- ◯ 2-3 km
- ◯ 3-5 km
- ◯ 5+ km
- ◯ Vet ej (Don't know)

3. Hur ofta åker du kollektiv trafik till och från jobb/skola? *
(How often do you use public transport back and forth to work/school?)

Markera endast en oval.

- ◯ Varje dag (Every day)
- ◯ Flera gånger i veckan (Several times a week)
- ◯ 1-2 gånger i veckan (1-2 times a week)
- ◯ 1-2 gånger i månaden (1-2 times a month)
- ◯ Några gånger per år (A few times a year)
- ◯ Nästan aldrig (Almost never)

4. Hur tar du dig just nu till och från jobb/skola? Flera alternativ går att välja. *
(How are you currently getting back and forth to work/school? Multiple options are available)

Markera alla som gäller.

- ☐ Går/Springer (Walking/Running)
- ☐ Cyklar/El-sparkcykel (Bicycle/E-scooter)
- ☐ Buss/Spårvagn (Bus/Tram)
- ☐ Bil (Private car)
- ☐ Annat (Other)
- ☐ Övrigt: _____

5. Vilka 3 alternativ prioriterar du högst när du väljer transportsätt? *
(Which 3 options do you prioritize most when choosing a mode of transport?)

Markera alla som gäller.

- ☐ Tidseffektivt (Time efficient)
- ☐ Prisvärt (Priceworthy)
- ☐ Bekvämt (Comfortable)
- ☐ Säkerhet (Safety)
- ☐ Miljövänligt (Environmentally friendly)
- ☐ Hälsosamt (Healthy)
- ☐ Vädret (Weather)
- ☐ Annat (Other)

6. Vad får dig att INTE välja kollektivtrafik:
(What makes you NOT use public transport)

Buss on-demand 2 av 4

Bus on-demand är en minibuss som hämtar upp dig någonstans utanför ditt hem och som du kan beställa i en app. Minibussen hämtar även upp andra personer i samma område och kör sedan till slutdestinationen. Nedan kommer vi att utgå från 12 olika scenarier. Vänligen svara så ärligt som möjligt.

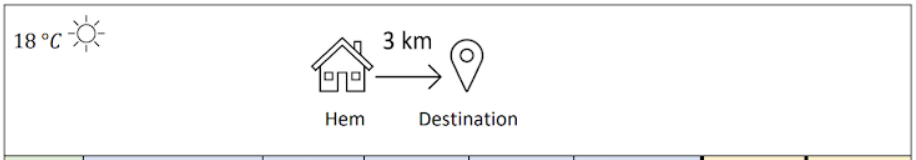
(Bus on-demand is a minibus that picks you up around your home that you can order in an app. The minubus will also pick up other people in the same area and then go to the final destination. Below we will assume 12 different scenarios. Please answer as honestly as possible.)

7. **I del 1** antar vi att vädret är soligt och att temperaturen är 18 grader. 6 olika scenarier med olika transportsätt antas. Välj ditt föredragna transportsätt i varje antaget scenario på ett ärligt sätt. *

Scenario 1.1, tänk dig att du behöver åka från hemmet till närmaste destination som tar dig till jobbet/skolan i bra väder (sol och 18 grader). Anta att du har de fyra alternativen i figuren nedan, och att du känner till restiden och kostnaden för varje alternativ, **vilket transportmedel föredrar du?**

(In Section 1, we assume the weather is sunny and temperature is 18 degrees. 6 different scenarios with different transport modes are assumed. Please choose your preferred transport mode in each assumed scenario honestly.

Scenario 1.1, imagine you need to go from home to the nearest destination that takes you to work/school in good weather (sunny and 18 degrees). Assume you have the four options in the below figure, and you know the travel time and cost of each option, which transport mode do you prefer?)



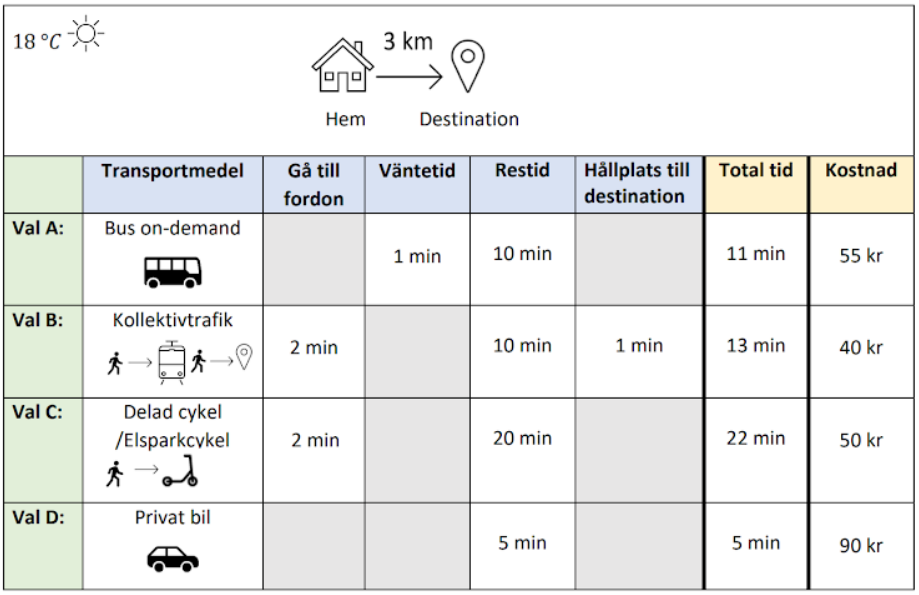
	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		1 min	25 min		26 min	10 kr
Val B:	Kollektivtrafik	2 min		20 min	3 min	25 min	40 kr
Val C:	Delad cykel /Elsparkcykel	2 min		14 min		16 min	50 kr
Val D:	Privat bil			5 min		5 min	90 kr

Markera endast en oval.

- Val A
- Val B
- Val C
- Val D

8. Det nya scenariot 1.2 skiljer sig från tidigare scenarier. Restiden och kostnaden för olika transportsätt har förändrats, vilket visas i figuren nedan. Vilket transportsätt föredrar du? *

(*In the new scenario 1.2 different from previous scenarios. The travel time and cost of different transport modes has changed shown in below figure. Which transport mode do you prefer?*)



	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		1 min	10 min		11 min	55 kr
Val B:	Kollektivtrafik	2 min		10 min	1 min	13 min	40 kr
Val C:	Delad cykel /Elsparkcykel	2 min		20 min		22 min	50 kr
Val D:	Privat bil			5 min		5 min	90 kr

Markera endast en oval.

- ◯ Val A
- ◯ Val B
- ◯ Val C
- ◯ Val D

9. Det nya scenariot 1.3 skiljer sig från tidigare scenarier. Restiden och kostnaden för olika transportsätt har förändrats, vilket visas i figuren nedan. Vilket transportsätt föredrar du? *

(*In the new scenario 1.3 different from previous scenarios. The travel time and cost of different transport modes has changed shown in below figure. Which transport mode do you prefer?*)

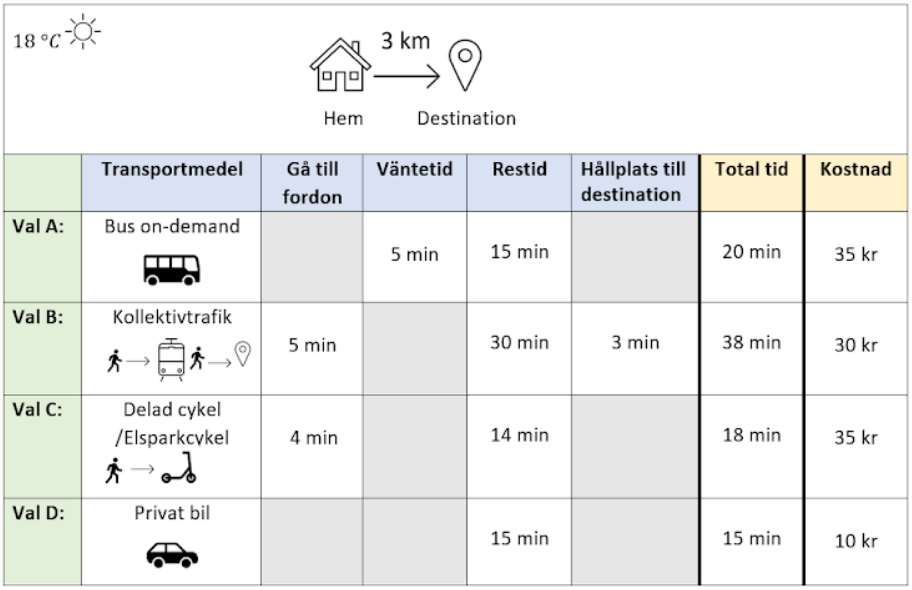
	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		3 min	25 min		28 min	35 kr
Val B:	Kollektivtrafik	8 min		10 min	5 min	23 min	10 kr
Val C:	Delad cykel /Elsparkcykel	6 min		8 min		14 min	20 kr
Val D:	Privat bil			10 min		10 min	40 kr

Markera endast en oval.

- ◯ Val A
- ◯ Val B
- ◯ Val C
- ◯ Val D

10. Det nya scenariot 1.4 skiljer sig från tidigare scenarier. Restiden och kostnaden för olika transportsätt har förändrats, vilket visas i figuren nedan. Vilket transportsätt föredrar du? *

(*In the new scenario 1.4 different from previous scenarios. The travel time and cost of different transport modes has changed shown in below figure. Which transport mode do you prefer?*)



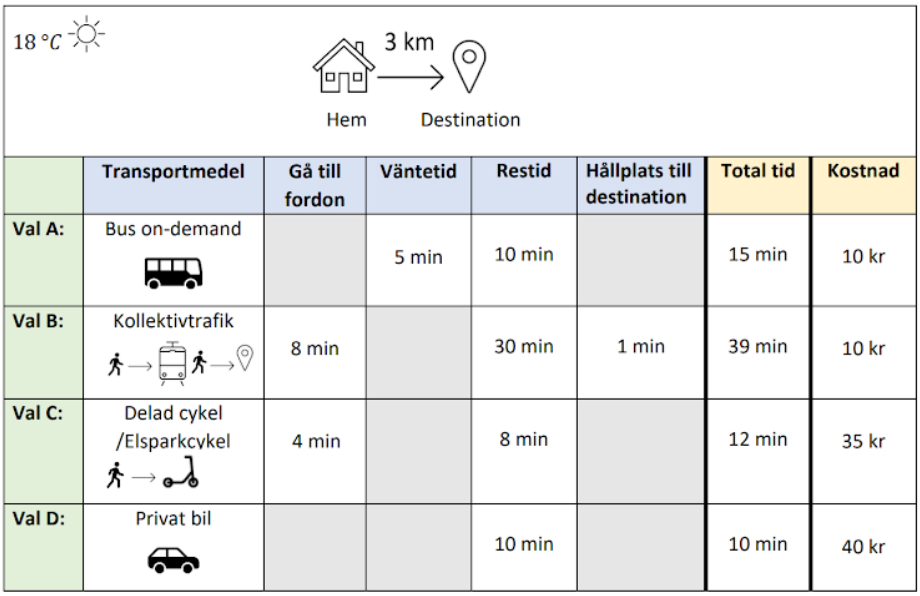
	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		5 min	15 min		20 min	35 kr
Val B:	Kollektivtrafik	5 min		30 min	3 min	38 min	30 kr
Val C:	Delad cykel /Elsparkcykel	4 min		14 min		18 min	35 kr
Val D:	Privat bil			15 min		15 min	10 kr

Markera endast en oval.

- Val A
- Val B
- Val C
- Val D

11. Det nya scenariot 1.5 skiljer sig från tidigare scenarier. Restiden och kostnaden för olika transportsätt har förändrats, vilket visas i figuren nedan. Vilket transportsätt föredrar du? *

(*In the new scenario 1.5 different from previous scenarios. The travel time and cost of different transport modes has changed shown in below figure. Which transport mode do you prefer?*)



	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		5 min	10 min		15 min	10 kr
Val B:	Kollektivtrafik	8 min		30 min	1 min	39 min	10 kr
Val C:	Delad cykel /Elsparkcykel	4 min		8 min		12 min	35 kr
Val D:	Privat bil			10 min		10 min	40 kr

Markera endast en oval.

- ◯ Val A
- ◯ Val B
- ◯ Val C
- ◯ Val D

12. Det nya scenariot 1.6 skiljer sig från tidigare scenarier. Restiden och kostnaden för olika transportsätt har förändrats, vilket visas i figuren nedan. Vilket transportsätt föredrar du? *

(*In the new scenario 1.6 different from previous scenarios. The travel time and cost of different transport modes has changed shown in below figure. Which transport mode do you prefer?*)

	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		3 min	15 min		18 min	55 kr
Val B:	Kollektivtrafik	5 min		30 min	3 min	38 min	30 kr
Val C:	Delad cykel /Elsparkcykel	6 min		14 min		20 min	20 kr
Val D:	Privat bil			15 min		15 min	10 kr

Markera endast en oval.

- Val A
- Val B
- Val C
- Val D

Del 2, dåligt väder (Section 2, bad weather) 3 av 4

13. **I del 2** antar vi att vädret är blåsigt och att temperaturen är 0 grader. 6 olika scenarier med olika transportsätt antas. Välj ditt föredragna transportsätt i varje antaget scenario på ett ärligt sätt. *

Scenario 2.1, tänk dig att du behöver åka från hemmet till närmaste destination som tar dig till jobbet/skolan i dåligt väder (blåsigt och 0 grader). Anta att du har de fyra alternativen i figuren nedan, och att du känner till restiden och kostnaden för varje alternativ, **vilket transportmedel föredrar du?**

(In Section 2, we assume new case: the weather is windy and temperature is 0 degrees. 6 different scenarios with different transport modes are assumed. Please choose your preferred transport mode in each assumed scenario honestly.

Scenario 2.1, imagine you need to go from home to the nearest destination that takes you to work/school in bad weather (windy and 0 degrees). Assume you have the four options in the below figure, and you know the travel time and cost of each option, which transport mode do you prefer?)

	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		1 min	25 min		26 min	10 kr
Val B:	Kollektivtrafik	8 min		20 min	5 min	33 min	10 kr
Val C:	Delad cykel /Elsparkcykel	4 min		8 min		12 min	35 kr
Val D:	Privat bil			10 min		10 min	70 kr

Markera endast en oval.

- ◯ Val A
- ◯ Val B
- ◯ Val C
- ◯ Val D

14. Det nya scenariot 2.2 skiljer sig från tidigare scenarier. Restiden och kostnaden för olika transportsätt har förändrats, vilket visas i figuren nedan. Vilket transportsätt föredrar du i dåligt väder (blåsigt och 0 grader)? *

(*In the new scenario 2.2 different from previous scenarios. The travel time and cost of different transport modes has changed shown in below figure. Which transport mode do you prefer in bad weather (windy and 0 degrees)?*)

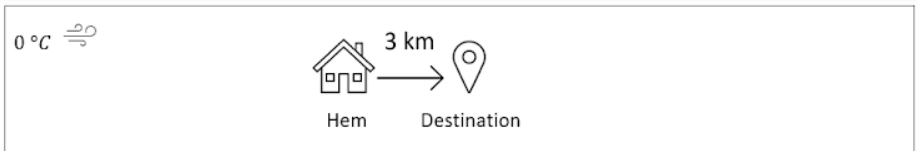
	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		1 min	10 min		11 min	55 kr
Val B:	Kollektivtrafik	2 min		10 min	1 min	13 min	40 kr
Val C:	Delad cykel /Elsparkcykel	2 min		14 min		16 min	50 kr
Val D:	Privat bil			5 min		5 min	90 kr

Markera endast en oval.

- Val A
- Val B
- Val C
- Val D

15. Det nya scenariot 2.3 skiljer sig från tidigare scenarier. Restiden och kostnaden för olika transportsätt har förändrats, vilket visas i figuren nedan. Vilket transportsätt föredrar du i dåligt väder (blåsigt och 0 grader)? *

(*In the new scenario 2.3 different from previous scenarios. The travel time and cost of different transport modes has changed shown in below figure. Which transport mode do you prefer in bad weather (windy and 0 degrees)?*)



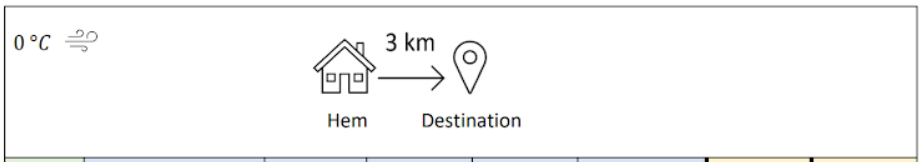
	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		5 min	15 min		20 min	35 kr
Val B:	Kollektivtrafik	5 min		10 min	5 min	20 min	30 kr
Val C:	Delad cykel /Elsparkcykel	6 min		8 min		14 min	20 kr
Val D:	Privat bil			15 min		15 min	10 kr

Markera endast en oval.

- Val A
- Val B
- Val C
- Val D

16. Det nya scenariot 2.4 skiljer sig från tidigare scenarier. Restiden och kostnaden för olika transportsätt har förändrats, vilket visas i figuren nedan. Vilket transportsätt föredrar du i dåligt väder (blåsigt och 0 grader)? *

(*In the new scenario 2.4 different from previous scenarios. The travel time and cost of different transport modes has changed shown in below figure. Which transport mode do you prefer in bad weather (windy and 0 degrees)?*)



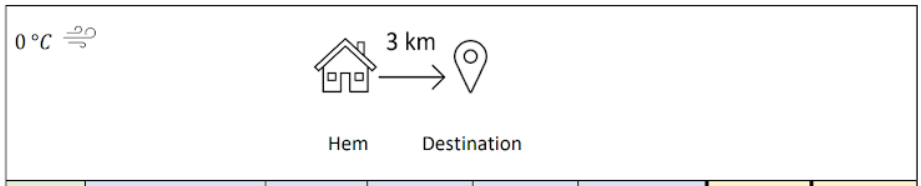
	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		3 min	15 min		18 min	55 kr
Val B:	Kollektivtrafik	8 min		30 min	5 min	43 min	30 kr
Val C:	Delad cykel /Elsparkcykel	2 min		20 min		22 min	50 kr
Val D:	Privat bil			10 min		10 min	70 kr

Markera endast en oval.

- Val A
- Val B
- Val C
- Val D

17. Det nya scenariot 2.2 skiljer sig från tidigare scenarier. Restiden och kostnaden för olika transportsätt har förändrats, vilket visas i figuren nedan. Vilket transportsätt föredrar du i dåligt väder (blåsigt och 0 grader)? *

(*In the new scenario 2.5 different from previous scenarios. The travel time and cost of different transport modes has changed shown in below figure. Which transport mode do you prefer in bad weather (windy and 0 degrees)?*)



	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		3 min	25 min		28 min	35 kr
Val B:	Kollektivtrafik	2 min		20 min	3 min	25 min	10 kr
Val C:	Delad cykel /Elsparkcykel	6 min		20 min		26 min	20 kr
Val D:	Privat bil			15 min		15 min	40 kr

Markera endast en oval.

- Val A
- Val B
- Val C
- Val D

18. Det nya scenariot 2.6 skiljer sig från tidigare scenarier. Restiden och kostnaden för olika transportsätt har förändrats, vilket visas i figuren nedan. Vilket transportsätt föredrar du i dåligt väder (blåsigt och 0 grader)? *

(*In the new scenario 2.6 different from previous scenarios. The travel time and cost of different transport modes has changed shown in below figure. Which transport mode do you prefer in bad weather (windy and 0 degrees)?*)

	Transportmedel	Gå till fordon	Väntetid	Restid	Hållplats till destination	Total tid	Kostnad
Val A:	Bus on-demand		5 min	10 min		15 min	10 kr
Val B:	Kollektivtrafik	5 min		20 min	1 min	26 min	40 kr
Val C:	Delad cykel /Elsparkcykel	4 min		20 min		24 min	35 kr
Val D:	Privat bil			5 min		5 min	70 kr

Markera endast en oval.

- Val A
- Val B
- Val C
- Val D

Allmänt (Generally) 4 av 4

19. Ser du positivt på att införa buss on-demand?
(Are you supportive of introducing bus on-demand?)

Markera endast en oval.

- 1 - Nej (No)
- 2 - Delvis (Partly)
- 3 - Spelar ingen roll (It dosen't matter)
- 4 - Ja (Yes)
- 5 - Ja väldigt positiv (Yes very positive)

20. Kön (Gender)

Markera endast en oval.

- Kvinna (Female)
- Man (Male)
- Icke binär (Non-binary)
- Vill inte ange (Prefer not to say)

21. Ålder? (Age?)

Markera endast en oval.

- 0-15
- 16-25
- 26-35
- 36-55
- 56-75
- 75+

22. Vad är din månadsinkomst innan skatt?
(Monthly income, pre-tax)

Markera endast en oval.

- ◯ 0 kr
- ◯ 0 - 15 500 kr
- ◯ 15 500 - 23 200 kr
- ◯ 23 200 - 40 000 kr
- ◯ 40 000 - 61 900 kr
- ◯ 61 900 + kr
- ◯ Vill ej ange (Prefer not to tell)

23. Vad har du för avklarad utbildning?
(Highest completed education?)

Markera endast en oval.

- ◯ Grundskola (Primary school)
- ◯ Gymnasiet (High school)
- ◯ Högskola 1-3 år (University 1-3 years)
- ◯ Högskola 3-5 år (University 3-5 years)
- ◯ Högre utbildning (Higher education)
- ◯ Vill ej ange (Prefer not to say)

24. Hur många bor i ditt hushållet?
(How many households people live in your home?)

Markera endast en oval.

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5 +

25. Har du månads- eller årskort för kollektivtrafiken?
(Do you have monthly or yearly public transit ticket?)

Markera endast en oval.

- ◯ Ja månadskort (Yes monthly)
- ◯ Ja årskort (Yes yearly)
- ◯ Nej (No)

Survey A What makes you NOT choose public transport: Vad får dig att INTE välja kollektivtrafik:
Dyrt och dålig tillgänglighet
Avståndet till busshållplatsen samt att de inte går så ofta.
Långa väntetider eller biljettkontrollanter
har bil
För dyrt och tar lång tid
Kontrollanter
Dyrt!
Priset
Tiden och priset
Billigare att gå
Oregelbundna tider
Att de kan vara mycket folk och att det inte alltid går att lite på tiderna.
Långa väntetider
För mycket folk.
Dyrt eller förseningar
Dyrt, opraktiskt vid handlig/ andra ärende, tids krävanden efter jobb/ skola
Behöver bil dit jag ska, Tidsvinst, oprktiskt med packning
Om resan är under fem minuter (ej prisvärt). Om det inte regnar och går fortare att cykla, då tar jag cykeln.
Att det går fortare att gå eller tillgång till annan skjuts
Dyrt och icke tidsmässigt lönsamt
Trångt, kräver mer planering i förtid, inte så bekvämt
ticket costs
Dyrt som tusan. Varför har de inte studentbiljetter på 90 min-biljetter?
Kan ta längre tid
Dyrt
Dyrt och onödigt. Jag bor 20 min gångväg från skolan och en spårvagnsresa tar ungefär 15 min
Om det tar för lång tid/många byten
Bussbiljetterna och månadskortet är för dyra för att överväga kollektivtrafik
Bekvämligheten med att bara kunna ta sin egna bil, orkar inte lägga tid på väntan och gångavstånd med kollektivtrafik.
Dyrt och ibland opålitligt, samt tar längre tid
Mer bekvämt och tideffektivt med bil
Lokala resorna är dyra och det tar längre tid.
Jobbigt att trängas och för dyrt med enkelbiljetter
Dyrt
Att jag måste byta minst en gång oftast med lång väntetid!
Priset
Time table
Få avgångar eller långa bytestider

Om det finns ett billigare eller snabbare alternativ
Dålig tillgänglighet
För dåliga kommunikationer
Förseningar
Anpassa sig efter tider och riskfaktorn sena vagnar eller diverse stopp i trafiken
Priset
Dåliga förbindelser
Dåliga avgångstider som ej passar med mitt schema. Dessutom går inte bussen till en hållplats som har anslutning till den buss jag behöver byta till för att ta mig till jobbet.
Ifall det är för krångligt att ta sig från punkt A till punkt B(många byten)
Pris, trängsel, längre tid än cykel, sämre fokus i skolan om jag inte rört på mig innnan.
Kostnaden
Pris på enkelbiljetter, 72 kr för tur och retur blir oftast dyrare än att ta bilen.
Det har blivit mkt sämre, långt mellan avgångarna
Inte den tidseffektivaste vägen
Trångt, mycket folk
Andra människor
I dagsläget att bussarna har bytt resväg och inte går direkt till centrum som förut.
Tar minst 1,5 timme per väg med kollektivtrafik mot 30 minuter Max med bil.
För trångt på bussen
Det är för dåliga förbindelser de vägar jag vill åka.
Dyrt med busskort
Jag arbetar hemma, men åker till Göteborg för möten mm. Dålig kommunikation frå
Onödigt långa resor.
Om det tar längre tid än något annat transportmedel
Dåliga förbindelser, långa restider, priset
Sena avgångar. Svårt att planera rutten (har bättre idéer själv på hur man kan smart göra byten längst vägen)
Trängsel
Orkar inte vänta
Att det är trångt, mycket folk
Cost, the experience of sharing a full bus with other people, and the pt not being reliable enough
Tid och byten
Skulle aldrig komma på tanken att åka kollektivt.
När det är orimliga bytestider som kväll i Bellevue när man ska till Utby. Brukade vara en del av stan genom direktbuss, nu känns det som långt och besvärligt från Göteborg.
Bussarna kommer inte i tid. Det tar orimligt långt tid pga flera byten att komma till jobbet. 20 min med bil, 70 min med kollektivtrafiken. Sen är bussar och spårvagnar smutsiga och man får trängas med människor med smittor. Dyrt är det också.
Det tar 3-4 ggr så lång tid som med bil. Det är inte trevligt att behöva trängas med en massa andra människor, byten stämmer dåligt vilket innebär onödig väntetid.
Dubbel restid mot bil
Trängsel

Dåliga tidtabeller, dyra priser och bekvämlighet
Kontrollanter
Det tar för lång tid och är inte tidseffektivt i min vardag.
Trängsel och förseningar
Långa bytestider och om man inte kan lita på tidtabellen
Bussarna kommer inte alltid som de ska och ibland kör de fel väg och missar hållplatser. Minsta lilla snö på vägen så ställs turer in! Gäller buss 22.
Långa byten, ibland många byten, långsam framfart i city, osmidigt när man ska frakta större varor
Priset
För dyra engångsbiljetter!
Dyrt, väntan, medpassagerare som luktar parfym, rök och som hostar.
Anslutningar går alldeles för sällan och det är för många byten med väntetid emellan. Bussarna är även överfulla, går inte att lita på att man får plats
Extrem dåliga möjligheter att ta sig till stan från Utby (tar för lång tid)
Det är så fruktansvärt dyrt (bor i Uppsala)
Många byten, när dyrare än bil
Mycket dåliga förbindelser till och från stan från Utby. Många har klagat lämge utan resultat. Undviker tyvärr buss nu och tar bilen om jag inte kan cykla.
Bra väder för att cyklar
Kollektivtrafiken kan vara lite oberäknelig. Om man ska till ett ställe det bara finns ett alternativ av kollektivtrafik och ska passa en tid behöver man oftast ta en tidigare buss/spårvagn för att hinna lösa problemet om bussen/spårvagnen inte skulle dyka upp eller vara inställt. Detta leder till att jag hellre gå om jag måste vara i tid till något för att det går att lita på.
Tid
Sällan behov för att åka kollektivt
Tar för lång tid
att bussarna ställs in så fort det blir minsta snö, 22:sn. barnen får inte skolbuss pga av att de ska kunna åka kollektiv. Men i vinter har bussen strandat elever/mina barn i kylan minst 14dagar..
Jag behöver köra och lämna hunden innan jobbet, fungerar inte med buss.
Till mitt jobb tar det mycket längre tid än bil.
När man inte kan lite på avgångar och när det är för glest mellan avgångarna
Tar för lång tid mellan arbete och hem
Dåligt m turer mitt på dagen.
Svårt att ta sig med byten
Gammal orkar inte gå
Dåliga med avgångar till och från Utby där jag bor
Trångt. Går sällan
Långt att gå till bussen
Tid, tar lång tid
No public transport available
Luktar illa, mycket folk och börjar tidigt så det är inte ett alternativ att sova på centralen
De har försämrat turen från centrum till Utby, med byte , de två turerna går dessutom m 3min mellanrum 56 o 510
Låg frekvens avgångar

Inställda turer, för mycket folk, smittorisken då folk åker förkylda/sjuka
Stämmer inte med mina arbetstider
Kostnaden
Det tar för lång tid i dagsläget att ta sig till jobbet m kollektivtrafik
Väntetid
Kväll o mörkt o skummisar i farten
Tidseffektivitet
Lathet
För långt till hållplats
Pris och tidtabell
Dåliga avgångstider, dåligt väder.
Dåliga busstider
Tar mycke längre tid än med bil
Opålitlig tidshållning
Dyrt, håller inte tiderna och tar längre tid än med bil
bussar som går för Sällan, många byten
Extra kostnad.
Tar för mycket tid.
Delays and overfilled public transport
Dåliga förbindelser till stan ifrån där jag bor.
Dyrt
Långt till hållplats
De kör väldigt dåligt!
Väljer alltid de alternativ som går fortast, undviker att åka kollektivt så gott de går.
Vill ha en promenad, långt till hållplats
Att det tar så lång tid, den är så långsam
Biljetterna är dyra
Om det tar längre tid att åka än annat transportmedel (cykel/gång). Även ifall jag vet att byten inte brukar fungera, då tar jag hellre cykel/gång till nästa transportmedel så jag vet att bytet inte krånglar till resan.
Bussar som inte håller tiderna, trängsel, ofta smutsigt på bussarna
Ska jag förlora tidsvinsten så vill jag att jag ska känna att det är ekonomiskt billigare. Idag är det knappt någon skillnad. Kostnade för bilen har jag redan och räknar inte med.
Om det går fortare att cykla och det är fint väder, eller inte är så långt att gå.
För dyrt med bussbiljetter
Tar mycket längre tid till jobbet med kollektivtrafik. Vill heller inte trängas med hostande och snörvlande resenärer. Hopplöst när rökare stiger på som stinker cigarett rök. Sen har vi ungdomar som sitter med skor på säten där man sedan ska sitta. Känner mig inte trygg att åka kollektivt genom vissa områden.
Inte tidseffektivt
Dåliga anknytningar och bacillskräck
Att det inte går direktbuss till stan där jag bor vilket leder till att det tar mycket lång tid att åka då de krävs byten
Priset och trivsel

Det tar tid, cyklar till jobbet
Orkar inte stå upp på bussen 25 minuter, smutsiga säten, dålig luft, lite benutrymme, busschaufförer som är sena/tidiga/kör dåligt/släpper inte på mm
Kontrollanter
Avståndet till jobbet, enkelhet. Tar allt som oftast längre tid att ta buss än bil om jag skulle göra det
När jag skall storhandla, hälsa på barnbarn, åka till kyrkogården bl a
Lättja
Det tar längre tid än att åka bil. Det är dyrare än att åka bil.
Flexibilitet
När jag har möjlighet att gå gör jag det snarare än betalar enkelbiljett för att det är för dyrt. Även om man som familj kan åka bil och det kostar typ en fjärdedel av vad tågresan gör.
Det tar för lång tid, man kan inte lita på att buss/spårvagn kommer enligt tidtabell. Flera inställda turer mycket folk och ofräscht.

Survey A What makes you NOT choose public transport: Vad får dig att INTE välja kollektivtrafik:
Dyrt och dålig tillgänglighet
Långt till hållplatsen och dålig kommunikationer in till centrum.
har bil
För dyrt och tar lång tid
Dyrt!!
Priset
Tar lånt tid o dyrt
Billigare att gå
Det tar lång tid
Att man inte kan lite på tiden
För mycket folk.
Otryggt vid hållplats
Snabbare att gå eller få skjuts av någon vän
Dyrt och tar längre tif
Trångt, kräver planering i förtid, inte så bekvämt
biljettpriser
Dyrt som tusan. Varför har de inte studentbiljetter på 90 min-biljetter?
Tar längre tid och behöver vänta ute medan man byter buss
Dyrt
Höga biljettpriser
För lång tid/för många byten
15-20 min med bil, mellan samma punkter 45-60 min kollektivtrafik
Pris
Förseningar eller pris
Bekvämligheten med egen bil. Orkar inte vänta på kollektivtrafik samt lägga mer tid på resevägar.
Mer bekvämt och tidseffektivt med bil
Det är dyrt och omständigt.
Priset
Otroligt dåliga förbindelser där jag bor
Om resan är under 5min, samt om det inte regnar och går fortfarande att cykla

Bekvämt
Om det är en fin sommardag
Dåliga tidtabeller tex byten passar inte bra (lång väntetid).
De dyra priserna gör att alternativet att cykla lockar mer under varmare dagar.
Förseningar
Tid samt att man ej kan lite på om tidstabeller stämmer
Priserna och stökiga medpassagerare som inte kan bete sig hyfsat, utan gapar, skriker, skräpar ner i bussar osv.
Ständiga förseningar och att det tar väldigt lång tid.
Trängsel
Snow that makes the train not go, then if possible work from home or try find friend with car. Or when it is posible to bike faster or rather similar time.
För få avgångar, lång väntetid.
Omvägar
Priset eller om dem är för smutsiga
För dyrt
Vädret, avståndet
Känner mig begränsad på tid
Cost and time efficiency
Åker kollektivt ändå, men tycker att det är dyrt
Inga bussbyten, snabbuss
Tickets controller biljetter kontroll
De blir billigare att ta bilen dom resorna jag gör!
Krångligt dyrt
Ofta väldigt mycket förseningar som gör att det inte blir pålitligt. Omständigt att ta sig in till stan du de år efter år ändrar bussarnas körväg så det tar längre och längre tid.
Kostar nästan lika mycket som att åka med bil
Dyrt, tar lång tid,
Inställda/opålitliga spårvagnar, lång väntetid vid byten ute i regn/kyla, att en biljett kostar lika mycket även om man bara ska åka 4 hållplatser
Ofräscha bussar, trängsel på bussen, förseningar
Jag bor på hisingen och förbindelserna över till centrum kan vissa tider vara rätt dåliga. Jag väljer bil när kollektivtrafiken endast erbjuder krångliga förbindelser som tar lång tid.
För många byten, buss och tåg som inte ”matchar” vilket leder till långa väntetider. Svårt att vara flexibel.
För att jag har en bil. Hade jag inte haft bil hade jag åkt kollektivt betydligt mer.
Inställda spårvagnar och bussar
När det tar längre tid än att gå, när bussen/spårvagnen är väldigt fulla, när det är varmt ute och bussen/vagnen inte har ventilation
dyra engångsbiljetter!
Finns inte kollektivtrafik som allternativ de tider jag jobbar. De börjar gå för sent på mprgonen
långsamt
För dyrt när man behöver åka längre än cykelavstånd.
Flera byten längs vägen, långa restider för bussar som stannar på många hållplatser. Tillägg, bor inte i Göteborg. Bor i Norrköping
Obekvämt, tar lång tid, dyrt för kvaliteten man betalar
Att inte vara beroende av att bussen är i tid. Frisk luft. Vardagsmotion. Restid. Flexibilitet.
Bra väder för att cykla exempelvis
Inställda avgångar, hög trängsel, arbete hemifrån
Frakt av stora saker, när det går snabbare att cykla.

Om det tar avsevärt längre tid för min resa
Förseningar, körsträckar
Sämre tidseffektivitet
Västtrafiks hiskeligt höga biljeyypris, för oss i Landvetter som ska till Gbg i kombo med löjligt dålig resväg mellan bostad i Landvetter och arbetsplats i Mölnlycke. Det krävs 3 olika bussar till jobbet och kan ta 50 min kontra ta bilen dörr till dörr och 13 min.
Om det tar för lång tid eller är för dyrt
Dyrt (många zoner), långt till hållplats
För dåliga förbindelser. Många byten och det tar för lång tid.
Lång restid
Inget
Tidskrävande
Tar lång tid
Oväder som t.ex översvämningar eller nåt chaos med tåg/buss pga snö.
5 km till närmsta busshållplats blir inte använt
När det inte går bussar frekvent
Dåliga tider i tidtabellen.
Dyrt
Kan knappt gå
För sällan och aldrig bra passande tid samt enorm omväg som bussen tar med flera byten. Trots att det ären av sveriges största arbetsplatser med 15000 arbetare så går det få bussar.
När jag ska handla större mängder, annars är det nästan alltid kollektivt.
Att de drar in viktiga linjer, till exempel där jag bor tog dem bort bussen som går till Landvetter centrum. Så nu måste jag köra eller blir körd till närmsta hållplats och de hjälper ju inte att bussen knappt går.
Människor, förseningar, trängsel och PRISET är en stor del. Förlorar inget ekonomiskt på bil och förlorar tidsmässigt på kollektivt.
Kostnad och resväg
4.5km uppförsbackar på hemvägen utan gatubelysning lr trottoar in i skogen. Väcker barnen kl. 05:00 o börjar jobbet kl. 06:25, och vi 3 i hushållet har NPF-diagnos, behöver jag säga mer?
Busstider, behöva anpassa sig
4 gånger längre tid och man åker runt halva stan, dubbla kostnaden
Tar för lång tid / för få avgångar
Ej sittplats, bytestider, tidskrävande,
Pris
Byten som gör att de tar extra lång tid att ta sig in till Göteborg Central
Kommer sluta åka kollektivt utanför Göteborg så fort jag får klart körkortet även om jag helst sluppit. Bor längs med Olofstorpsvägen där bussarna går extremt sällan och inte över huvud taget på helgen. Går inte ens att beställa en taxi som ersätter. När skolbarnen har lov går den inte heller.
Jobbar som resande säljare med tjänstebil.
För mycket passagerare. Smittorisk.
Ofta strul med tågen Alingsås-Gbg, inställda, försenade... och "inte billigt"
Jag måste byta i Gbg. Byten gör att det inte blir effektiv restid. Använder bilen i tjänsten. Åker ofta tåg på fritiden till Gbg men tycker det är dyrt och oekonomiskt om hela familjen om fyra ska åka tåget.
Tar för lång tid, för många byten innan jag kan komma till jobbet.
Att bussarna direkt till gbg slutar gå vid kl 9 på vardagar
When the destination is too close
Att tågen inte går. Osäkerheten

Flera byten
Dålig turtäthet, inga bussar kväll/helg.
För långt till hållplatsen
Dyrt, långt till stationen
Att bli drabbad av förseningar
Dyrt. Kan inte åka kollektiv till vissa vänner, det skulle ta flera timmar.
Hög kostnad
Ofta trångt och inställda bussar/tåg
Priset
När det är för dyrt
Dyrt och förseningar
För lång restid och gles avgångstid.
Tar lång tid, trångt i rusningstrafik
Tidsåtgången vid lämning och hämtning på skolan
Inställda, försenade bussar/tåg.
Brist på smidighet och att tåg/buss inte går i tid
Anslutningsbussarna till tåget matchar inte
Dåliga tider och ännu sämre förbindelser
Mycket förseningar och inställda tåg
Inget, tycker att kollektivtrafiken är bra så som den är
Tar tyvärr för lång tid. Dels att gå till bussen och sedan med byten
Pris och otillgängligt
Trängsel
Tar för lång tid och är obekvämt
Priset
Att västtrafik aldrig kommer och att det är alldeles för dyrt
Funktionshinder
Otillgängliga tider
Indragen busslinje
Att man aldrig kan lita på om den kommer eller inte.
Att det tar för lång tid
Dyrt, tar längre tid och för mycket människor som trängs. Det är alltid någon som äter en macka som luktar surströmming.
Det tar ca 60 min med buss, och 2, ibland 3 byten. Det tar ca 30 min med bil till pendelparkering och sen buss. 0-1 byte.
Osmidigt samt tidsvinsten
Osmidiga byten, att det inte finns sittplats, tar extra tid.
För mycket folk/fulla bussar
Byte av transportmedel
Passa exakta tider, missar jag får jag vänta en halvtimme, bytestider, bil tar mig direkt, kostnaden
Busskorten om man bor i en kommun men jobbar i en annan kommun är för dyra vilket gör att det inte är förmånligt ur ett kostnadsperspektiv att ta buss istället för bil. Också om man arbetar deltid och inte behöver ta buss varje dag så blir busskorten för dyra.
Dyrt och tar lång tid
Priset, avståndet
När busschaufförен åker förbi hållplatsen utan att kolla om nån står där för att ”spara in tid”…
Långa restider och stadsbusstrafik då det brukar vara ryckig körning som framkallar åksjuka.
Byten, trånga bussar som går långsamt pga kö, trafiksignaler

Jag gillar att promenera och den motion det ger mig
väder och tid
Tid och tillgänglighet
Obekvämt. Jag gillar inte att tryckas ihop med massa främlingar.
Busslinkw indragen.. Nu behöver man gå 3 km till station. Är inte möjligt med allt att bära.
Tar mer tid.
Förseningar, dåligt väder, mycket folk
När det finns möjlighet att gå föredrar jag det framför att köpa enkelbiljett i kollektivtrafiken. Samt ibland om det kostar väldigt mycket mindre att åka bil, vilket det ofta gör om man åker som familj.

```
%pip install biogeme
%pip install pandas
%pip install numpy
```

```
import biogeme
import pandas as pd
import numpy as np
```

```
import biogeme.database as db
import biogeme.biogeme as bio
import biogeme.models as models
from biogeme.expressions import Beta
```

```
%pip install openpyxl
```

```
# import data
data = pd.read_excel('Goodweather.xlsx')
```

```
# select columns
data = data.iloc[:,2:]

# rename columns
data = data[['bod_at', 'bod_wt', 'bod_tt', 'bod_et', 'bod_cost', 'pt_at',
       'pt_wt', 'pt_tt', 'pt_et', 'pt_cost', 'shared_at',
       'shared_wt', 'shared_tt', 'shared_et', 'shared_cost', 'car_at', 'car_wt','car_tt', 'car_et', 'car_cost','choice']]
#lägga in age income
```

```
# convert data to db.Database
database = db.Database("gothenburg",data)
database.fullData
```

```
globals().update(database.variables)
```

```
# define the coefficient
# ASC
ASC_bod = Beta('ASC_bod',0, None, None,0)
ASC_pt = Beta('ASC_pt',0, None, None,0)
ASC_shared = Beta('ASC_shared',0, None, None,0)
ASC_car = Beta('ASC_car',0, None, None,0)
# ASC_escooter = Beta('ASC_SE',0, None, None,1)
#vad menas med kommentaren ovan?

#access time
B_at_bod =  Beta('B_at_bod',0, None, None,0)
B_at_pt = Beta('B_at_pt',0, None, None,0)
B_at_shared = Beta('B_at_shared',0, None, None,0)
B_at_car = Beta('B_at_car',0, None, None,0)

# waiting time
B_wt_bod =  Beta('B_wt_bod',0, None, None,0)
B_wt_pt = Beta('B_wt_pt',0, None, None,0)
B_wt_shared = Beta('B_wt_shared',0, None, None,0)
B_wt_car = Beta('B_wt_car',0, None, None,0)

# travel time
B_tt_bod =  Beta('B_tt_bod',0, None, None,0)
B_tt_pt = Beta('B_tt_pt',0, None, None,0)
B_tt_shared = Beta('B_tt_shared',0, None, None,0)
B_tt_car = Beta('B_tt_car',0, None, None,0)
```

```
# egress time
B_et_bod =  Beta('B_et_bod',0, None, None,0)
B_et_pt = Beta('B_et_pt',0, None, None,0)
B_et_shared = Beta('B_et_shared',0, None, None,0)
B_et_car = Beta('B_et_car',0, None, None,0)

# cost
B_cost = Beta('B_CT',0, None, None,0)
#varför bara en här?
```

[9] Pytho

```
# define the utility function
# 1: private car; 2:pt; 3:bike, 4:walking; 5:taxi; 6:escooter
U1 = ASC_bod + B_wt_bod * bod_wt + B_tt_bod * bod_tt + B_cost * bod_cost
U2 = 0 + B_at_pt * pt_at + B_tt_pt * pt_tt + B_et_pt * pt_et + B_cost * pt_cost
U3 = ASC_shared + B_at_shared * shared_at + B_tt_shared * shared_tt + B_cost * shared_cost
U4 = ASC_car + B_tt_car * car_tt + B_cost * car_cost
```

[10] Pytho

```
U = {1: U1,
     2: U2,
     3: U3,
     4: U4,
     }
```

[11] Python

```
av = {1: 1,
      2: 1,
      3: 1,
      4: 1,
     }
```

[12] Python

```
# calculate the coefficient
logprob = models.loglogit(U, av, choice)


biogeme = bio.BIOGEME(database, logprob)
biogeme.modelName = '01logit'


results = biogeme.estimate()


pandasResults = results.getEstimatedParameters()
print(pandasResults)

logprob = models.loglogit(U, av, choice)
```

[ ] Pytho