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Car Reduction Strategies

A case study of Ghent, Belgium

Delft University of Technology

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Traffic Reduction Strategies in Ghent

Research through Conjoint Analysis into Traffic Diversion Strategies and the Implementation of Congestion Charges in the City of Ghent, Belgium.

By

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Preface

This thesis was written by Edith Goderis to graduate the BSc Civil Engineering at Delft University of Technology. The thesis is conducted in the department of Transport and Planning, since I will be pursuing a master's degree in this field. I decided to write on car reducing strategies in cities due to my interest in smart city adaptations and resilience to changing climate, population numbers and other circumstances.

The target group for this thesis is people in the research- and academic field, interested in transport and planning in an urban context. Furthermore, this thesis can be of interest to urban planners and municipalities, who are looking for insights into various car reduction strategies.

I would like to thank my supervisor, Dr. Yufei Yuan for giving me guidance and support throughout the research- and writing process and Dr. Dorine Duivels for her mid-term directions and feedback, which allowed me to further develop my thesis in the right direction. Furthermore, thanks to my peers, who were able to provide me with weekly reviews and insights, I was able to further improve my work. Lastly, I would like to thank Nicole Huyghe, for assisting me in finding the right software and tools to conduct a successful conjoint analysis.

Edith Goderis
Delft, June 2022

Summary

For the past decades, cities and urban areas have been shaped according to the needs of increasing car ownership and traffic. However, due to rising health, environmental and safety considerations, cities are moving away from car-oriented urban planning and are instead introducing strategies to reduce car-dependency and usage in city centres. One of such strategies is the implementation of congestion charges, in which someone is charged a certain fee when entering a specific zone in the city. Furthermore, alternative transport modes, such a biking and public transport are being optimised and encouraged.

This study is an investigation of these strategies in the context of the city of Ghent in Belgium. More specifically, the report aims to answer the research question:

"How can congestion charges be implemented and alternative transport modes adapted to reduce private car traffic in the centre of Ghent?"

The research primarily evolves around the analysis of data gathered from a choice-based conjoint survey study. This method was chosen in order to test various scenarios with a product (congestion charges) which is not yet launched on the market.

The survey was sent out through social media channels and opened for 14 days. In total, 58 responses were collected. This was a rather small sample size and therefore the possible bias should be carefully noted and taken into consideration when analysing the results. A strong bias was noted in terms of the age, socio-economic background and origin zone of the respondents.

The general sample reacted rather positive when asked about their opinion on congestion charges. Most respondents 'agreed' to 'strongly agreed' to the possible positive implications of congestion charges on the environment and traffic flow in the city. The frequent car users tended to respond more negatively and sceptical towards the implementation.

A congestion charge fee of minimum €11 would have to be charged to efficiently convince people to choose another transport mode instead of their car. This should be combined with a reduction in travel time difference between car and public transport to at least 20 minutes. This would avoid people choosing to no longer travel at all when the congestion charges are introduced. A reduction in travel time to 10 minutes or less without congestion charges would also lead to an increase in use of public transport over car use, especially for frequent car users. Furthermore, the general sample shows that biking is the preferred alternative transport mode, whereas frequent car users would rather opt for public transport.

In order to increase the reliability of the results, the sample size would have to be increased in future research. Furthermore, the diversity of the sample would have to be ensured, in order to give a representative account of the true population.

Contents

1 Introduction

This chapter has the purpose of sketching a general overview of the report, through the background motivation of the research, objective, general outline, scope and stakeholders.

1.1 Car Use in Cities

Over the past decades, cars and private car ownership have grown into one of the most significant modes of transport and have shaped the way cities and urban areas have been designed. Urban planning has revolved around accommodating cars, leaving little space for other transport methods and urban functions. However, “concerns about obesity, physical inactivity, pollution, climate change, and road traffic injuries” have sparked an interest amongst municipalities, urban developers and citizens to shift away from car-oriented urban design and instead develop and implement strategies to push private cars out of city centres and encourage more sustainable modes of transport (de Nazelle, et al., 2011).

Excessive car use can have several negative impacts on urban areas, whole societies or on individuals. One of the major negative effects of car use are accidents. According to Bhalla et al. (2014), 1.3 million death and 78 million injuries globally per year are due to car accidents. The EU roads accounted for 30,000 deaths per year in 2011 (European Commission, 2016). Reducing car traffic in urban areas can hugely reduce the number of car accidents. Research has shown that after the implementation of the congestion charge in London, there was a significant decline in car accidents of 34 less accidents per month (Green, Heywood, & Navarro, 2016).

Furthermore, excessive car use in urban areas can have a significant impact on environmental exposure and health. Air pollution from motor vehicles causes 184,000 deaths per year on a global scale (Bhalla, et al., 2014). Furthermore, motorised vehicles in cities cause noise pollution, heat increase and a loss of green space – all of which have negative impacts on human health and quality of life (Nieuwenhuijsen & Khreis, 2016). Additionally, travelling by car has a negative influence of physical activity and social contact, as the traveller only has to use one mode of transport and does not get in touch with fellow travellers (Nieuwenhuijsen & Khreis, 2016).

1.2 Motivation and Objective

Societal Relevance

As mentioned earlier, car traffic in urban areas can have multiple negative effects on the environment, physical and mental health of citizens. In order to reduce the pressing threats and problems related to fast growing populations, rising temperatures and climate change, car dependency needs to be eliminated. Therefore, municipalities need to invest in strategies which will encourage their citizens to change their travel behaviour and choose cleaner modes of transport. This report will research how municipalities can tackle this challenge and how congestion charge schemes can be a strategy towards reducing cars in city centres. The report will be focussed on the case study of Ghent, Belgium.

In 2015, the city of Ghent published the Mobiliteitsplan (Mobility Plan), in which their goals for keeping the city "liveable, accessible, safe and clean" are expressed (Mobiliteitsbedrijf Stad Gent, 2022). This plan will be discussed in more detail in the *Literature Study* chapter. The city of Ghent has thus expressed their motivation in becoming a clean city and tackle rising mobility issues and has introduced several policies that reflect this motivation. This makes Ghent an interesting city to study how further policies can assist the success of this motivation.

Research Gap

Much research has been done on the effect of private transport modes in urban areas. It is a known fact that car dependency and usage in cities causes traffic congestions, air and noise pollution, loss of green space and biodiversity, etc. These aspects can be related to loss in economic revenue in cities, health and environmental problems and more. Therefore, urban planners, engineers and municipalities and politicians have researched strategies and policies to reduce private motorised traffic in city centres.

One of these strategies is the congestion charge, which discourages people to take their cars into the city and instead increases the attractiveness of other modes of transport. Many cities have researched into this policy. However, there seems to be a lack of research from smaller cities and none in the context of a Belgian city. Therefore, this paper aims to fill the research gap by analysing the possibilities of congestion charge policies in smaller scale cities and more specifically in the case of the Belgian city, Ghent.

A personal motivation for the topic of research has been included in Appendix A.

Objective

The report aims to answer the following research question:

How can congestion charges be implemented and alternative transport modes adapted to reduce private car traffic in the centre of Ghent?

This research question will be answered through the following sub questions:

(a) What are congestion charges and where/how can it be applied?

Relevance	It is important to sketch what is meant by congestion charges and look at case studies where this policy has been applied. This will give insights into the effect it may have.
How	Literature study

(b) What is the current modal split and traffic situation in the centre of Ghent?

Relevance	The main societal groups, reasons, times, and other factors of current private car traffic need to be identified to give insights into who the target audience is and which factors influence their decision in mode of transport.
How	Literature study

(c) What is the current vision of the municipality and how is this reflected in their policies?

Relevance	The current policies need to be identified as they can have an effect on how current traffic systems operate.
How	Literature study

(d) How can congestion charges play a role in diverting private car traffic in the centre?

Relevance	The answer to the previous sub questions will lay the foundation to answering how current policies are inadequate and how congestion charges can offer a solution.
How	Literature study and analysis of the previous sub questions

(e) How will congestion charges be most efficient in diverting private car traffic? This includes: (i) which congestion charge fee is needed to change travel behaviour and (ii) how can the alternative modes be adapted accordingly?

Relevance	Before being able to implement congestion charges, the specifics need to be determined in order to make the policy adapted to local traffic patterns and needs.
How	This will be done through a CBC survey, which will determine the thresholds at which people will choose a different mode of transport. The specifics of this survey will be discussed in the section *Methodology*.

1.3 Set-Up of the Report

The report will be set up in the following chapters:

Chapter 1 contains an introduction of current problems, a general outline and scope of the report. Chapter 2 will give an introduction through literature study of congestion charges through case studies and an evaluation of the current situation in Ghent. This chapter will thus aim to answer sub questions a to d. Chapter 3 will be focussed on the methodology of collecting and evaluating of the data. Chapter 4 will then present and analyse the found data, which presents the answer to sub question e. Chapter 5 eventually presents a conclusion of the results, a discussion of the research method and recommendations for future research.

1.4 Scope and Stakeholders

The scope of this report is private car use in the city centre of Ghent. Furthermore, the research will be focussed on the use of congestion charges as a strategy to divert private car use from the city centre.

This research will affect various stakeholders, which are stated below.

- Car travellers: People who currently travel to the city by car are the main source of data collection in this research. Their opinions and travel behaviour will be investigated.
- The municipality of Ghent: both urban planners and the city politicians will gain insights from this research. The results could inspire them for the implementation of future policies or the possibilities of changing the traffic flow and control in the city.
- Citizens: The travel behaviour of Ghent 'users' directly affects the livelihood and general quality of life in the city centre. Changes in this behaviour can have a significant impact on their immediate surroundings.
- Other users of the city: as mentioned before, the travel behaviour of Ghent 'users' directly affects the livelihood and general quality of life in the city centre. Changes in this behaviour can have a significant impact on their immediate surroundings, how the city is experienced and accessed.
- Businesses: The accessibility by private transport modes can have a significant impact on businesses located in the city centre, as they might experience less clients, guests, deliveries, etc. In further research, the impact on businesses can be evaluated in depth.

2 Literature Study

This chapter is a literature study on the use of congestion charges as a traffic diversion strategy. A general introduction to congestion charges will be made and several case studies will be discussed.

2.1 Ghent's Mobility Vision and Policies

Ghent's Mobility Plan as published in 2015 expresses the "long-term approach which will guarantee quality of life and sustainable mobility" in the city of Ghent. With the Mobility Plan, the city aims to give space back to pedestrians and cyclists and wants to encourage the use of the appropriate modes of transport depending on the nature of the journey. The Mobility Plan includes several aspects. Firstly, there is the Circulation Plan, which was set up in 2017 and aims to regulate traffic flow within the R40 (the city ring). Secondly, the Parking Plan was introduced in 2016 to reshape the parking fares, facilities, etc. of the city. Lastly, in 2020, the city introduced the low emission zones, which prohibits the most polluting vehicles from entering within the R40 zone. (Mobiliteitsbedrijf Stad Gent, 2022).

The Circulation Plan has resulted in a shift in choice of transport mode including a reduction in car use and a rise in sustainable modes, such as biking. Furthermore, the accessibility of the city has remained the same and traffic flow has improved with less congestion forming. However, the congestion forming and loss of time has increased on busier roads around the city centre. Due to this, the perception of Ghent citizens towards the plan is rather negative, as trajectories have become larger. (Mobiliteitsbedrijf i.s.m. Transport & Mobility Leuven, 2019).

In general, the city and its citizens have a history of adaptive travel behaviour according to the socio-economic and environmental context of the time. This shows how Ghent is an interesting city to study congestion charges and other strategies.

2.2 Introduction to Congestion Charges

2.2.1 Congestion Charges as a Strategy

Congestion charge is used as a tool to relieve urban areas from congestion by discouraging people to take their private vehicles and opt for other transport modes, by charging people entering certain areas by private car. It is based on the idea that people make their choices based on marginal private costs and benefits but often exclude external costs, such as loss of time for others, environmental damage, etc. Congestion charges work on the principle that the amount paid by the private vehicle traveller is a way to 'pay back' for the negative effects. (Liu & Zheng, 2013) Furthermore, benefits are not only the reduction of traffic congestion, but also benefits related to revenue increase, transit ridership increase, improved transit service, travel time savings and other environmental and public health improvements (Liu & Zheng, 2013). However, the implementation of congestion charges can be challenging due to "social, political and legal issues", which is why it has only been implemented in few cities such as London, Stockholm and Milan (Liu & Zheng, 2013).

2.2.2 Case Studies

There are multiple cities worldwide which have researched and/or implemented road congestion strategies. They have been successfully implemented in London and Stockholm and unsuccessfully in the case of New York. These cities will be evaluated to gain insights into their approaches and which lessons can be learnt.

London, UK

In 2003, road pricing schemes were introduced in the metropolitan area of London, covering a total of 21 square kilometres (corresponding to 1.3% of the metropolitan area). At the starts, travellers were charged with a fixed price of UK£5 between 7:00 and 18:30 from Monday to Friday, with the exception of holidays (Rong-Chang, Soi-Hoi, & Ping-Hua, 2007). The current scheme is a UK£15 (€17.85) daily charge per vehicle from 7:00 to 18:00 on Mondays to Fridays and 12:00 to 18:00 on weekends and bank holidays (Mayor of London, 2022).

An evaluation by Transport for London has shown the following trends (Rong-Chang, Soi-Hoi, & Ping-Hua, 2007): vehicle-kilometres reduced by 10-15%, delay per vehicle reduced by 20-30%, traffic volume reduced by 16%, net financial revenue of UK£80 million.

The case of London shows interesting lessons related to public acceptance. The scheme was at first opposed by stakeholders in fear of negative effects on the economy. However, a study after the implementation showed that the majority of businesses did not have any negative impact. In general, the acceptance rose from 40 to above 50% after the trial period. London's congestion charge success is thus mainly due to the high public acceptance and political commitment. (Liu & Zheng, 2013)

Stockholm, Sweden

The congestion charge fees in Stockholm were permanently implemented in 2007 and depend on the hour interval and area of vehicles entering and leaving the city. Assuming similar times as the London charge, to enter Stockholm city centre during peak season at 7:00 would cost 45SEK and 20SEK to leave at 18:00 (Swedish Transport Agency, 2021). This amounts to a total of 65SEK, which is around €6.31.

The benefits of the Stockholm congestion charges include the following (Congestion Pricing, 2020): 20% stabilized traffic reduction and 30-50% decrease in traffic delays.

The main lessons learnt from the Stockholm case is related to public acceptance. Before the trial period, an investigation was done on public acceptance of the scheme which showed that 55% of residents of the city of Stockholm were opposed to the idea. The main groups who were not in favour of the scheme were immigrants, male, residents outside of the charging zone and people who paid more for the congestion charge system. However, after the trial period, public acceptance rose to 53% due to the noticeable benefits, such as less congestion and more parking space. (Liu & Zheng, 2013)

New York

In 2007, the Mayor of New York introduced the congestion charge proposal in the State Legislature. After extensive research, it was found that the majority of NYC residents supported the plan. However, a small group of people from four NYC boroughs outside of Manhattan were strongly opposed and able to block the proposal through the Assembly. These groups were significantly more auto-dependent and did not have rapid and convenient access to other transit options to reach the Manhattan job market. (Liu & Zheng, 2013)

From these case studies, it can be concluded that public acceptance and political support is of significant importance for the success of implementing a congestion charge scheme. However, the case of Stockholm has shown that public acceptance can rise when the benefits are physically seen. Therefore, the convenience and reliability of other transit modes can be considered of highest importance to reach public support and eventually a successful congestion charge scheme. This knowledge will be taken into consideration when designing the research of this paper.

3 Methodology

As mentioned earlier, a CBC survey will be used to gather data. In this chapter, the methodology of setting up and carrying out this survey will be discussed.

3.1 Target audience

3.1.1 Car Users in the City Centre

The people using private car transport in Ghent's city centre can be divided between the city's citizens (people living in the city centre) and users (people travelling to the city centre).

About 54% of Ghent's citizens' movement happens by car, with an equal division between functional movement (to school, work, etc.), service movement (to the supermarket, doctor, etc.) and recreational movement (for physical activity, cultural visits, etc.) (Stad Gent, 2015).

Ghent users can be subdivided between the following groups (Stad Gent, 2015):

- Commuters: about 65% of employers at companies located in the city with more than 100 employers commute by car.
- Students: about 10% of students travel to their campus by car.
- Port workers: the majority of port workers travel to work by car.
- Tourists and recreational visitors: day visitors (eg. for recreational purposes) as well as international tourism forms a significant part of the city's economy.
- Other: the majority of private car users in the city centre do not have their destination in the centre, but travel through because it offers the shortest route.

3.1.2 Defining the Target Audience

Not all of the previously mentioned groups are target audiences for this specific research. The table below shows which groups are of significance for this report and will thus be targeted with the survey. The primary aim is to get as many respondents as possible for the survey. Therefore, the target audience will be identified through introductory questions in the survey. A discussion of how these target groups will be filtered from all respondents is discussed in the methodology.

Table 1: Specification and elimination of target audience

Group	Target audience	Comments
Ghent citizens	Yes	The movement of Ghent citizens to, away from and through the city form and large portion of all movement and should therefore be taken into consideration.
Commuters	Yes	It is assumed that these people choose private car transport out of convenience and their reasons and motivation should therefore be investigated.
Students	Yes	Although this group forms a small percentage of car users, they will be included in the survey results.
Port workers	No	Travel to and within the port area is difficult by public transport. A survey in 2008 showed that port workers would be willing to consider other modes of transport, if these would be more efficient (Stad Gent, 2015). The responsibility is thus primarily on the municipality to develop these alternatives. Until then, congestion charges do not offer a fair competition.
Day visitors	Yes	It is assumed that these people chose private car transport out of convenience and their reasons and motivation should therefore be investigated.
International tourists	No	International tourists will reach the city through other modes of transport (trains, taxi's, …) and will not usually move through the city by car.
Other	Yes/no	Studies have shown that the majority of car users through the city centre do not have a destination within the city, but simply go through the centre because it offers the shortest route. This audience is thus significantly broad.

3.2 Intro to Choice-Based Conjoint Analysis

The method of data analysis in this report is a conjoint survey. Conjoint analysis is a type of 'stated responses' survey, which aims to reveal the respondent's choice, ranking and rating of various alternatives based on the alternatives' attributes (Correia & Bradley, 2022). Conjoint analysis is chosen as it is highly advisable when researching pricing levels of goods which are not yet on the market (Conjoint.ly, 2022) This is the case, as the congestion charge price is not yet launched but a hypothetical market product. There are three types of conjoint studies: the choice-based, ranking and rating (Correia & Bradley, 2022). In this case, a choice-based conjoint (CBC) study will be done, which asks respondents to choose from a selection of options. This is the most common form of conjoint analysis as it is considered the most reliable by sketching the most realistic market research context (Conjoint.ly, 2022). An overview of how the data will be analysed is sketched in the section *Survey Results and Analysis*.

A choice-based conjoint analysis asks the respondents to choose from a set of product concepts. Each product concept has varying product variables. From the participants' response, a unique value (utility) can be assigned to each product variable. The conjoint analysis thus indirectly asks the respondent to rank the features they find most important by presenting them with realistic trade-offs. (Sawtooth Software, 2016)

A conjoint analysis consists of the following concepts. The choice of product can be influenced by variables, called attributes. For example the attributes cost, time, and convenience can influence the choice of transport mode. The attributes are valued through levels, for example €10, €20 or €30 as total travel cost. These levels and attributes form many combinations of product concepts, called alternatives. A set of alternatives can then be combined into a choice task, from which the survey participant can choose which alternative they find most suitable depending on the question asked by the analyst. The participant will be presented with a series of choice tasks until enough data on all alternatives is gathered. (QuestionPro, 2017)

The CBC study will be incorporated into a survey, as explained in the next subchapter.

3.4 Survey Design

In order to determine the methodology to set up the survey, the example of the study "Public acceptance towards congestion charge: a case study of Brisbane" by Liu and Zheng is partly followed, as a similar investigation in the case study of Brisbane is conducted (Liu & Zheng, 2013). The survey will consist of three major sections, as explained below.

Section 1: Opening Statement

This section will contain a brief overview and description of the concept of congestion charges and how they would be used in the case of Ghent. Furthermore, the context of the survey will be sketched with the controlled variables. This is needed because not all participants will have previous knowledge on the subject and thus aims to allow all participants to make informed decisions throughout the survey.

Furthermore, a general statement will be included which notifies the participants of the purpose of the survey, how the data will be used and how their information and privacy will protected.

Section 2: Background

This section aims to generate a general profile of the participant. The general profile will be sketched through questions on socio-demographics, primary transport mode and general travel behaviour

Section 3: General Opinion

This section aims to get a general overview of the participants' attitude towards congestion charges. This will include questions on their sentiment of the effect of congestion charges on the environment, economy, infrastructure and travel behaviour. (Liu & Zheng, 2013)

Section 4: Choice Based Conjoint (CBC) Block

This section aims to investigate the impact of certain congestion charge factors on the tendency of the participant to choose a different mode of transport. Participants will be presented with a situation based on a combination of the attributes and levels and will be able to indicate which of the presented situations will most likely influence their choice of travel mode.

Choice Option

Participants will be able to choose which alternative they are most likely to travel with. The survey is designed around the most common travel modes: car, bike and public transport. Furthermore, the respondents will have the option to choose they will not travel at all.

Attributes

Based on a study by Transport for London, the main reasons people choose to travel by car over other modes are: ease and convenience, travel time, comfort, encumbrance, trip chaining and cost (Roads Task Force, 2013). Part of the aim of the report is to make suggestions to the municipality on which congestion charge fees in combination with which adjustments in public transport services will be most influential in changing people's choice of transport.

The table below specifies the previously stated reasons and which ones will be included as attributes (Roads Task Force, 2013).

Table 2: Definition of attributes

Reason	Meaning	Include as attribute	Comment
Ease and convenience	Door-to-door, waiting time, interchanging	Yes	Generalised under number of interchanges
Travel time	Speed, reliability	Yes	Total travel time, includes waiting time
Comfort	Seating, temperature, safety	No	Difficult to define discrete levels
Encumbrance	Luggage, passengers, children	No	Difficult to define discrete levels, depends on reason for travel
Trip chaining	Use of car at destination	No	Difficult to define discrete levels, depends on reason for travel
Cost	Cost of transport	Yes	Possible adjustment, congestion charge fees could be invested into cheaper transit fares

Additionally, the congestion charge fees will be another attribute.

Levels

Firstly, the levels for congestion charge cost are based on the case study of London and Stockholm. As mentioned earlier, the daily congestion charge fees in London and Stockholm are €17.85 and €6.31 respectively. Ghent is of a smaller scale than the cities of London and Stockholm and therefore the levels will be defined from €5 with steps of €2 up until €15 per trip per vehicle.

Secondly, the number of interchanges throughout the journey needs to established. Research by FOD Mobiliteit en Vervoer has shown that the majority of commuters travelling to Ghent have their origin in the municipalities of Evergem, Merelbeke, Lochristi and Destelbergen (see figure below for a conceptual map) (Stad Gent, 2015).

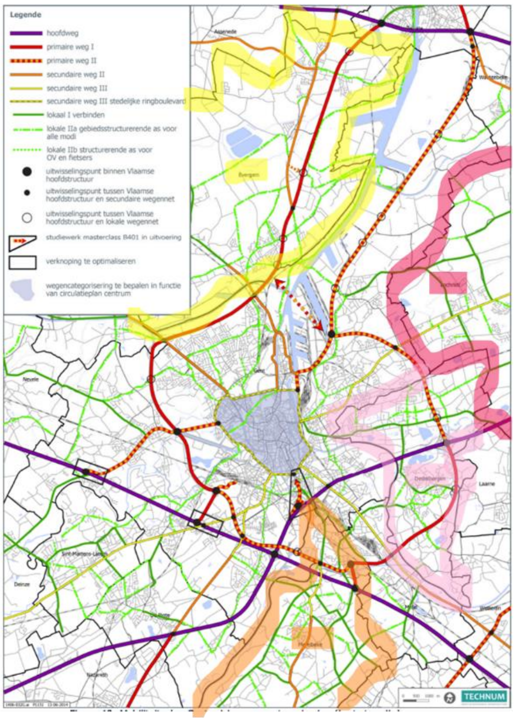

Figure 1: Map of Evergem, Merelbeke, Lochristi, Destelbergen (Stad Gent, 2015)

It is assumed that these origins are representative for all car travel to Ghent. Through the use of Google Maps (Google, 2022), the number of changes can be found, as indicated in the table below.

Table 3: Determine attribute levels for number of changes

Origin	Number of changes	Total minimum number of changes
Evergem	0	2
Merelbeke	0	2
Lochristi	1	3
Destelbergen	0	2

Note: the number of changes above is based on travel between the main stations. It is assumed that at least 1 other change needs to be made between home and origin station as well as Ghent station and the destination, as shown in the last column. However, in order to simplify the survey and make the alternatives relatable to all respondents. The levels will be determined as no change or minimum 1 change.

Third, the levels for travel time are established using the same reasoning through Google Maps as the number of changes. The following travel times are noted:

Table 4: Determine attribute levels for travel time

Origin	Travel time by car (in minutes)	Travel time by public transport (in minutes)	Time difference	Total travel time
Evergem	27	21	-6	+9
Merelbeke	16	20	+4	+19
Lochristi	22	32	+10	+25
Destelbergen	16	30	+4	+19

Note: travel is assumed between the city centres with leaving time of 8am on a Monday, positive travel times mean car travel is faster. Again, an extra 15 minutes is added to account for the travel between origin-station and station-destination.

The average time difference ranges between 9 and 25 minutes. This can be generalised to a range between 10 and 30 minutes. The levels will be ≤10, 20, ≥30 minutes difference.

Fourth, the public transport fares need to defined. This will be expressed in a percentage reduction of current fares. The levels are >30, 30-0 and 0% reduction of current fares.

The alternatives will thus be formed as a combination of the attributes and levels as shown in the table below. Participants will be presented with 15 choice tasks with the question of which transport mode they are most likely to choose out of bike / public transport / car with congestion charge / other. The public transport and car option will include specific values for the attributes and levels. The alternatives per choice task will be assigned randomly through the software of Conjoint.ly.

Table 5: Attributes and Levels

Attribute	Level
Congestion charge fees *Expressed in €/trip/vehicle*	5
	9
	11
	13
	15
Number of changes *Expressed in total changes door-to-door*	0
	≥1
Travel time difference *Expressed in amount of minutes shorter travel by car*	≤10
	20
	≥30
Public transport fares *Expressed in percentage reduction of current fares*	>30
	30-0
	0

Please note that the full version of the survey and can be found in Appendix B.

3.5 Survey Conducting

The survey will be made on the platform of Conjoint.ly, a software which is specialised in conjoint analyses, and sent out through social media and other online platforms to friends, family and other connections. As I have connections in Ghent of many age groups and backgrounds, I assume I will reach a sufficiently varied audience. Conjoint.ly suggests collecting 250 responses for a sufficient analysis, based on the amount of possible combinations of attributes and levels. However, it is unlikely this amount will be reached and I will therefore aim to reach as many responses as possible.

Through the background questions, the target audience will be filtered and further insights will be obtained.

The survey will have a Dutch and English version to reach as many people as possible.

3.6 Survey Results, Analysis and Use of Data

The data will be analysed through a CBC analysis, as explained earlier. This subchapter describes how the results will be used and how the Conjoint.ly tools can be used to give further insights.

3.6.1 General

From the survey results, the McFadden's pseudo-R^2 can be calculated as follows:

$$\mathrm{R}^2_{McF} = 1 - \frac{\ln{(L_M)}}{\ln{(L_0)}}$$

With L_M being the likelihood for the fitted model, and L_0 being the likelihood for the null model. The R^2_{McF}-value indicates the survey report's ability to describe the respondent's answers, based on whether or not the respondents' have a clear preference for features or not (Conjoint.ly, 2022). A high R^2_{McF}-value (ie. above 65%) indicates a strong fit.

3.6.2 Utilities

Conjoint.ly uses Hierarchical Bayesian multinomial logit modelling as a statistical model to estimate 'partworth utilities' for each attribute and level of the individual market offerings (ie. transport modes). These utility scores are a numerical value reflecting to what extent each attribute and level influences the participants' choice. The utilities are calculated as follows (method is taken from conjoint.ly) (Conjoint.ly, 2022).

Attribute utility: this shows the relative importance of each attribute compared to the other attributes.

1. Calculate the individual preference score per level. This is the number of times each level is chosen by the respondents.
2. Calculate the range of preference within each attribute. This is the maximum preference score value – the minimum preference score value of the levels within one attribute per respondent.
3. Calculate the importance ratio for each attribute. This is the range of preference divided by the total sum of all range of preferences for all attributes per respondent.

4. Calculate the average importance. This is the average of all importance ratios per attribute for all respondents.

Level utility: this shows the relative performance of each specific level in influencing the respondents' choice.

1. Calculate the average preference. This is the average preference scores across respondents.
2. Scale the utility to set 0 as average. This is done by subtracting the value for each level from the average of all levels within the same attribute.
3. Scale the utility across each attribute. This is done by dividing the level utility by the overall utility range for all attributes. The overall utility range for all attributes is the sum of the range utility of each level's average utility across respondents for each attribute.

The attribute utility can be used to give insights into how likely each mode of transport is to be chosen by the respondents. This can be helpful for the municipality to see which transport modes can/should be invested in to improve. For example, if the majority chooses bike instead of car, the municipality should invest in bike facilities to optimise bike traffic in terms of flow, safety, etc. On the other hand, it could show that in order to increase the likelihood of choosing public transport, the public transport service should be improved. The level utilities can then give insights into which aspects of public transport are most influential. Furthermore, the level utility will make an analysis of congestion charge pricing possible, by showing which price level is most likely to convince people to choose another mode of transport instead of their car.

3.6.3 Ranked List of Concepts

The 'ranked list of product concepts as preferred by customers' is a list of potential combinations of features and prices that represent product concepts (i.e. specific travel modes). For each travel mode with specific features and price levels, the 'value to customers' is given. This is the average partworth utilities across individual respondent's total partworth utility scores for the combination and scaled with 0 as the average value. (Conjoint.ly, 2022)

This tool will give insights into the general choice of transport mode with specific attributes and levels which is most preferred by the respondents.

3.6.4 Preference Share Simulation

Another analysis tool on the software of Conjoint.ly is the 'preference share simulator', which simulates shares of preference for different market offerings (ie. transport modes).

Using the partworth utilities as explained in the previous section, the relative preference for each alternative can be computed, which then allows the software to estimate the percentages of preferences for each transport mode. Furthermore, by identifying which offerings are currently on the market (eg. current transport modes) through the specific attributes and levels, a new product can be launched (eg. congestion charges for car travel) and a simulation will be made of the redistributed preference shares. This preference share distribution thus shows what % of time people will make a certain travel mode choice, depending on factors such as increasing congestion charge fees. This can, for example, give insights into the sensitivity of travel choices to congestion charge fee levels.

3.6.5 Segmentation

Segmentation allows the comparison of results across different user groups. The user groups can be identified based on the background questions. Each of the above mentioned results can be compared across different user groups. This could give insights into how people with different travel behaviour experience congestion charges, which aspects influence their choices and what their general opinion is. The significance of these difference can be determined using confidence intervals. This will be discussed further in the *Results* chapter.

3.7 Hypotheses

Based on general knowledge and the literature research, some hypotheses for the results can be stated as follows.

- It is expected that the general opinion on congestion charges will be rather negative, especially amongst frequent car users. This trend was shown in the research paper set in Brisbane (Liu & Zheng, 2013) but also in the case studies of London , Stockholm and New York.
- As stated before, people choose car travel over public transport due to convenience reasons (Roads Task Force, 2013). It is therefore expected that travel time difference and number of transfers has the highest attribute utility.
- In terms of level utilities for public transport, it is expected that the lower the time travel difference, number of transfers and fee price, the higher the utilities. This would correspond with an increase in travel convenience.
- For congestion charges, it is expected that the higher the price, the higher the negative utility score (indicating a stronger dispreference). Based on the congestion charge fees in Stockholm and London, it is expected that a fee of €5 would already have a significant dispreference.

4 Results

This section gives an overview, study and analysis of the results of the survey. A more practical discussion will then follow in Chapter 5.

The survey was launched on May 17th, 2022 and terminated after 14 days, on May 31st. In total, 186 people opened the link to the survey. However, only 20 fully completed the survey and 38 completed the survey but were marked as “low quality” responses because they took too short to answer certain questions. However, these will still be included in the analysis, as the short response time might be due to, for example, the fact that the respondent has already decided to always take the bike as transport mode and therefore did not look through the details of other transport modes. This group is still a significant user group so should be included in the analysis. A total of 58 responses will thus be included in the survey. This is a rather small sample size, which might affect the reliability of these results. A critical analysis will follow in the *Discussion*.

The survey has a R^2_{McF}-value of 83.1%, indicating a strong fit. This means that the survey report is a strong description of the respondent’s answers and could therefore be predicted with a 83.1% accuracy (Conjoint.ly, 2022).

4.1 General Results and Descriptive Analysis

This section includes a general overview of how each question in section 2 and 3 was answered. A full overview of all responses can be found in Appendix C.

4.1.1 Section 2: Background

These answers are compared to the general population and demographics of Ghent, as found on the database “Gent in cijfers” (translation: “Ghent in numbers”) published by Stad Gent. This is done to identify possible bias in the survey results.

Age

The age diversity of the survey shows significant bias. The figures 2 and 3 show the survey response and the actual age diversity in the city of Ghent. This comparison shows there is a strong bias from the 18-30 years old group, which is much larger than the actual percentage of 16.4% in the general population.

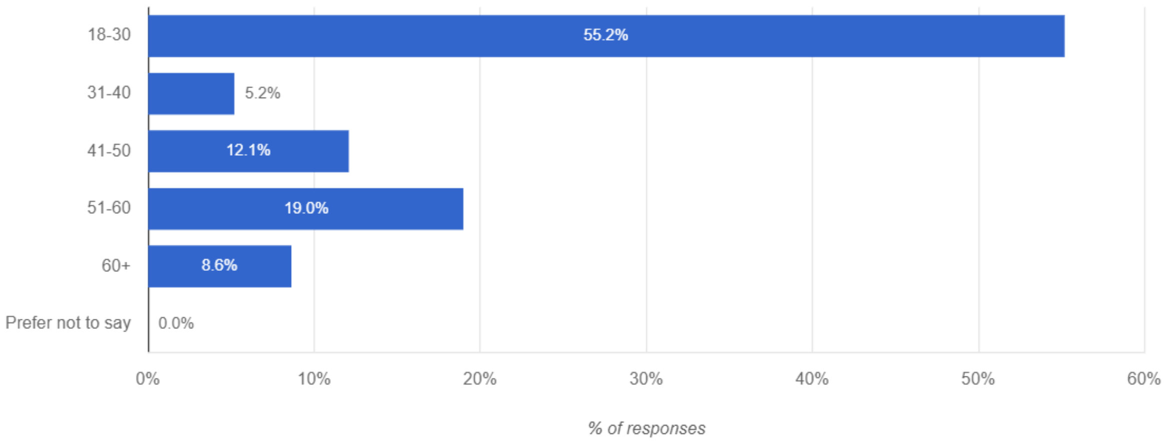

Figure 2: Survey response to age group

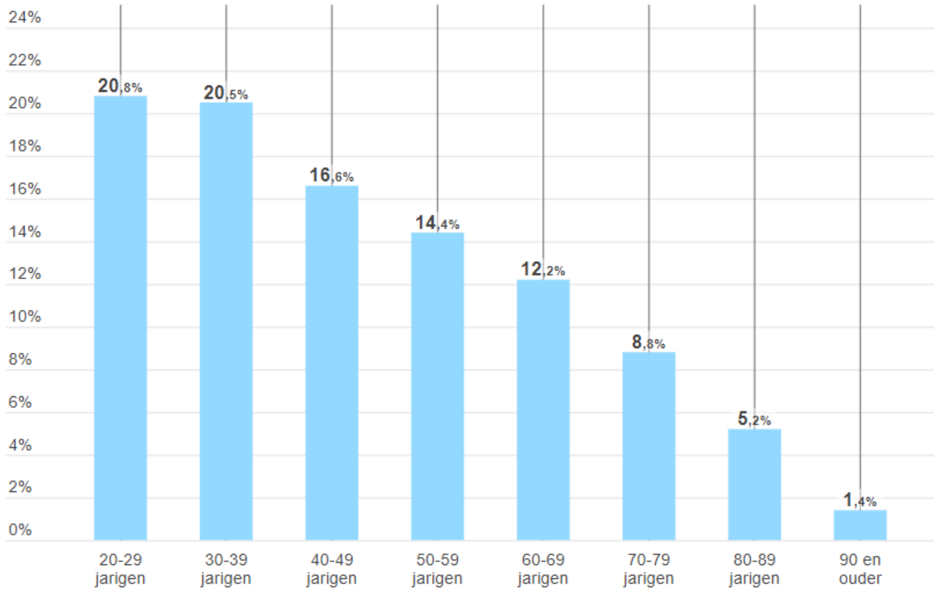

Figure 3: Age diversity in Ghent (Stad Gent, 2021)

Employment

The percentage of Ghent citizens employed between 20 and 64 years is 72% (provincies.incijfers.be, 2021). Furthermore, Ghent counts around 70,000 students and around 150,000 citizens between the age of 20 and 70, indicating a student percentage of around 50%. In the survey, 36.2% answered to be student and 48.3% indicated to be employed. Considering the survey did not have an age limit, this employment diversity is not significantly biased.

Modal Split

The most used transport mode indicated in the survey is representative with the actual modal split in Ghent and thus there is no bias in the survey (Stad Gent, 2017). The answers from the survey showed that the majority of respondents usually travel to Ghent by bike (43.1%) or by car (41.4%).

Origin of Travel

The most common regions of origin of people travelling to Ghent could not be found on the demographic website of Ghent. However, the majority of respondents travel from Ghent centre (20.7%), Mariakerke (22.4%) or answered 'None of the above' (25.9%). The high number for 'Mariakerke' is expected to be a bias, as most of my family and friends come from this municipality.

Reason for Travel

The most frequent reason for travelling is representative to the actual motives of travel to and within Ghent (Stad Gent, 2017), with the majority of survey respondents travelling for work/studies (41.4%) and recreational purposes (39.7%).

4.1.2 Section 3: General Opinion

In this section, the respondents were asked to what extend they agree with certain statements. The scores go from 1 to 5, corresponding to strongly disagree to strongly agree respectively. In general, the majority of respondents have a positive attitude towards the potential positive effects of implementing congestion charges. This is reflected in the average mean score of 3.8/5 for the following statements: "The revenue from congestion charges should be used to improve the environment", "Congestion charges will reduce traffic congestion" and "Congestion charges would make me bike or use public transport more often". However, the opinion about possible negative effects are more varied. The average mean result for the statements "The existing public transport systems can cope with increased passenger volume", "Congestion charges will have a negative impact on the economy" and "Congestion charges makes the city a less attractive option to work" is 2.7/5.

Please note again that a full overview of all responses can be found in Appendix C.

4.2 CBC Analysis

4.2.1 Utilities

This section shows the relative importance of each attribute and level, which indicates which aspects people value most when making a travel mode choice. Firstly, the attribute utility for public transport gives the results as shown in the figure below. These were calculated as indicated in the *Methodology* chapter.

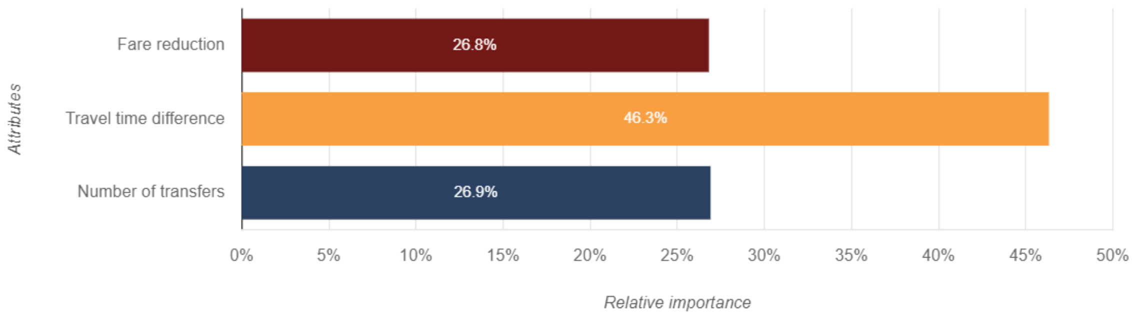

Figure 4: Attribute Utility for Public Transport

The attribute utility reflects how important each attribute is relative to the other attributes, across consumers (considering that each consumer values different product attributes) (Conjoint.ly, 2022). Therefore, it can be seen that the respondents put highest importance in the travel time difference between car and public transport when choosing public transport as travel mode. Furthermore, fare reduction and number of transfers are valued equally.

To determine which travel time difference has the highest impact, the level utilities have to be considered. How these are calculated is also explained in the chapter *Methodology*. The values are centred around 0 with high positive values meaning high preference and high negative values meaning high dispreference. The level utilities therefore reflect which level the average consumer prefers. (Conjoint.ly, 2022) Attribute utilities already showed that travel time difference is considered important. The figure below shows the various levels and their utilities of this attribute.

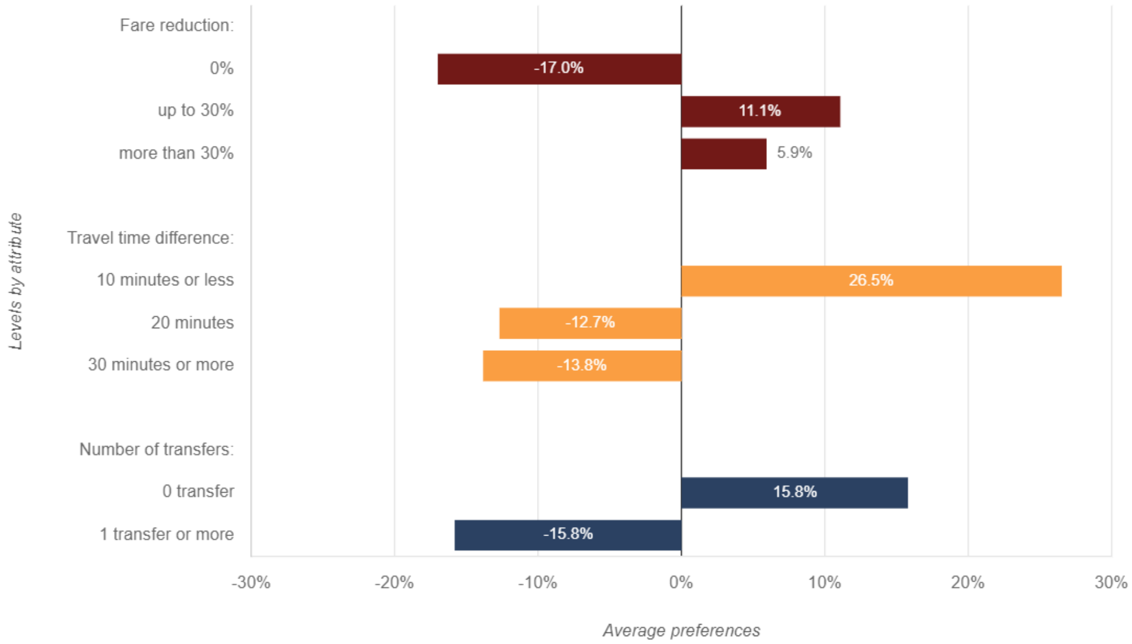

Figure 5: Level Utilities for Public Transport

From the level utilities in the figure above, it can be seen that a time difference of 10 minutes or less has the highest importance in influencing people to choose public transport, showing that people value a small time difference strongly. Secondly, the results for fare reduction are somewhat unexpected (as people value a higher fare reduction less than a lower one) but could be interpreted that people have a tendency to not choose public transport due the current fares (and thus a fare reduction of 0%). Lastly, the levels for number of transfers shows an expected result, as no transfers has a high utility compared to multiple transfers.

Furthermore, the level utilities for the congestion charges are as follows.

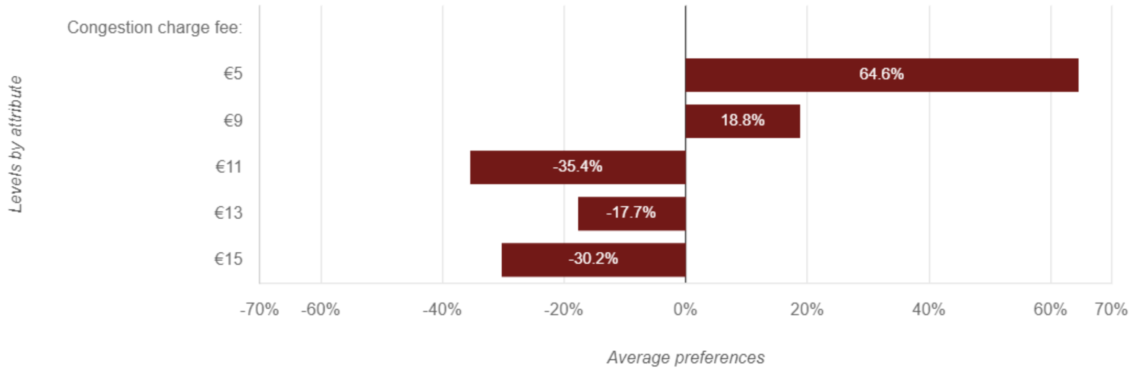

Figure 6: Level Utilities for Congestion Charges

This shows that people prefer to choose car travel when the charge is only €5 or €9. The remaining results are somewhat unexpected, as it indicates people have a stronger dispreference for €11 than €13 or €15. The results thus show that from €11 onwards, people have a stronger tendency not to choose car travel, whereas a fee of €13 or €15 would not cause even more people to not choose car travel. Therefore, a charge of €11 would be sufficient to convince as many people as possible to choose other transport modes.

4.2.2 Ranked List of Concepts

Furthermore, the ranked list of product constructs shows the top 5 most preferred options from all combinations, based on the relative importance of the levels and attributes.

Travel mode	Congestion charge fee	Travel time difference	Fare reduction	Number of transfers	Value to customers	Rank
Bike	N/A	N/A	N/A	N/A	60.6	1
Car	€5	N/A	N/A	N/A	50.2	2
Public transport	N/A	10 minutes or less	up to 30%	0 transfer	46.3	3
Public transport	N/A	10 minutes or less	more than 30%	0 transfer	41.6	4
Public transport	N/A	10 minutes or less	0%	0 transfer	20.1	5

Figure 7: Ranked List of Concepts

This shows that bike travel is the most valued mode of transportation. Secondly, the list shows that a congestion charge fee of €5 has no significant influence on people's choice of transport, as it is still the second-highest ranked concept. Furthermore, the list shows that public transport is the third-most preferred transport mode, with a travel time difference of 10 minutes or less and 0 transfers. This importance of a low travel time difference corresponds to findings from the level utilities.

4.2.3 Preference Share Simulation

The preference shares indicate the relative preference of choice for each transport mode. Through Conjoint.ly, these can be simulated for new market goods. In this case, car travel with congestion charges was considered a new market good, while 'bike', 'public transport' and 'I will not travel at all' were set as competitor goods. For the public transport attributes and levels, fare reduction was configured to 0%, number of transfers was configured to at least 1 transfer and the travel time difference was set to 20 minutes. These configurations were made to sketch the current situation of public transport. The preference shares indicate what % of time a particular transport mode would be chosen. (Conjoint.ly, 2022)

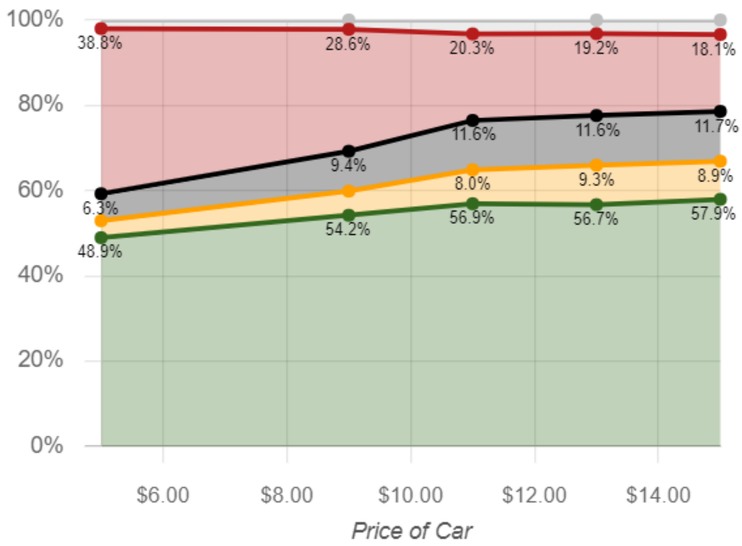

Figure 8: Preference Shares - Sensitivity to Congestion Charge Fees

Note: The prices on the Y-axis should be in € instead of $. The values correspond to (from top to bottom): '**None of the above**', '**Car**', '**I will not travel at all**', '**Public transport**' and '**Bike**'.

From the figure above, it can be seen that the biggest change in travel behaviour occurs between a €5 and €11 congestion charge fee. As prices for car travel rise, there is a rise in people choosing not to travel at all, to travel by public transport or by bike and less people will choose for car travel. Between a €5 and €11 charge, the % of time people choose for car travel declines from 38.8% to 20.3%. The importance of an €11 charge corresponds to the findings from the level utilities. A charge of €15 versus €11, however, does not make a significant difference in travel behaviour. It should be noted that the largest decline in car travel is due to a rise in people who choose to not travel at all. This can have a negative impact on the city's economy.

From the utilities for public transport, it was seen that the travel time difference has the highest attribute utility. Therefore, the travel time difference is now set as a variable, with congestion charge configured to €11 (as this value led to the most significant difference) and the other public transport attributes kept as 0% fare reduction and 1 transfer or more.

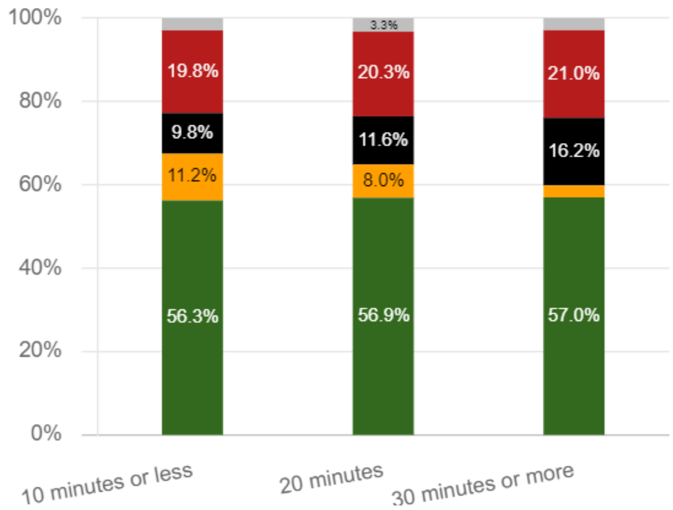

Figure 9: Preference Shares - Sensitivity to Travel Time Difference

Now, it can be seen that the amount of people choosing not to travel can be reduced by reducing the travel time difference. A similar, but less strong, trend is seen when fare reduction and number of transfers are used as variables. This indicates that the efficiency of public transport has a large share in affecting people's choice of travel mode. This is an expected outcome and reflects the findings of previous studies (Liu & Zheng, 2013). More about this result will be discussed in the subchapter *Discussion*.

4.3 Segmentation Frequent Car Users

Secondly, the results were segmented to identify several user groups and analyse how these user groups might have different travel behaviour from other groups. A significant difference was seen for the results of frequent car travellers. This is also the main target group for congestion charges, so their results should be studied in-depth.

The significance of the differences was determined by the confidence interval and level. The confidence level was put at 90%. The confidence interval is then determined so that there is a 90% probability that the confidence interval contains the true population (Conjoint.ly, 2022). If both values for the sample group of car users and other users fall outside the confidence interval of the total sample, the difference is considered significant. Below, these significantly different results are discussed.

The group which indicated to travel to the city most frequently by car consists of 41% of all respondents. For the area of origin, 45.8% of this groups answered ‘None of the above’, which is significantly higher than the general population and non-frequent car users. This could indicate that this group has to come from further to travel to Ghent, which could explain their tendency to choose car travel.

Furthermore, frequent car users tend to have a more negative attitude towards congestion charges. They answered significantly different to the statement: “The congestion charge would make me bike or use public transport more often for travelling to the city”, with a mean value of 2.5 compared to 4.0 for non-frequent car users and 3.4 for the total sample. This means car users are less likely to change their travel mode, which is an expected result and correlates with the results from previous studies (Liu & Zheng, 2013). Frequent car users also agree significantly more to the statement: “Working in the city would be a less attractive option to me because of a congestion charge”, with a mean value of 3.5 compared to 2.0 for non-frequent car users and 2.6 for the total sample.

In general, this group is less likely to change their transport mode, and instead is more likely to continue travelling by car. More specifically, the level utilities for congestion charge show that for a fee of €9, this user group has a significantly higher preference for car travel than the general results. However, from €11 upwards, there seems to be a similar dispreference for car travel, except a significantly higher dispreference for €13. This can be seen in the figure below. From this, it can be concluded that a charge of €9 would be less sufficient in changing travel mode choice for car users than for the other users. However, similarly to the general results, a charge of €11 would be sufficient.

Attribute	Level	All responses (N = 58)	Car Users (N = 24)
Congestion charge fee	€5	64.6%	65.0%
Congestion charge fee	€9	18.8%	31.3%
Congestion charge fee	€11	-35.4%	-31.2%
Congestion charge fee	€13	-17.7%	-30.0%
Congestion charge fee	€15	-30.2%	-35.0%

Figure 10: Level Utility for Congestion Charges - All responses vs. Car users

Furthermore, car travellers' Ranked List of Concepts shows that their first two preferred transport modes is still car travel with a congestion charge of up to €9. This correlates with the previous finding that a charge of €9 would not be sufficient to convince car users to change travel behaviour. Furthermore, the option of bike travel only ranks on the 16th place, compared to the first place for the general results. Instead, this group tends to choose more for public transport as alternative mode, considering a time travel difference of less than 10 minutes or 20 minutes. This is most likely due to the further zone of origin – and thus larger travel distance - of this group, which explains why bike travel might not be selected as mode of transport. This group is therefore reliant on public transport as alternative mode.

Travel mode	Congestion charge fee	Travel time difference	Fare reduction	Number of transfers	Value to customers	Rank
Car	€5	N/A	N/A	N/A	53.3	1
Car	€9	N/A	N/A	N/A	36.2	2
Public transport	N/A	10 minutes or less	up to 30%	0 transfer	33.8	3
Public transport	N/A	10 minutes or less	more than 30%	0 transfer	29.7	4
Public transport	N/A	20 minutes	up to 30%	0 transfer	15.4	5

Figure 11: Ranked List of Concepts - Car Users

5 Analysis and Conclusion

This chapter aims to give an in-depth analysis of the research method, the found data and how it can be interpreted. The research method and results are first discussed, after which a conclusion follows and further recommendations for future research.

5.2 Discussion

5.2.1 General

As mentioned before, based on the number of possible combinations of levels and attributes, Conjoint.ly recommended a total of 250 respondents. However, the survey only achieved a rather small sample size of 58 responses. From the drop-off report of respondents, it could be seen that 17 people quit the survey when they reached the CBC block. Some feedback from respondents indicated that they didn't realise the levels changed for each CBC question and thus thought that the survey got stuck on one question, leading them to quit the survey.

Furthermore, the survey showed a strong bias in age group, with most respondents being in the 18-30 age group. This might be because the survey was spread through social media platforms, which might be more accessible to younger audiences. There was also a bias in zone of origin, as the majority of respondents indicated to travel from Mariakerke, which is where I come from and thus indicates I disproportionally reached people from my close circle. However, the other background and demographic aspects did not show any significant bias and reflected the true population rather well. Either way, the results should be analysed critically, as the bias and small sample size might affect the accuracy and validity of the results.

The limitations stated above will be further discussed in the *Recommendations* chapter, which will indicate strategies to reduce these limitations in future research.

5.2.2 Car Reduction Strategies

The results of the survey gave some important insights in car reduction strategies for the city of Ghent. First of all, it was unexpected that the general sample population responded rather positively towards the implementation of congestion charges. From the literature study on the case studies of London, Stockholm and New York, it could be seen that the general attitude is usually sceptical and negative at first. This difference could be explained by the following characteristics of the small sample:

- The majority of respondents already uses the bike as main travel mode. This might indicate that this group is already making travel choices to avoid using car travel and thus more in favour of car reduction strategies.

- Although the respondents were not asked about their income, it can be assumed that the majority is of middle class and therefore less 'bothered' by additional congestion charges fees. Certain socio-economic groups might be more reliant on their car for transport and less able to pay additional charges, which would be reflected in a more negative attitude towards congestion charges.

However, similarly to the findings of the literature study, people who indicate to usually travel by car also had a more negative attitude towards congestion charges.

5.2.1 Congestion Charge Fee

As seen from the level utilities, a congestion charge fee of €11 has the largest effect in convincing people not to travel by car. A higher charge has similar effect and therefore does not need to be implemented to reach even more car travellers. Therefore, a charge of €11 is suggested. However, a higher charge would lead to a higher revenue for the municipality, which could be invested in financing the implementation of the congestion charge strategy and other beneficiary purposes. The need for higher charges should be investigated through a cost-benefit analysis, which goes beyond the scope of this report.

It is notable that the fee of €11 is rather high, considering the fees in London and Stockholm are €17.85 and €6.31 respectively. Ghent is a much smaller city than London and Stockholm and therefore lower charges would be expected. This unexpected result might again be explained by the biased middle-class survey sample, which can afford higher charges than the general population.

5.2.2 Importance of Bike Transport

From the Ranked List of Concepts, it could be seen that the majority of respondents chose bike travel as mode of transport when congestion charges were introduced. This shows that bike travel is a competent mode of transport and should therefore be stimulated as much as possible. Therefore, the municipality could invest further in optimising bike travel by improving bike routes, safety and convenience. This could be done by introducing and extending bike infrastructure, rewards and sharing services.

However, it should be noted that the majority (43.1%) of respondents already indicated bike as their most frequently used travel mode. This would have influenced later responses, as these users are already less likely to choose car travel and always opt for bike travel. This high number of frequent bike users also reflects the bias in age group. Most respondents were in the age group of 18-30 years old, which includes students and young workers for who bike travel is relatively more accessible. The older population might be less able to use bike transport due to physical limitations and might therefore be more dependent on car travel. Therefore, it is important to look at the group of respondents who usually choose car travel. This group will be discussed in the next section.

5.2.3 Public Transport as Alternative Mode

Frequent car users were significantly less likely to choose bike as alternative transport mode. Instead, they continue to prefer car travel up to a charge of €9. From a charge of €11 and above, they tend to choose public transport as alternative mode. This is most likely because their travel distance is too far to bike or walk. Therefore, public transport options have to be optimised for this group to consider travel by public transport as a valuable option. From the attribute and level utilities, it can be seen that the travel time difference between car and public transport needs to be maximum 20 minutes and/or the congestion charges need to be minimum €11 to convince this group to choose public transport.

Furthermore, from the total sample and share of preferences it could also be concluded that a reduction in travel time for public transport could convince people to choose public transport. This would be particularly valuable to avoid people no longer travelling at all when the congestion charges are introduced.

In general, it can be seen that a low travel time difference is highly important and could potentially increase the amount of people choosing public transport instead of car travel. How this can be achieved goes beyond the scope of this report. However, some suggestions are to increase the frequency, reliability, convenience and number of alternatives of public transport.

5.4 Conclusion

This report aimed to research car reduction strategies in Ghent with the focus on the implementation of congestion charges and adaptation of alternative modes such a public transport. This was done through CBC survey analysis on the Conjoint.ly software platform. This method proved successful, as many and in-depth results were gathered which gave significant insights into congestion charges and travel behaviour.

More specifically, this thesis aimed to answer the following research question: “How can congestion charges be implemented and alternative transport modes adapted to reduce private car traffic in the centre of Ghent?”

From the results, it can be generally concluded that the implementation of congestion charges could be successful in reducing car traffic as the general sentiment towards the systems are rather positive. Although the response to congestion charges was expected to be rather negative, the majority of respondents seemed to be in favour of congestion charges and the positive effects it could have. However, it was notable that people who usually travel by car showed less confidence in the positive potential of congestion charges and had a more negative attitude towards the implementation.

A minimum fee of €11 would have to be charged to convince people not to take their car. A further increase seems unnecessary, as it does not increase the likelihood of people choosing other transport modes. Furthermore, a lower price does not convince people enough to change their travel behaviour.

Furthermore, it was seen that bike travel was the most chosen alternative for the general results, whereas car users chose for public transport as alternative mode. For either groups, a smaller time difference of preferably 10 minutes or less seemed to be the most convincing aspect to opt for public transport.

However, it should be stresses that a mere 58 respondents were gathered, which might limit the validity of the results and the ability of the analysis to reflect the true travel behaviour of the full population. More specifically, a notable bias in terms of age, socio-economic status and travel origin has to be taken into consideration when analysing and interpreting the findings of this study.

5.3 Recommendations

As mentioned before, this research shows some flaws which could influence the validity of the results. The recommendations below reflect how these flaws could be addressed in future research.

- The survey should be spread more on various channels in order to receive a higher number of responses and a higher diversity of respondents, which better reflects the true population. As mentioned before, the survey results contain an age- and socio-economic bias. This can be avoided by spreading the survey through various types of channels (not only social media) with a wider range (not only my own social circles).
- Many (17) people quit the survey when they reached the CBC block due to confusion. The survey should thus be better designed to give clear instructions and questions. This could decrease the number of quitting respondents and thus increase the total amount of responses.
- The survey could be more specific in terms of travel scenarios and choices, which would be more tailored to the individual respondent's travel behaviour. In this way, the scenarios would be as realistic as possible, allowing responses to be more representative of the real world.

Furthermore, complementary to this research, the list below gives ideas on which aspects can be further researched in the future, in order to extend the knowledge of this topic.

- Investigate different methods of implementing congestion charges, such as charging when entering the city, charging different fees during peak hours, a payment systems through (monthly) subscriptions, etc. Which one would be more effective? What are people's opinions on each type?
- Investigate the logistics of introducing congestion charges. This could be done through a cost-benefit analysis and could help to determine how much needs to be charged minimum to still make profit which could be re-invested in urban mobility and other purposes.
- Investigate other points of view. What do politicians and urban planners in Ghent think?
- More in-depth study of current car users. What are their motives, why and when do they choose for car travel? What is their specific point of origin and how are public transport options between this trajectory? How could these alternative modes be adapted to decrease car use?
- Further research on how the lessons from this paper can be implemented in the city. What are the possibilities of adjusting public transport to decrease travel time? How can bike facilities be optimised?

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Appendix A
Personal Motivation

The research of this topics stems from a personal interest in how urban areas deal with fast growing populations and pressing climate change threats. Growing up and living in cities of varying scales such as Ghent, London, Delft an Stockholm, I have been confronted with various types of cities and have personally experienced the effect of different approaches towards making cities more robust. In particular, I have developed an interest in urban mobility and transport and therefore wanted to explore this topic through my bachelor thesis. Furthermore, I aim to continue expanding my academic knowledge by pursuing a master's degree in Urban Mobility, for which this bachelor's thesis will lay a great foundation.

More specifically, I have lived in London for four years and spent the fifth semester of my BSc at KTH in Stockholm, two of the cities in Europe which have established congestion charges to limit the amount of private cars in the city centre. Furthermore, I have grown up in Ghent in Belgium and have seen how the city has expressed its motivation to become more sustainable and robust and how it has tackled mobility issues over the years. I therefore was intrigued in researching how the strategy of congestion charges could be applied in my own home town, Ghent.

Appendix B Survey

This appendix contains the full English version of the survey.

Request statement

Dear friends, family and network,

I am researching the possibility of implementing congestion charges in the city of Gent for my Bachelor thesis. For this, I am collecting data through a short survey. Would you please fill this in as soon as possible? It will take less than 10 minutes and would be very valuable for my research.

You can fill in the survey by clicking on the following link:
https://run.conjoint.ly/study/267859/twfddwxi9v

(You can complete the survey through smartphone and pc)

Feel free to share. Thank you in advance for your help.

Edith

Survey

Section 1: Opening Statement

Welcome to this study. It will require less than 10 minutes of your time. We appreciate your participation.

This survey is set up as part of the research for a Bachelor's Thesis at Delft University of Technology. The aim is to investigate the plausibility of introducing congestion charges in the city of Ghent. More on congestion charges and the specifics can be found below.

The information gathered from this survey is strictly anonymous.

For questions or concerns, please contact Edith Goderis on the following email address: E.E.L.goderis@student.tudelft.nl

Congestion charge is used as a tool to relieve urban areas from congestion by discouraging the use of private vehicles and encouraging the choice for other transport modes. This is done by charging people when entering certain areas by private car. Congestion charges work on the principle that the amount paid by the private vehicle traveller is a way to 'pay back' for the induced negative effects. (Liu & Zheng, 2013) Furthermore, benefits include the reduction of traffic congestion, revenue increase, transit ridership increase, improved transit service, travel time savings and other environmental and public health improvements (Liu & Zheng, 2013).

Appendix B
Survey

Section 2: Background

Question	*Answer choices*
1. How many times a month do you travel to Ghent on average?	Once or less 2-4 5-8 More than 8
2. What is your age?	18-30 31-40 41-50 51-60 60+ Prefer not to say
3. What is your employment status	Student Working Retired Prefer not to say
4. What is your most used transport mode to the city?	Walk Bike Car Public transport Other
5. What is your most common origin zone when travelling to Ghent?	Gent centre, Mariakerke, Drongen, Wondelgem, Sint-Amandsberg, Oostakker, Desteldonk / Mendonk / Sint-Kruis-Winkel, Gentbrugge, Ledeberg, Afsnee, Sint-Denijs-Westrem, Zwijnaarde, Lochristi, Destelbergen, Merelbeke, Sint-Martens-Latem, Deinze, Nevele Other
6. What would be your main reason for travelling to Ghent by car?	Commute (eg. study or work) Recreation (eg. sports) Functional (eg. doctor) Other

Section 3: General Opinion

The following questions were asked (Liu & Zheng, 2013):

- Revenue raised from implementing congestion charges should be used to improve the environment.
- Implementing a congestion charge can help reduce traffic congestion.
- The existing public transport systems can cope with the increased volume of passengers caused by implementing the congestion charge.
- The congestion charge would make me use public transport more often for travelling to the city.
- Implementing a congestion charge is not good for the economy because people would travel to the city less frequently.
- Working in the city would be a less attractive option to me because of a congestion charge.

For each question, the respondents could choose on a 5-step scale from strongly disagree to strongly agree.

Section 4: CBC Block

The respondents were introduced to the CBC part of the survey through the following statement.

Now imagine congestion charges are implemented, which means you will have to pay when entering the city of Ghent by car. Assume your most usual trip trajectory and reason for travelling to Ghent. You will be asked which transport mode you prefer, based on varying specifics per transport mode.

Please note the following remarks.

- You may assume there are no changes in how you travel by car (current gas prices, parking prices, available routes, etc.), except for the additional congestion charge.
- The congestion charge fees are charged per day, upon entering the indicated city centre zone between 7:00 and 18:00 on weekdays and between 12:00 and 18:00 on weekends and holidays.
- The city centre zone in which you will be charged lies within the R40.

Appendix B
Survey

You will have the choice between the following transport modes:

- By car
    - with varying congestion charge fees expressed in € per trip per vehicle.
- By bike
    - assume your currently available bike options, routes and travel time.
- By public transport
    - with varying number of transfers, expressed in total transfers door-to-door.
    - with varying travel time difference, expressed in amount of minutes longer travel than by car.
    - with varying public transport fares, expressed in percentage reduction of current fares.
- To not travel at all
- Other

The respondents were then repeatedly presented with various choice tasks. The choice task could look like the example below. Each participant had to answer 12 choice tasks, each time with a different combination of levels for each attribute. These were randomly assigned by the software of conjoint.ly and varied per respondent.

Which of the following travel modes would you choose?

Travel mode	Bike	Car	I will not travel at all	Public transport	None of the above
Congestion charge fee	N/A	€11	N/A	N/A	
Fare reduction	N/A	N/A	N/A	more than 30%	
Travel time difference	N/A	N/A	N/A	10 minutes or less	
Number of transfers	N/A	N/A	N/A	0 transfer	

Go back

Figure 12: Example Choice Task

Section 5: Final Remarks

Would you like to share any other thoughts?

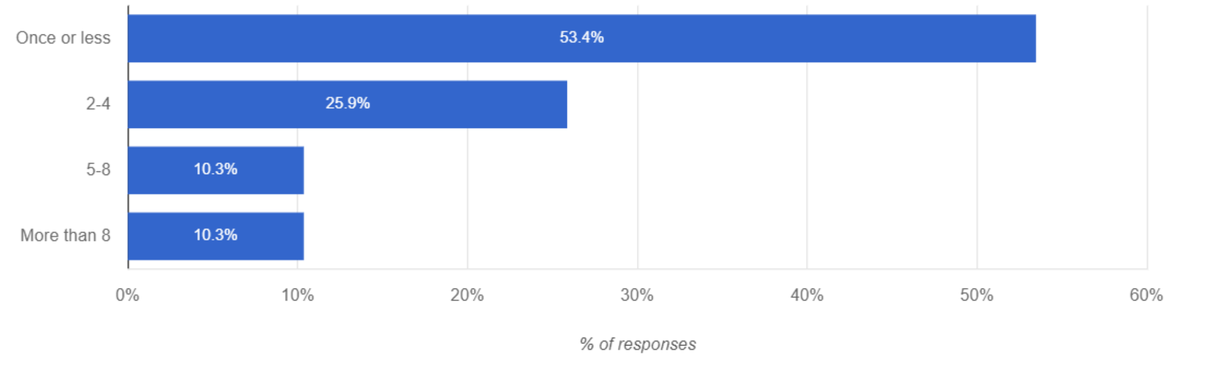
Appendix C
General Results

Section 2: Background

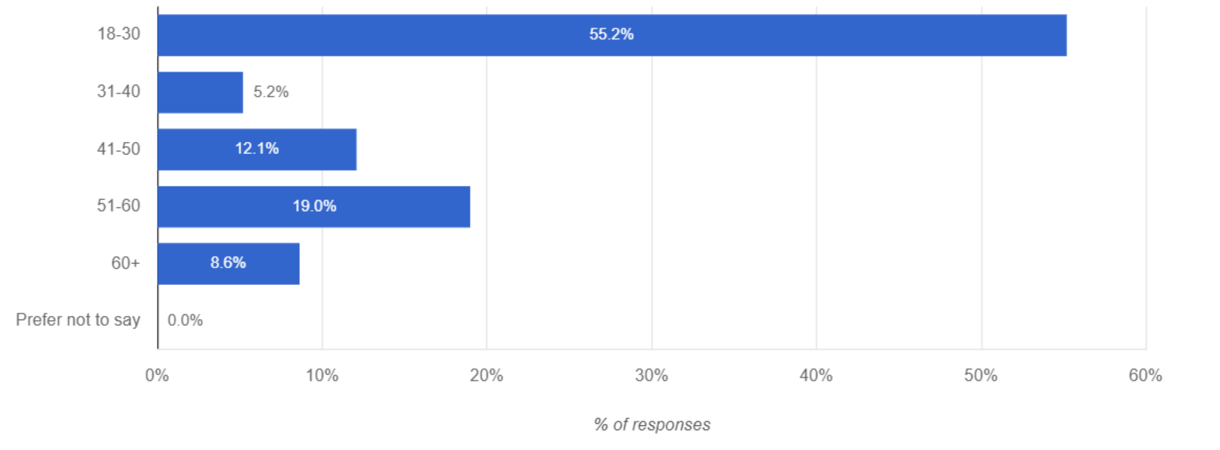
The table below gives a general overview of how each question in section 1 was answered.

Table 6: General responses section 2

1. How many times a month do you travel to Ghent on average?

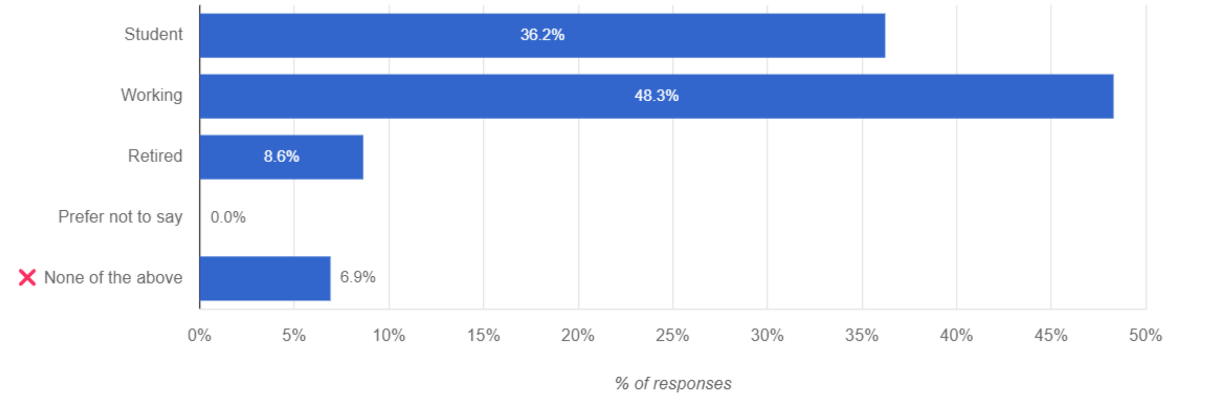


2. What is your age?

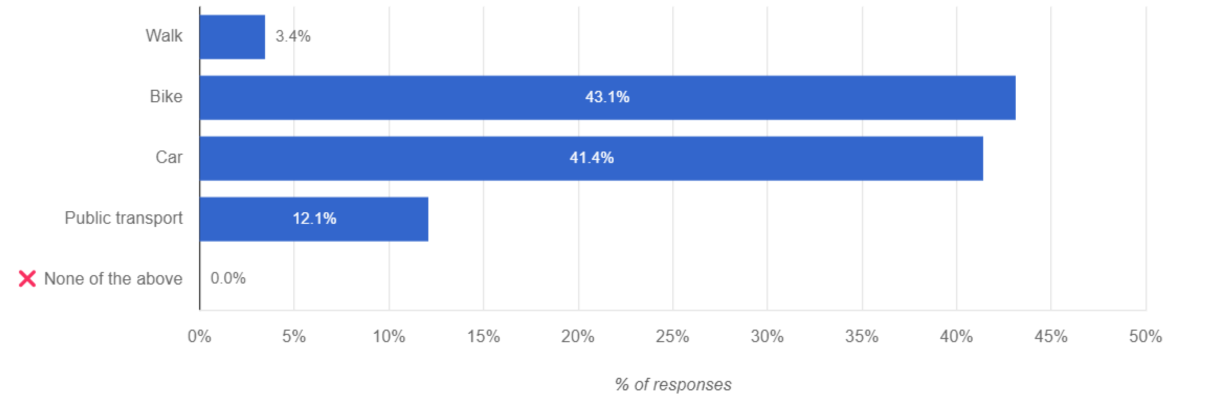


Appendix C
General Results

3. What is your employment status

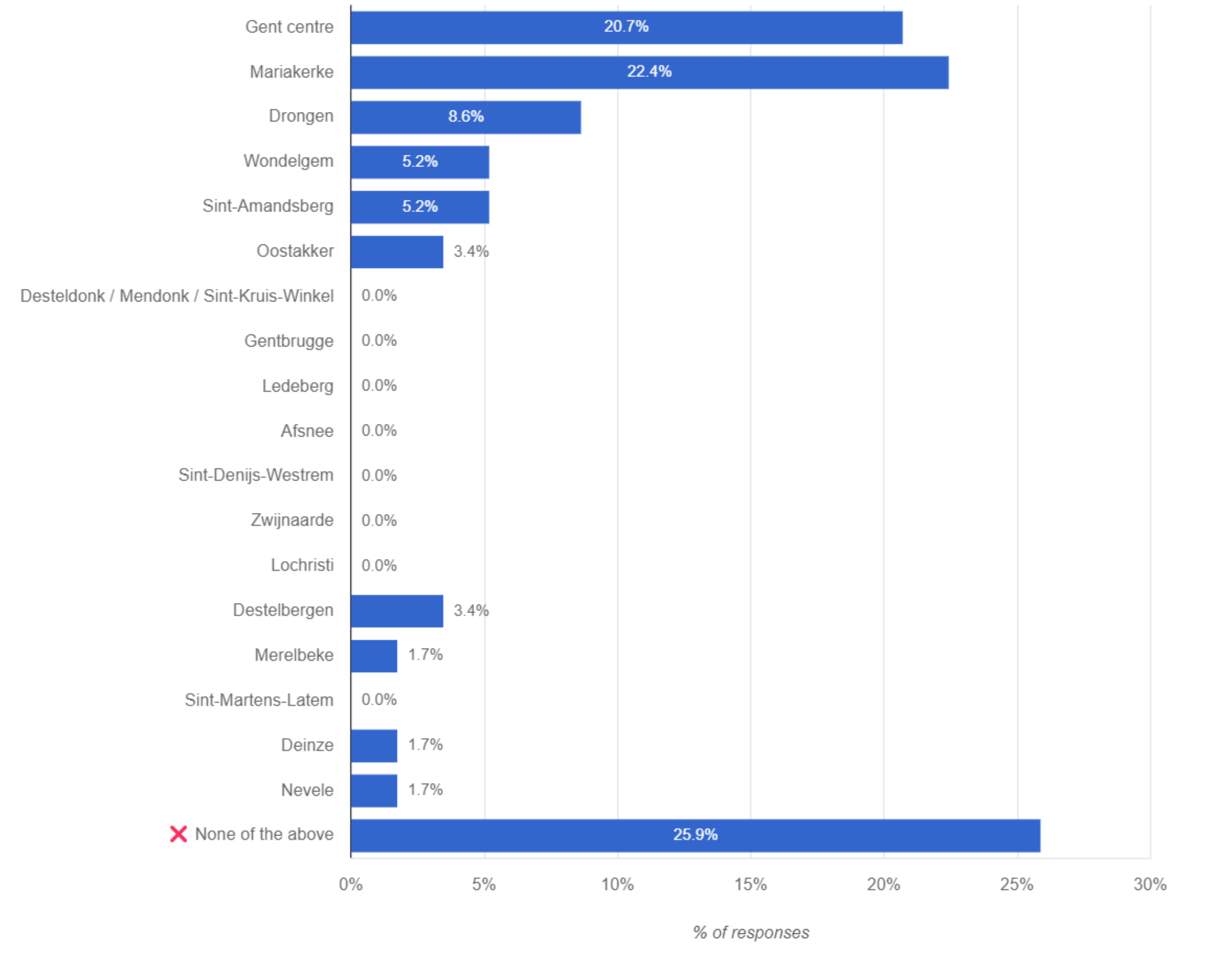


4. What is your most used transport mode to the city?

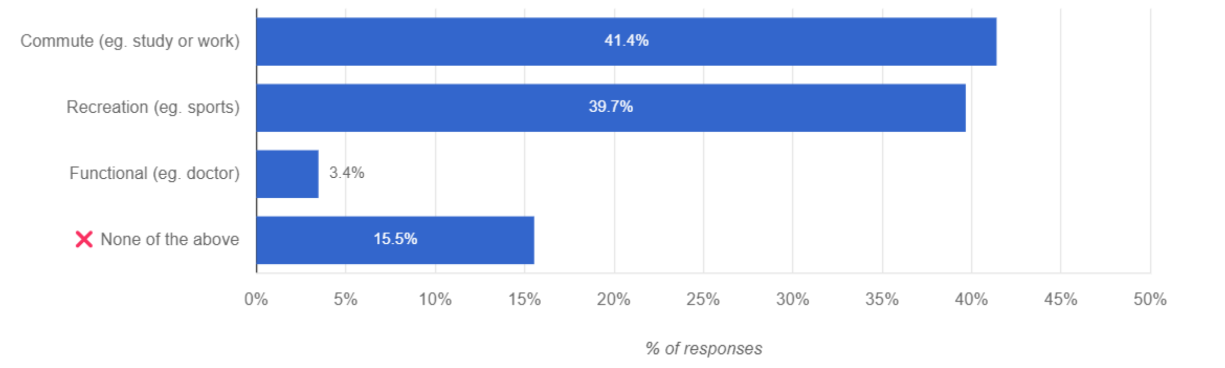


Appendix C
General Results

5. What is your most common origin zone when travelling to Ghent?



6. What would be your main reason for travelling to Ghent by car?

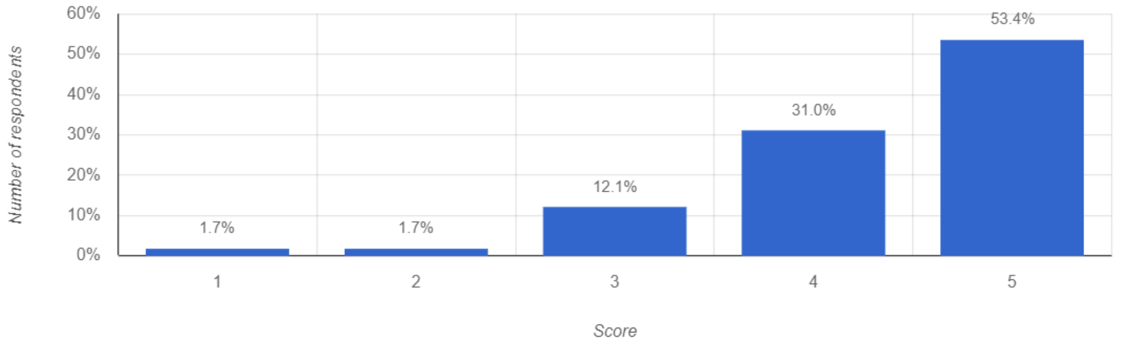


Section 3: General Opinion

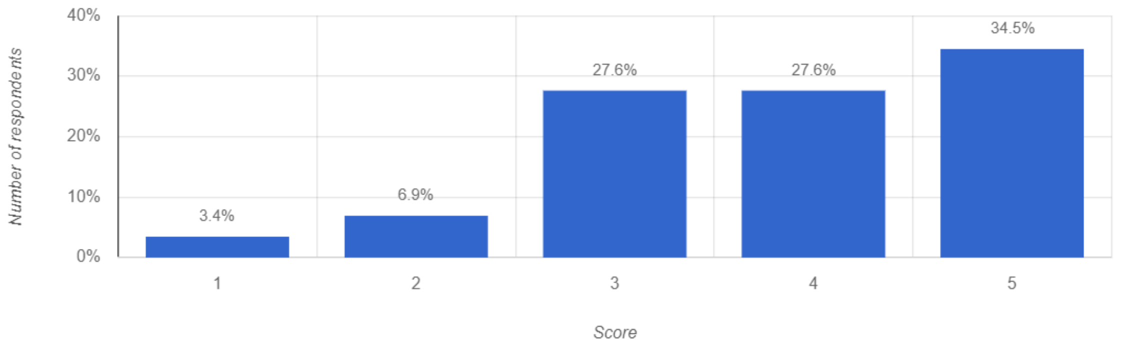
The table below shows the general overview of how each question in section 2 was answered. Note: the scores 1 to 5 correspond to strongly disagree to strongly agree respectively.

Table 7: General responses section 3

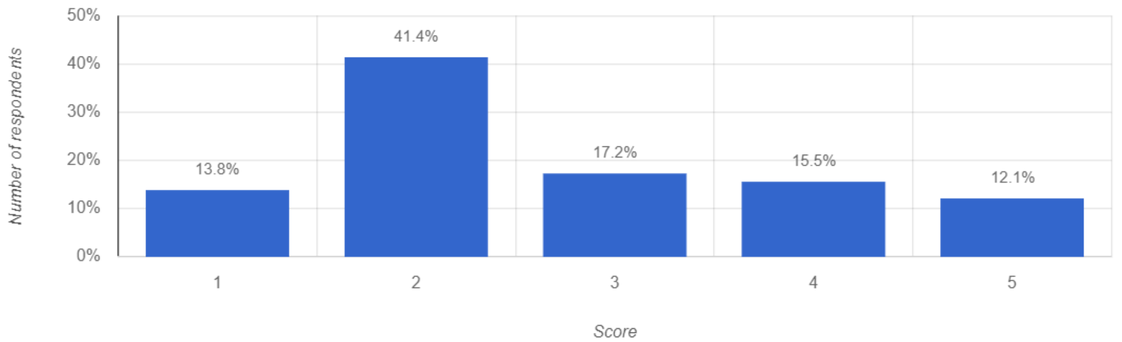
1. Revenue raised from implementing congestion charges should be used to improve the environment.



2. Implementing a congestion charge can help reduce traffic congestion.

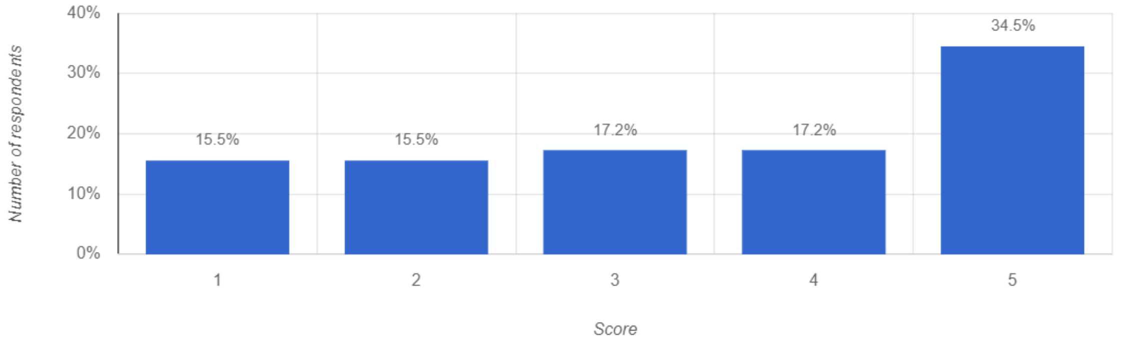


3. The existing public transport systems can cope with the increased volume of passengers caused by implementing the congestion charge.

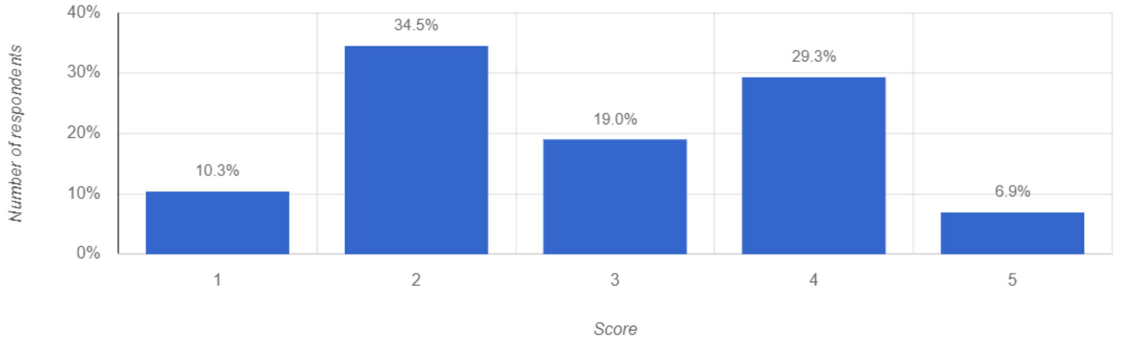


Appendix C
General Results

4. The congestion charge would make me use public transport more often for travelling to the city.



5. Implementing a congestion charge is not good for the economy because people would travel to the city less frequently.



6. Working in the city would be a less attractive option to me because of a congestion charge.